

Nordisk Selskap For Strålevern, det 11te ordinære møtet

Det Syvende Nordiske Radioøkologi Seminar

26. - 29. august 1996 Reykjavík, Ísland



General information	1
Program	2
 Abstracts:	
Monday 26 Aug	3
 Tuesday 27 Aug	
NKS Session 1	4
 NKS Session 2	5
 Medical use of radiation. Effects of radiation	6
 Domestic and workplace exposure	7
 Wednesday 28 Aug	
Limnic / Terrestrial radioe.	
Internal rad. and dosimetry	8
 Terrestrial radioecology	
Rad. waste. Non-ionizing r.	9
 Terrestrial radioecology	10
 Thursday 29 Aug	
Marine radioecology	11
 Emergency preparedness 1	
 Emergency preparedness 2	12
 Various aspects of radiation protection. Closing session	13
 List of Participants	14
	15

General information

On arrival in Iceland

"Get together party" Sunday from 19:00 - 21:00 at Mánaberg, Lágmúli 4. Buses depart from Scandic Hotel Loftleiðir at 18:50 and 19:00.

Conference venue

All sessions will be held at Scandic Hotel Loftleiðir.

Conference language

Official language of the conference is Scandinavian or English.

Registration and information

The Conference Secretariat and registration desk will be open for registration and information:

Sunday , August 25	16:00 - 19:00
Monday, August 26	08:00 - 14:00
Tuesday, August 27	12:30 - 14:00
Wednesday, August 28	12:15 - 13:30
Thursday, August 29	12:15 - 13:45

Registration fee for accompanying persons is 9.200,- ISK (800,- DKK). This includes the "Get together party", the reception at Reykjavík City Hall, conference dinner and excursion to Nesjavellir and Thingvellir. Excursion for accompanying persons is planned, contact the Conference Secretariat.

Oral presentations

Each presentation, except for invited papers, must not exceed 15 minutes, including discussion.

Slides

Facilities for preview of slides will be provided at the conference site. Slides should be handed to the technician at least 10 minutes before the session begins.

Posters

The posters will be located in the back of the session hall (hall 4). The size of the poster boards is 90cm wide x 120cm high. The posters should be mounted on Sunday after 16:00 or Monday before 09:00. Short presentations of not more than 4 - 5 minutes are expected in the sessions (about 3 transparencies). Time does not allow for any questions or discussion in the session itself; instead, the authors are requested to attend their posters in the subsequent pauses (coffee break or end of lunch).

Chairmen

The chairmen are kindly asked to be present in their sessions at least 10 minutes before the beginning of the session, and to make certain that the speakers observe the timetable.

Messages and E-mail Service

A computer with a e-mail service will be available in the conference lobby, near the registration desk. Participants can send and receive e-mail. Incoming e-mail will be printed out and posted on the bulletin board, near the registration desk, along with other messages to participants. The e-mail address is: nsfs@geirik.is

Conference Badges

Your personal badge is your entrance ticket to all sessions and social functions. Please remember to always wear your Conference Badge for easy identification.

Technical Exhibition

The technical exhibition is located in the back of session hall (hall 4).

Excursion

The excursion on Wednesday goes to the geothermal areas close to Reykjavík. We visit the power plant at Nesjavellir and then drive on to the national park at Þingvellir for a light refreshment. The weather in August is, as always in Iceland, difficult to predict. As a precaution we recommend warm clothing and rain coats in the luggage.

Banking facilities

A bank is located at the conference venue. Opening hours are Monday to Friday from 09:15-16:00.

Program summary

Sunday August 25

16:00 - 19:00 Registration
19:00 - 21:00 *Get together party (Buses from Scandic Hotel Loftleiðir)*

Monday, August 26

08:00 - 09:00 Registration
09:00 - 09:15 Opening ceremony
09:15 - 10:00 The Bo Lindell Lecture
10:00 - 10:30 Coffee break
10:30 - 12:00 Invited Lecture
12:00 - 13:15 Lunch
13:15 - 14:15 Invited Lecture
14:15 - 15:15 Panel discussion
15:15 - 15:45 Coffee break
15:45 - 16:45 Invited Lecture
18:00 *Reception at Reykjavik City Hall (Buses from Scandic Hotel Loftleiðir)*
19:30 *Conference dinner at Scandic Hotel Loftleiðir (Buses from City Hall)*

Tuesday, August 27

09:00 - 10:30 NKS session 1
10:30 - 11:00 Coffee break
11:00 - 12:30 NKS session 2
12:30 - 13:45 Lunch
13:45 - 16:00 Medical use of radiation. Effects of radiation
16:00 - 16:30 Coffee break. Viewing posters
16:30 - 18:00 Domestic and workplace exposure.

Wednesday, August 28

08:30 - 10:15 Parallel sessions **1A: Limnic and terrestrial radioecology.**
 1B: Internal radiation and dosimetry.
10:15 - 10:45 Coffee break. Viewing posters
10:45 - 12:15 Parallel sessions **2A: Terrestrial radioecology, incl. analytical techniques.**
 2B: Radioactive waste. Non-ionizing radiation.
12:15 - 13:30 Lunch. Viewing posters
13:30 - 14:30 Terrestrial radioecology.
14:30 - 15:00 Coffee break
15:00 - 16:15 NSFS meeting
16:15 - 20:30 Excursion to Nesjavellir / Þingvellir

Thursday, August 29

08:30 - 10:00 Marine Radioecology.
10:00 - 10:30 Coffee break. Viewing posters
10:30 - 12:15 Emergency preparedness - 1.
12:15 - 13:45 Lunch. Viewing posters
13:45 - 15:30 Emergency preparedness - 2.
15:30 - 16:00 Coffee break
16:00 - 17:30 Various aspects of radiation protection. Closing session.
17:30 - 17:45 Closing of the conference

Monday August 26 Morning sessions

08:00 - 09:00 Registration

09:00 - 09:15 Opening ceremony

09:15 - 10:00 The Bo Lindell Lecture

Chairman: **Sigurður M. Magnússon**

Roger H. Clarke. Towards ICRP 2000: Issues that are of importance for radiological protection as the millennium approaches

10:00 - 10:30 Coffee break

10:30 - 12:00 Invited lectures

Chairman: **Kaare Ulbak**

10:30-11:00 **Charles B. Meinholt.** Current activities of the NCRP -- controversies and all

11:00-11:30 **Bo Lindell.** Elementary risk concepts

11:30-12:00 **E. Gail de Planque.** Common Sense, Risk Analysis and Regulations

12:00 - 13:15 Lunch

Monday August 26 Afternoon sessions

13:15 - 14:15 Invited lectures

Chairman: Lars Erik Holm

13:15-13:45 **Kenneth L. Mossmann.** Radiation risks and linearity: sound science?

13:45-14:15 **William A. Mills.** Radiation risk in perspective

14:15 - 15:15 Panel discussion

Chairman: Jack Valentin

15:15 - 15:45 Coffee break

15:45 - 16:45 Invited lectures

Chairman: Erling Stranden

15:45-16:15 **Franz Marcus.** Nordic cooperation in nuclear safety

16:15-16:45 **F. X. Massé.** Establishment and maintenance of professional credentials in radiation protection

18:00 *Reception*

19:30 *Conference dinner*

Tuesday August 27 Morning sessions

Examples of NKS related work: emergency preparedness, radioecology, and information

09:00 - 10:30 Session 1

Chairman: Torkel Bennerstedt

- 09:00-09:15 **Torkel Bennerstedt.** The NKS program 1994 - 1997
- 09:15-09:30 **Klaus Sjöblom et al.** International emergency exercise 1997 in Nordic countries
- 09:30-09:45 **Vibeke Hein.** Nordisk riskkommunikation och utveckling av NKS' informationsmål
- 09:45-10:00 **Tord P. Walderhaug.** Multilateral informasjonsutveksling med internett teknologi
- 10:00-10:15 **Thomas Ulvsand.** Planläggning för sanering
- 10:15-10:30 **Þorsteinn V. Jónsson.** Kvalitetssäkring inom gammaspektrometri med ackreditering som mål

10:30 - 11:00 Coffee break

11:00 - 12:30 Session 2

Chairman: Raimo Mustonen

- 11:00-11:15 **Sven P. Nielsen.** Intercomparison of radionuclides in sediments, NKS/EKO-1
- 11:15-11:30 **E. Holm et al.** Radiocaesium and plutonium from the North Pole to the Antarctic
- 11:30-11:45 **Deborah Oughton et al.** Mobility of Cs and Sr in soils: implications for transfer factors and ecological half-lives in Nordic ecosystems
- 11:45-12:00 **Karl J. Johanson.** Svampens roll i överföring av Cs-137 från skogen till människa
- 12:00-12:15 **R. Saxén et al.** Distribution of ^{137}Cs and ^{90}Sr in a Finnish lake ecosystem
- 12:15-12:30 **Jóhann Þórsson et al.** Sheep grazing and radiocaesium, some external factors

12:30 - 13:45 Lunch

Tuesday August 27 Afternoon session 1

13:45 - 16:00 Medical use of radiation. Effects of radiation

Chairman: Gunnar Saxeboel

- 13:45-14:00 **Ole Hjardemaal.** Deterministiske skader og dosisreduktion i interventionel neuroradiologi i Danmark
- 14:00-14:15 **Wolfram Leitz.** Strålrisk vid mammografiscreening - försumbar eller ett stort problem?
- 14:15-14:30 **Dorte Eide Paulsen.** Persondoser fra medicinsk brug af Positron Emission Tomografi
- 14:30-14:45 **Gabor Szendrö et al.** Uppföljning av datortomografianvändning i Sverige
- 14:45-15:00 **Peter Grøn.** Metode til separation af gennemlysnings- og fotograferingsdosis ved arealdosis målinger på patienter
- 15:00-15:15 **Tord P. Walderhaug og Guðlaugur Einarsson.** Analyse av data fra arealdosemålinger av pasienter i röntgendiagnostikk
- 15:15-15:30 **Niels Vinberg og Klaus Ennow.** Behandling av godartede thyreoideasygdomme med I-131 natriumiodid i Danmark 1990 - 1995
- 15:30-15:45 **Björn E. Sandström and Micael Granström.** Apoptosis: Effects of ceramide and ionizing radiation
- 15:45-16:00 **Poster presentation:**
- C. Bauréus and E. Holm.** Further studies of radioactivity in dialysis patients
- Guðlaugur Einarsson and Tord Walderhaug.** An inexpensive phantom for quality control in dental radiography
- H. Korpela.** Doses to patients from nuclear medicine investigations in Finland in 1994
- H. M. Olerud.** Patient doses from CT examinations in Norway, with analysis of factors affecting the effective dose, including specific clinical indications
- 16:00 - 16:30 Coffee break. Viewing posters

Tuesday August 27 Afternoon session 2

16:30 - 18:00 Domestic and workplace exposure

Chairman: Tua Rahola

- 16:30-16:45 **R. Falk et al.** Individual radon exposure history measured by an etched track detector technique
- 16:45-17:00 **Aleksander Birovljev and Terje Strand.** Radon concentration in new dwellings in Norway
- 17:00-17:15 **Arne Stråby.** Radonmätning på arbetsplatser i Sverige
- 17:15-17:30 **Jörgen Gustafsson.** Criteria's in evaluating thorax counting results of uranium fuel fabrication operators
- 17:30-17:45 **Irene Lysebo et al.** NORM in Oil Production - Occupational Doses and Environmental Aspects
- 17:45-18:00 **Ilona Mäkeläinen.** Results of radon epidemiological studies in Finland

Wednesday August 28 Parallel session 1A

08:30 - 10:15 Limnic and terrestrial radioecology

Chairman: Tone D. S. Bergan

08:30-08:45 **Mikael Moring.** ^{137}Cs in a large freshwater basin - A dynamical model

08:45-09:00 **Hanne Mehli.** Radiocesium in grazing sheep - A statistical analysis of variability, survey methodology and long term behaviour

09:00-09:15 **A. Rantavaara.** Radioactivity of timber

09:15-09:30 **Ingar Amundsen et al.** Transfer and long term behaviour of ^{137}Cs in sheep at Tjøtta, Norway, 1988-1995

09:30-09:45 **Birgitta Åhman.** Transfer of radiocaesium via reindeer to man - the effect of countermeasures used in Sweden after the Chernobyl accident

09:45-10:15 **Poster presentation:**

Inger Andersson et al. Transfer of Cs-137 from soil to vegetation and to grazing lambs in a mountain area in Northern Sweden. Ecological half-life of the nuclide

A. Paasikallio. The effect of minerals on the transfer of radiocaesium to grass

Hans Möre and Rolf Falk. A foodbasket investigation to assess the average intake of ^{137}Cs by population in Sweden in 1994

Jussi Paatero. Measurements of Airborne Beryllium-7 in Northern Finland

Vesa Suolanen. User specific environmental transport analyses code DETRA

10:15 - 10:45 Coffee break. Viewing posters

Wednesday August 28 Parallel session 1B

08:30 - 10:15 Internal radiation and dosimetry

Chairman: Matti Suomela

08:30-08:45 **Lars Böttner-Jensen.** Retrospective radiation dosimetry using optically stimulated luminescence on natural materials and ceramics for assessing population doses in nuclear accidental areas

08:45-09:00 **Poul Christensen.** Dosimetry of beta and low-energy photon radiation: Standardisation, individual dosimetry and monitoring of the workplace

09:00-09:15 **Robert Hedvall.** Thirty-seven years of dosimetry at Studsvik

09:15-09:30 **Tua Rahola.** Ökande möjligheter till jämförelsemätningar och interkalibrering av system för direkta mätningar av radionuklidor i människa - Förbättrad kvalitetskontroll

09:30-09:45 **Michael Tillander et al.** Installation of two whole-body counting systems in new laboratory rooms

09:45-10:00 **Christopher L. Räaf et al.** Urinary excretion of cesium-137 for estimation of body content and internal absorbed dose

10:00-10:15 **Poster presentation:**

Bente Lauridsen and Jens Søgaard-Hansen. Whole-body measurements at a research facility

Anders Björeland och Göran Ågren. Studier av ^{137}Cs i befolkningsgrupper bosatta i Norrland, en uppföljning

L. Nyblom et al. The dose to the Swedish population from caesium in the body, estimated from whole-body measurements on a representative group

10:15 - 10:45 Coffee break. Viewing posters

Wednesday August 28 Parallel session 2A

10:45 - 12:15 Terrestrial radioecology, including analytical techniques

Chairman: Mette Øhlenschläger

10:45-11:00 **Klas Rosén et al.** Migration of radiocaesium in Swedish soil profiles after Chernobyl accident, 1987-1995

11:00-11:15 **Hans Mellander.** A portable gamma spectrometry system for environmental applications

11:15-11:30 **Brit Salbu.** ^{90}Sr in various matrices - speciation and analysis

11:30-11:45 **Anne B. Ruud et al.** Titrering med EDTA som alternativ metode for bestemmelse av yttriumutbytte ved ^{90}Sr -analyser

11:45-12:15 **Poster presentation:**

Lynn Marie Hubbard et al. Radiocaesium redistribution in a Swedish pine forest

Jorma Suomela och Leif Moberg. En enklare metod att analysera strontium-90 testad på jordprover från Tjernobyl-området

Sigurður E. Pálsson. On the choice of the mathematical transformations for visualizing different properties of gamma ray spectra

Kristina Rissanen och Tua Rahola. Radioaktiva ämnen i livsmedel producerade i finska Lappland

Robert Hedvall. Thirty-nine years of environmental monitoring at Studsvik

Wednesday August 28 Parallel session 2B

10:45 - 12:15 Radioactive waste. Non-ionizing radiation

Chairman: Karin Brodén

10:45-11:00 **Steinar Backe et al.** Oppgraving av et 25 år gammelt deponi for radioaktivt avfall i Norge

11:00-11:15 **Gordon C. Christensen et al.** Kombinert lager og deponi for lav- og middels radioaktivt avfall i Himdalen i Norge

11:15-11:30 **Anita A. Sørlie et al.** IAEA-WATRPs vurdering av det planlagte kombinerte lager og deponi for radioaktivt avfall i Himdalen, Norge

11:30-11:45 **Enn Kivisäkk et al.** Recommendations on exposure to 50 Hz magnetic fields in Sweden

11:45-12:00 **Anders Glansholm.** Optical radiation from two industrial laser stations

12:00-12:15 **Enn Kivisäkk et al.** Testing of the sunscreens on the Swedish market

12:15 - 13:30 Lunch. Viewing posters

Wednesday August 28th Afternoon

13:30 - 14:30 Terrestrial radioecology

Chairman: Elis Holm

13:30-13:45 **Eldar Gaare and Eiliv Steinnes.** Use of the moss *Hylocomium splendens* for the mapping of radiocaesium fallout from the Chernobyl accident

13:45-14:00 **Marja-Leena Markkula and Aino Rantavaara.** Consumption of mushrooms and some wild food products in Finland

14:00-14:15 **Lavrans Skuterud et al.** Importance of wild mushrooms for intake of radiocaesium by populations in Russia

14:15-14:30 **Sigurður Emil Pálsson et al.** Fallout from atmospheric nuclear tests in the sixties - Review of data from Iceland

14:30 - 15:00 Coffee break

15:00 - 16:15 N.S.F.S. meeting

16:15 - 20:30 *Excursion to Nesjavellir / Þingvellir*

Thursday August 29 Morning session 1

08:30 - 10:00 Marine Radioecology

Chairman: Sigurður E. Pálsson

08:30-08:45 **Sven P. Nielsen.** A sensitivity analysis of a radiological assessment model for Arctic waters

08:45-09:00 **E. D. Ólafssdóttir et al.** The Icelandic marine environment. Monitoring of Cs-137

09:00-09:15 **Deborah Oughton et al.** Tracer studies on sediment water interaction kinetics of Sr-90 and Cs-137

09:15-09:30 **Erkki Ilus et al.** Kärnkraften och miljön i Finland - med speciell hänsyn till den marina miljön

09:30-09:45 **Bjørn Lind and Lars Føyn.** Location and visual investigation of dumped nuclear waste in the fjords at the east coast of Novaya Zemlya

09:45-10:00 **Poster presentation:**

Tarja K. Ikäheimonen et al. A study on the behaviour of cesium and plutonium in the sedimentation process under varying redox-conditions

Seppo Klemola et al. Determination of Pb-210 in sediment samples by gamma ray spectrometry: Application of an efficiency transfer method

Tone D. Bergan and Gunnar Hannestad. Determination of Po-210 and Pb-210 in river and sea sediments

10:00 - 10:30 Coffee break. Viewing posters

Thursday August 29 Morning session 2

10:30 - 12:15 Emergency preparedness - 1

Chairman: Eldri Naadland

10:30-10:45 **Inger Andersson och Robert Finck.** Mätning av radioaktiva ämnen i betesgräs och mjölk i händelse av en kärnenergiolycka. Förslag till beredskapsorganisation i Sverige

10:45-11:00 **Robert Finck.** Lokala referensmätningar av gammastrålning i svenska kommuner. Erfarenheter från fem års mätningar

11:00-11:15 **Arne Sæbø.** Overvåking av regulære utslipp ved IFE-Kjeller i perioden 1948-1994

11:15-11:30 **J. Roed et al.** Decontamination in a Russian settlement

11:30-12:15 **Poster presentation:**

Ingvar Friberg. A method for ^{90}Sr -determination in environmental samples shortly after a nuclear accident

Kenneth Lidström et al. Mobile equipment for preparedness purposes

Jussi Paatero. The Meteorological Institute's contribution to the national radiation monitoring programme in Finland

Klaus Sjöblom. Olycksscenario för havsberedskapsövningar

Kjell Nyholm och John-Christer Lindhé. "EMERCON & ECURIE - internationell rapportering vid kärnkraftolyckor med datorstöd

S. Väisälä. Radiation monitoring on the border and in the metal scrap recycling industry in Finland

Mats Eriksson et al. Urlaknings effekter av ^{137}Cs , ^{40}K och ^{210}Po vid lutning av fisk och kött

12:15 - 13:45 Lunch. Viewing posters

Thursday August 29 Afternoon session 1

13:45 - 15:30 Emergency preparedness - 2

Chairman: Jens Hovgaard

- 13:45-14:00 **T. Ramsey et al.** RaMona, Radiation Monitoring and Alarm System for the IFE-Kjeller Site
- 14:00-14:15 **Ulf Bäverstam.** Probabilistic assessment of doses and depositions after a hypothetical accident at the Barsebäck nuclear power plant, using 2 years hourly meteorological data
- 14:15-14:30 **Lisbeth Warming.** International intercomparison of criticality accident dosimetry systems at the Silene Reactor
- 14:30-14:45 **Eldri Naadland and Finn Ugletveit.** International exchange of information in the event of nuclear accidents
- 14:45-15:00 **Christer Samuelsson.** Radiation risk information to the public: Principles or common sense?
- 15:00-15:15 **Tord Larsson.** Järnvägsvagn kontaminerad med Cs-137
- 15:15-15:30 **Bent Lauritzen.** Radiological consequences in Denmark from a severe reactor accident in the Ignalina power plant

15:30 - 16:00 Coffee break

Thursday August 29 Afternoon session 2

16:00 - 17:30 Various aspects of radiation protection. Closing session

Chairman: **Sigurður M. Magnússon**

16:00-16:15 **Lars Persson.** Ethical issues in radiation protection

16:15-16:30 **Jack Valentin.** "Potential exposure" i praktiken

16:30-16:45 **Kaare Ulbak.** European Basic Safety Standards Directive 1996

16:45-17:00 **Asker Aarkrog.** Radioecology, development and trends

17:00-17:15 **Jan Olof Snihs.** Radiation protection, development and trends

17:15-17:30 **Anneli Salo.** Emergency preparedness, development and trends

17:30 - 17:45 Closing of the conference

Program committee

Sigurður M. Magnússon
Tord P. Walderhaug
Garðar Mýrdal
Sigurður E. Pálsson

Nordic reference group

Jack Valentin, Sweden
Ole Hjardemaal, Denmark
Erling Stranden, Norway
Matti Suomela, Finland

The Bo Lindell Lecture

Towards ICRP 2000: Issues that are of importance for radiological protection as the millennium approaches

Roger H Clarke
Chairman, ICRP

ABSTRACT

The work of the Main Commission of ICRP is supported by its four Committees on: Biological Effects, Secondary Standards, Protection in Medicine, and Application of the Commission's Recommendations. This paper will discuss those aspects of the work of these Committees that are likely to be significant for the development of radiation protection policy and practice into the next century. It will particularly deal with the questions of risks at low doses of radiation and the "threshold controversy". The issue of genetic susceptibility to radiation induced cancer is another area in which ICRP is working and will be covered. There are also programmes of work concerning the development of internal dosimetry that will be described. Finally the programmes on radiological aspects of waste disposal and release of contaminated land are addressed since these are topics for which the idea of a threshold has recently been proposed. The paper will argue counter proposals.

CURRENT ACTIVITIES OF THE NCRP -- CONTROVERSIES AND ALL

Charles B. Meinholt
National Council on Radiation Protection and Measurements
7910 Woodmont Avenue, Suite 800
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ABSTRACT

The National Council on Radiation Protection and Measurements (NCRP) and its predecessor organizations have been providing advice on radiation protection and measurement issues since 1929. The Council received a Congressional Charter in 1964 which predicates its structure and operation.

There are 75 Council members and more than 400 scientists working on about 40 Scientific Committees dealing with a wide variety of topics in the following program areas: Radiobiology and Epidemiology, Operational Radiation Safety, Metabolism and Dosimetry, Environmental Issues, Radioactive and Mixed Waste, Nonionizing Radiation, Radiation Protection in Medicine, Public Decision-Making, and Radiation Measurement. As might be expected, several of the topics are the source of various levels of controversy. The health effects of ELF radiation and the adoption of the linear no-threshold model are among the most controversial at the present time. The approach to resolving these issues reflects the strengths in the NCRP Program.

The NCRP's relationship with the ICRP is strong, although the NCRP, while endorsing the basic quantities, units, and risk estimates, will occasionally make alternate recommendations as suggested by its Scientific Committees and approved by the Council members.

Elementary risk concepts

Bo Lindell

Abstract

The paper reviews elementary risk concepts and, in particular, the meaning of probability in risk assessments. The author makes a distinction between "macroscopic" and "microscopic" risks. With *macroscopic* risk he means any risk in a situation where a frequency generating mechanism can be identified or postulated. In contrast, with *microscopic* risks he means risks in situations where no frequency generating mechanism can be presumed. In the latter case, relevant for unique events relating to one particular individual or installation, the probability of a harmful event is entirely based on the subjective belief of whoever states a probability value, conditional to that person's knowledge and experience. The evaluation of radiation risks is an interesting example.

Common Sense, Risk Analysis and Regulations

Dr. E. Gail de Planque

In times of limited resources, regulatory schemes are bound to come under close scrutiny. In the ideal world, scarce resources would be directed where they would do the most good. Recent tensions in the United States concerning budget and regulation have elicited much debate over a particular model of regulatory decision-making called risk analysis, which is frequently espoused as the panacea to the often-voiced complaint that many regulations make no sense and frequently inhibit the goals they are designed to achieve. Risk analysis is an extremely valuable tool which, when used appropriately, can restore common sense to regulation.

Essentially, risk analysis can be divided into three distinct components: risk assessment, which attempts to measure and describe the risk or hazard associated with an activity or the use of a substance or technology; selection of an acceptable level of risk; and, risk management, the process and infrastructure used to keep the risk below the level determined to be acceptable. Each of these components involves an intermix of science and value judgements and cannot be left solely to experts but must in some way include politicians and the public if the approach is to succeed. Superimposed upon the approach of risk analysis are the needs to prioritize risks to assure that attention and resources are devoted to the regulation of risks that are truly significant and not to further reductions of minimal risks, and, to assure a uniform approach to risk-based decision-making among the various regulatory bodies particularly with respect to how common sense is inserted into the process.

The immediate challenge is to utilize the logic of risk-based decision-making to develop a practical overarching regulatory framework. Not a challenge for the meek, but one that must be met if both the economic and environmental well-being of our societies is to be assured in the future.

RADIATION RISKS AND LINEARITY: SOUND SCIENCE?

Kenneth L. Mossman
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ABSTRACT

The U.S. federal government has promulgated regulations that compel private parties and state and local governments to allocate resources for the protection of the public health and safety. Occupational safety and health regulations alone have been estimated to cost approximately \$9 billion annually with negligible risk reduction benefits. Such regulations depend upon the concept that reduction in dose leads to a concomitant reduction in health risk.

Significant questions have been raised about the appropriateness of the linear, no-threshold (LNT) theory as a predictive model to estimate health effects at low radiation doses and as a theoretical foundation for radiation protection standards and practices. The LNT model is based on three fundamental assumptions: (1) adverse health outcomes (e.g., cancer) might result from a single ionizing event in a critical cell, i.e., any radiation dose, no matter how small, is potentially harmful, (2) the probability of adverse health outcomes is linearly related to absorbed dose, and (3) radiation damage is not repairable. It is now well-known that the dose-response curves for some, but not all, health effects are non-linear in the low dose range, that radiation-induced damage (to DNA) can be repaired, and that cellular DNA is in a dynamic state in which damage, including base damage and single strand breaks, is constantly occurring and being repaired.

This paper explores some of the scientific issues at the heart of the LNT debate including limits of radioepidemiology studies, repair of radiation injury, and hormesis. It is concluded that the validity of the LNT model must be seriously questioned and that alternative approaches to regulatory decision making must be identified.

THE 1996 HEALTH PHYSICS SOCIETY'S POSITION STATEMENT: "RADIATION RISK IN PERSPECTIVE"

W.A. MILLS

The Society's Science and Public Issues Committee's statement on radiation health risk, published in the Society's March Newsletter, is an effort to bring attention to the fact that estimates of cancer mortality at very low levels of radiation exposure can not be stated with a level of statistical confidence usually found acceptable in science. Findings to date from the more than four-decade study of the Japanese A-bomb survivors show a statistical significant increase in total cancer mortality only at radiation doses of 0.1 Gy or more. Distinguished scientific committees of the U.S. National Academy of Sciences and the United Nations have used this population to provide risk estimates at this dose level. However, for reason of "prudent" public health protection a linear, nonthreshold dose response model has been adopted in promulgating radiation standards at levels a 1000-fold lower. An important question is what scientific confidence level can be placed on cancer death risk estimates at this level. The public perception arising from such estimates is that there is no safe level of radiation exposure. The Society's position statement is an attempt to provide a perception that best reflects what is known about radiation risk with a reasonable degree of scientific certainty. Development of and responses to the position statement will be discussed.

Nordic cooperation in nuclear safety

Franz Marcus
Nordisk kernesikkerhedsforskning
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Abstract

The Nordic countries provide an example of regional cooperation that takes many shapes. In the nuclear field this cooperation has been extensive for forty years despite the fact that it became clear several years ago that only two of the five Nordic countries would have nuclear power.

The focus of cooperation has shifted over the years, and with it the circles involved. Starting when atomic energy appeared in the fifties as a magic new source of energy and a tool for science, medicine and industry, the Nordic governments agreed to a cooperation scheme . The fallout from bomb tests, on the other hand, led the radiation authorities to work together. There were early large development projects that soon turned towards the safety oield. At the present time the cooperation is mainly between the safety, emergency and radiation protection authorities.

The results of this cooperation have been numerous and varied, confirming the value of working together. A few examples of achievements over the years are the "Nordic group" of reactor core calculations, the Nordic atomic libraries, the Nordic transport group, the Nordic "flag books", inter-Nordic agreements on assistance and information, etc.

Our experience indicates that efficient cooperation must build upon close personal relations that need to be created and continuously nourished, and require contacts at many different levels. It also shows that considerable results can he achieved with a minimum of bureaucracy, but it needs steady monitoring of trends and adaption to new situations.

ESTABLISHMENT AND MAINTENANCE OF PROFESSIONAL CREDENTIALS IN RADIATION PROTECTION

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ABSTRACT

Recognition of qualified experts in radiation protection is an issue IRPA has been concerned with from its inception. It has long been known that the recognition mechanism differs widely throughout the world community and IRPA Associated Societies have each dealt with the needs of their members in this regard in their own way. Some unification of the recognition of qualified radiation protection experts was first thought to be important with the organization of the Commission of the European Communities, anticipating the need for such expertise to be able to move freely within the EC states. A number of attempts have been made to determine the feasibility of such standardization by first intercomparing the existing systems internationally. Such intercomparisons have only verified the wide diversity of existing recognition systems, confirming the difficulty that would be associated with any standardization attempt. We are therefore shifting our focus to the issue of professional education and training as a means of gradual standardization in the profession.

The NKS program 1994 - 1997

Torkel Bennerstedt, Secretary General

The philosophy behind NKS, its structure, the main sponsors, and the nine ongoing projects will be presented.

As a consequence of a common concern for the potential hazards of Nordic and international nuclear installations, NKS (Nordic Nuclear Safety Research) was formed some 30 years ago. It is a Danish - Finnish - Icelandic - Norwegian - Swedish cooperative body dedicated to research and dissemination of information in nuclear safety and radiation protection. Technical and organizational plant data, man-machine interface, environmental impact, waste handling, emergency preparedness and communication strategies are some important aspects of the work.

The purpose is to carry out cost-effective Nordic Projects, producing reports, manuals, databases, recommendations and seminars that are of practical value to the financing bodies and end-users. Among these, ministries, concerned national authorities and power producing companies predominate. The total budget for 1996 amounts to approximately USD 1.5 million plus contributions in kind by participating organizations, worth at least another USD 3 million. The NKS program involves some 250 Nordic experts in various fields.

Two projects deal with reactor safety: how to avoid severe accidents by evaluating and improving safety in selected areas; and how to minimize the consequences of such an accident via studies of severe accident phenomenology and computerized accident management. One project deals with final disposal of long-lived low and medium level radioactive waste. Environmental impact of radioactive releases, especially cesium-137, is studied and predictive models are calculated using field data in one project on marine radioecology, and one on long ecological half-lives in semi-natural systems. There are three projects on emergency preparedness, one of which covers mobile measurements, quality assurance in sampling and analysis, and operational intervention levels; one focusing on drills and exercises, and a Nordic system for exchange of information and data; and one on planning for clean-up operations under various conditions during the first three weeks after a fallout. One project is concerned with media contacts, information policies and risk communication.

International cooperation with EU, OECD/NEA etc., as well as with countries in Eastern Europe and elsewhere will be touched upon. The presentation ends with a quick glimpse into the future.

INTERNATIONAL EMERGENCY EXERCISE 1997 IN NORDIC COUNTRIES

Klaus Sjöblom (LOVIISA NUCLEAR POWER PLANT)

Hannele Aaltonen & Riitta Hänninen (FINNISH CENTRE FOR RADIATION AND NUCLEAR

Eldri Naadland (NORWEGIAN RADIATION PROTECTION AUTHORITY)

Åke Persson (SWEDISH INSTITUTE OF RADIATION PROTECTION)

Participants and time schedule INternational EXercises of INEX 2

INEX 2 will be composed of serie of international exercises.

<i>Accident host</i>	<i>Time</i>	<i>Site</i>
Switzerland	November 7th, 1996	Leibstadt
Finland	April 17th, 1997	Loviisa
Canada	November 1997	Darlington

These exercises will be sponsored by OECD/NEA. The IAEA, CEC and WMO will also participate. In addition to accident host country, bordering countries will participate simultaneously, activating their own emergency command posts to receive and transmit information on which to base their decisions as to protective countermeasures. Countries not bordering accident host ("far field countries") will also participate using their existing bilateral and multilateral communication agreements.

Nature of INEX 2 exercises

Based on a postulated accident scenario but real weather in the The exercises will last one day with threat, release and immediate post-release phases. The main acitivities of INEX 2 are:

- Real time exchange of information
- Decision making based on plant condition.
- Public information

Nordic aspect

Nordic Nuclear Safety Research program 1994-1997 contains a large emergency exercise that is going to be combined with the INEX-2 objectives. This encourages all Nordic countries to participate actively in the exercise in April 1997. Because of the constraints

- one accident plant (Loviisa)
- real weather conditions (release direction cannot be pre-estimated)
- long distances (wind speed 5 m/s corresponds 400 km / 24 h)

other countries than Finland or Estonia and Russia are unlikely to receive the postulated radioactive release at least within the exercise day. Yet the exercise should be international and large! Therefore most Nordic countries should prepare themselves to concentrate their participation to those activities that are not directly related to an immediate contamination situation. All five Nordic countries have representatives in the exercise planning committee and they will inform about the exercise in their home countries.

Nordisk riskkommunikation och utveckling av NKS' informationsmål

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Abstrakt

Atomenergiulykker respekterer ikke nationale grænser. Det er en af grundende til, at et nordisk samarbejde om befolkningsinformation er vigtigt. Sker der en ulykke, vil den få konsekvenser for alle/flere af de nordiske lande. Med de tætte grænser samt sproglige og kulturelle forbundethed vil oplysninger givet i et af de nordiske lande blive sammenlignet med oplysninger givet i nabolandet. De nordiske myndigheder opnår derfor en langt større troværdighed, hvis de kender til hinandens informationer, så eventuelle forskelle i foranstaltninger kan forklares. Information om risiko er svær. Det er den, fordi det ikke er entydigt, hvad der er farligt. Hvordan informerer man om et svært emne til en modtager, der ikke er interesseret - det er et af de spørgsmål, vi har stillet os. Det drejer sig udelukkende om forhåndsinformationen. I tilfælde af en ulykke er interessen pludselig meget stor, og informationsstrømmen synes ofte for ringe. Hvilke faktorer spiller ind, for at mennesker opfatter risiko på det rette niveau, bliver bange, hvis det er nødvendigt, eller undgår panik selv om situationen er ukendt - det er noget af det, vi i fællesskab forsøger at analysere. Hvad kan man egentlig opfatte, når man er i en presset situation - det ved man noget om også fra andre områder, fx fra hospitalsverdenen, en viden som vi samler ind for at blive bedre til at kunne tilrettelægge den information, der skal sendes ud, når noget sker. Ét vigtigt element er uden tvivl muligheden for at få svar på egne spørgsmål, at kommunikere og ikke bare modtage informationer.

Det arbejdes sideløbende med de generelle informationsspørgsmål med at forbedre kendskabet til NKS. Der opstilles kommunikationsstrategi og grafisk profil, ligesom der afholdes kurser i formidling for projektledere, og nye kommunikationskanaler tages i brug.

Multilateral informasjonsutveksling med internett teknologi

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Abstrakt

Ved en kjernekraftulykke er det av interesse å gjøre informasjon som normalt ikke taes hånd om av formelle varslingssystem, så som ECURIE, tilgjengelig for andre land. Slik informasjonsutveksling er i dag først og fremst basert på telefax og elektronisk post mellom enkeltpersoner. Et problem ved denne form for informasjonsutveksling er at sender ikke selv kan kontrollere at sendingen er tilfredsstillende overført, men isteden er avhengig av en bekrefstelse fra mottager om vellykket overføring. I tillegg vil utveksling basert på telefax blokkeres dersom informasjonsströmmen blir for stor. Et system hvor sender kun sørger for å gjøre informasjonen tilgjengelig, hvorpå det er mottakers ansvar å foreta selve overføringen, og som baseres på digital kommunikasjon, unngår dette problemet.

Et utkast til et system basert på disse kriterier, og som benytter World Wide Web og Internettet har vært utviklet i regi av NKS (NKS EKO-4.2). Innbygd i systemet er differensiert adgangsbegrensning og muligheten for kryptering av data skal også utvikles. Det er imidlertid viktig å være klar over at systemet er i seg selv fullstendig passivt, og som sådan ikke vil kunne benyttes som et varslingssystem.

Systemet vil bli presentert med eksempler på benyttelse. Implikasjoner med hensyn til sikkerhet av nettverk og data, konfidensialitet og tilgjengelighet av data vil bli diskutert.

Planläggning för sanering. The EKO-5 project

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Abstract

A prestudy "Preplanning of early cleanup after fallout of radioactive material", made by Studsvik EcoSafe in Sweden, pointed out the need and request for preplanning of actions of cleanup. The prestudy proposed that a main study should be started to propose test methods, elaborate scenarios, describe relevant cleanup strategies in different environments and to prepare a checklist. Based on the prestudy and on discussions this project was started, with the goal as stated below. Because of the common interest between the Nordic countries NKS is the organisation responsible for the project.

The result of the project is intended to be a document pointing out what can be planned in advance regarding early cleanup actions after a nuclear plant accident. Early shall in this case mean the three first weeks after an accident. The project shall only deal with questions concerning external radiation. The responsibility for these actions is differently organized in the Nordic countries and the document shall be usable to *persons in charge of planning or decision makers* on the appropriate level of organisation for each country. The document shall principally be aimed towards persons without professional competence in the field of radiology.

Results will be presented for a limited number of generalized environments and fallout situations

- urban/suburban/rural
- regional differences (in for example house types and constructing material)
- dry or wet deposition

For the time being work is going on in a project group with participants from Denmark, Finland, Norway and Sweden. There is yet no results to present.

KVALITETSSÄKRING INOM GAMMASPEKTROMETRI MED ACKREDITERING SOM MÅL

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ABSTRAKT

Þorsteinn V. Jónsson är delprojektledare för ett sammordiskt delprojekt som Nordisk Kärnsäkerhetsforskning (NKS) står för. Enligt EU direktiv 93/99 skall de laboratorier som gör mätningar på livsmedel ackrediteras enligt Europastandard EN 45 001 före 1. november 1998. Målet med delprojektet är att stödja de nordiska strålskyddsmyndigheterna med att ställa rimliga krav, enligt EU direktivet, på laboratorier som gör mätningar av gammastrålning i livsmedel. Vidare är det meningen att initiera samarbete mellan de nordiska laboratorierna som förbereder sig för att söka ackreditering. Inte minst är det tänkt att delprojektet skall leda till ökad kvalitet av de nordiska laboratoriernas arbete.

I projektbeskrivningen står bl a följande: "Arbetet med delprojektet bör utmynna i gemensamma nordiska rekommendationer för berörda myndigheter och mätlaboratorier. Dessa skall baseras på dels EU-direktivet, dels på nationella behov och krav. Vidare skall rekommendationerna betona vikten av att såväl ackrediteringen som de använda mätprocedurerna tar hänsyn till både normal- och beredskapsläget."

På seminariet ges en kort översikt av ackrediteringsprocessen och en resumé av innehållet i EU direktiv 93/99 och Europastandard EN 45 001. Prototyper presenteras av *kvalitetsmanualen* och *tekniska manualen*, baserade på Geislavarnir ríkisns laboratorier. De kan användas som referensmaterial för andra laboratorier som börjar förbereda sig för ackrediteringsprocessen.

INTERCOMPARISON OF RADIONUCLIDES IN SEDIMENTS, NKS/EKO-1

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Abstract

An intercomparison exercise on analyses of radionuclides in sediment samples has been carried in 1995 out as part of the Nordic NKS/EKO-1 project on marine radioactivity. The participating laboratories represent the Nordic countries as well as Estonia, Latvia, Lithuania and Japan, totalling 22 laboratories. Two samples of top sediments were distributed among the participants, one sample collected in Kattegat and one from the western Baltic Sea. All participants submitted data on Cs-137 and many submitted data on the natural radionuclides Ra-226, Th-232 and K-40. Data were also submitted on other radionuclides (e.g. Co-60, Pb-210, Po-210, Sr-90, transuranics). The variability across all data on Cs-137 in the Kattegat sample where the average concentration was 27 Bq kg^{-1} corresponds to a standard deviation of 23%, and for the Baltic Sea sediment sample the average concentration of Cs-137 was 61 Bq kg^{-1} and the variability between the data sets corresponds to a standard deviation of 11%. A few simple mistakes were observed during the exercise (e.g. interchange of data for the two samples).

Radiocaesium and plutonium from the North Pole to the Antarctic

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The major scientific expeditions to the Antarctic and the Arctic, such as the Swedish Arctic Expedition (YMER-80), Swedish Antarctic Research Expedition (SWEDARP 88/89), Swedish Arctic Expedition (SWEDARCTIC-91), the Swedish-Russian Tundra expedition (TUNDRA-94) covered areas in the North and South Atlantic from 90° N to 72° S and in the Arctic Ocean from 15°W to 160°E.

During these expeditions, in particular, surface water was collected at sampling stations and during steaming between stations and from Sweden to the Antarctic and the Arctic and analysed for radiocaesium and plutonium. In combination with data published from other major expeditions such as for example the GEOSEC expedition 72/73 the distribution of radionuclides in time over 22 years and space can be assessed.

Data show that radiocaesium from nuclear detonation tests carried out in the late 1950's and the early 1960's shows a long residence time in surface waters in the North and South Atlantic. The half-life, corrected for physical decay is in the order of 100 years while plutonium has a half-life of 7-8 years.

Results from the central Arctic ocean and continental shelf along the European-Siberian Tundra show that radiocaesium from European reprocessing plants is transported eastwards along the coast to the Laptev Sea and then advected into the central Arctic ocean with the so called Trans Polar Drift. The origin of plutonium in the Arctic Sea was mainly from nuclear tests and only 5-10% for $^{239+240}\text{Pu}$ had European reprocessing facilities as origin in 1980 but 20-40% for ^{238}Pu and ^{241}Pu . The effective ecological residence time for plutonium in the Arctic is longer (17 years) than for other areas of the North and South Atlantic. This might be due to different scavenging processes in polar regions, other yet not defined sources, the maximal pulse from Sellafield, 1974-1979, reached the Arctic 10 years later or difference in source term behaviour.

Mobility of Cs and Sr in Soils: Implications for Transfer Factors and Ecological Half-lives in Nordic Ecosystems

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The mobility and transfer of a radionuclide varies between sites and with time after deposition. Long-term changes in transfer factors in terrestrial ecosystems usually reflect changes in the speciation or distribution of radionuclides in soils. In soils, the mobility of a radionuclide is influenced by three main factors: 1) the initial physico-chemical form of the fallout; 2) transformation processes which change the original distribution of species; and 3) the radionuclide's subsequent reactivity with soil components. The reactivity of any element with soil components is a function of its reaction strength, rate and reversibility. Therefore, information on radionuclide speciation, the kinetics of transformation processes and soil-radiation interactions, together with the effect of environmental parameters is important for understanding variations between different sites.

This paper presents some studies on the mobility of radionuclides in environmentally (Weapons' fallout, Chernobyl) and experimentally (^{134}Cs and ^{85}Sr tracer) contaminated soils. Particular attention being paid to the influence of Cs and Sr mobility in soils on the transfer of radionuclides in Nordic soil-veg-lamb food chains. The main methods used include sequential extraction, dynamic tracer experiments and analysis of stable Cs and Sr distribution.

The results confirm the importance of the three factors in determining radionuclide mobility. Chernobyl contaminated soils are often associated with low mobility of ^{90}Sr due to the presence of fuel particles, and studies on Ukrainian soils indicate that transformation processes leading to particle weathering are dependent on particle composition well as environmental parameters (e.g. pH). Laboratory tracer studies on soils collected from various Nordic sites, show that ionic Cs and Sr are rapidly bound to soils: Sr remaining in exchangeable forms, but Cs becoming strongly fixed to soil components. Fixation of ^{137}Cs in soils seems to be the predominant process leading to reduction in soil-vegetation transfer factors. Soil chemistry and mineralogy clearly influences radionuclide mobility between the different sites. Analysis of stable Cs distribution shows that transfer factors at steady state vary between the different sites. Hence environmental differences and ^{137}Cs contact time rather than differences in fallout speciation probably account for the anomalies between Nordic sites. Finally the significance of soil ingestion on calculated veg-lamb transfer factors has been investigated using a recently developed, sensitive method using NAA analysis of Sc faeces.

Svampens roll i överföring av Cs-137 från skogen till människa.

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Svamp innehåller mycket höga halter av Cs-137 samtidigt som det finns en mycket stor variation mellan Cs-137 halterna i olika svampar. Detta innebär att man måste veta dels konsumtionen av svamp, dels vilka arter som vi konsumerar för att kunna beräkna potentiell överföring av Cs-137 via svamp. Vi har därför genomfört en undersökning om svenska folkets svampplockningsvanor. Den vanligaste svampen som plockas i Sverige är enligt denna undersökning trattkantarell (*Cantharellus tubaeformis*) följd av kantarell (*C. Cibarius*) och Karl Johan (*Boletus edulis*). Den beräknade totala mängden av plockad svamp år 1995 som var ett mycket dåligt svampår var 0.6 kg jämfört med 1.8 kg under ett normalår. Transfer faktorer för trattkantarell är 0.94, för vanlig kantarell 0.39 och för Karl Johan $0.28 \text{ m}^2 \text{ kg}^{-1}$ vilket skulle innebära att medeltalet i Sverige, med en medeldeponering av Cs-137 på 10.000 Bq m^{-2} , för dessa arter skulle vara 9600, 2400 respektive 1200. Med de från enkäten erhållna mängder och utnyttjande av ICRPs dose conversion factor innehåller detta $8 \mu\text{Sv}$ under 1995 och $18 \mu\text{Sv}$ ett normalår.

På likartat sätt går det att beräkna hur mycket av det Cs-137 som överförs till människa via älg och rådjur är orsakat av svampintag av älg och rådjur. Det visar sig att omkring 30-40 % av den totala överföringen av Cs-137 via älg och rådjurskött egentligen beror på att dessa djur konsumerar svamp.

Det finns ytterligare en nivå där svampen kommer in som en viktig komponent i Cs- 137 omsättningen och det är i mark-växt överföring. Fortfarande är det svårigheter att kvantifiera svampens roll i denna transfer. Vi har försökt närma oss problemet med svampens roll i marken. En frågeställning vi kan ge svar på är om Cs-137 halten i fruktkroppar är likartad som i mycelet i marken. Det förefaller vara ganska likartat vilket innehåller att flera tiotal % av markens innehåll av Cs-137 återfinns i svampkompartimentet i marken. En fråga som vi försökt få ett svar på är i vilken utsträckning en transport av Cs-137 i marken sker inom svampmycelet. Det är välkänt att det i svampmycel *in vitro* sker en relativ snabb transport av olika ämnen bla. Cs- 134. I naturen förefaller det ske en viss transport både i vertikal och horisontal led. Om detta innehåller att tex vandringen nerut i markprofilen motverkas av upptransport i svampmycelet kan vi dock inte svara på ännu.

Distribution of ^{137}Cs and ^{90}Sr in a Finnish lake ecosystem

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ABSTRACT

Behavior and temporal changes of ^{137}Cs and ^{90}Sr in different parts of aquatic ecosystem of Asikkalanselkä, the southern part of the lake Päijänne, was studied. The lake is important both for freshwater fishing and as a source for drinking water for about 1 million inhabitants in the capital area. Asikkalanselkä is the southernmost, oligotrophic basin of the lake, with an area 52,8 km².

Distribution of ^{137}Cs in Asikkalanselkä and especially its sedimentation was earlier studied by the Institute of Radiochemistry in co-operation with Paavo Ristola Oy and later with the Center of Environment of the city of Helsinki. A sedimentation model for Asikkalanselkä was developed¹. The Finnish Center for Radiation and Nuclear Safety (STUK) has studied changes of ^{137}Cs in water and fishes from the lake since 1986. A joint study between the Institute of Radiochemistry and STUK on long-term distribution of deposited ^{137}Cs and ^{90}Sr to different compartments of the aquatic system and especially on their transfer to fishes in Asikkalanselkä was started in 1991. The main goal of the study was to produce experimental data on ^{137}Cs and ^{90}Sr for validation of a dynamic transfer model².

The average deposition of ^{137}Cs in the catchment of Asikkalanselkä was more than 60 kBq/m². The deposition was checked by analysing soil and lichen samples from the area. Lichen samples were also used to estimate the deposition of ^{90}Sr to the area. Besides temporal changes in the distribution of the nuclides between water, particles in water and sediment as well as changes in the vertical distribution of ^{137}Cs in sediment profiles, ^{137}Cs and ^{90}Sr in several fish species were also determined annually. Changes and variations of ^{137}Cs and ^{90}Sr in different fish species, concentration ratios of the two nuclides between fish and water as well as transfer of the nuclides from deposition to fish will be discussed.

Run-off from the catchment to the lake was studied by analysing water from some small rivers discharging to the lake and soil samples from the catchments of the rivers. In water of those rivers concentrations of ^{90}Sr were almost the same and in some cases even somewhat higher than those of ^{137}Cs , though the deposition of ^{137}Cs was about 150 times higher than the deposition of ^{90}Sr .

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SHEEP GRAZING AND RADIOMAESIUM, SOME EXTERNAL FACTORS

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ABSTRACT

Iceland has been participating in NKS's lamb projects since 1990, when the RAD-3 project was started, and later in the EKO-2 project. As both projects concentrate on nuclide transfer from soil to grazing lambs, the Icelandic Radiation Protection Institute (IRPI) suggested collaboration with the Agricultural Research Institute's (AGRI) Animal Nutrition Division. In 1994 50% of all meat production was lamb meat, making it the main meat product in Icelandic Agriculture. The annual lamb meat sale in that year was $27.2 \text{ kg capita}^{-1}$, 46% of the total meat sale. It is thus clear that lamb meat consumption must be considered as one of the main pathways for radionuclides into the human foodchain.

One of the aims of the Icelandic study have been to collect data from as broad spectrum of land types as possible. The RAD-3 project was carried out at two different locations, in highland pasture, previously used for grazing research and at the experimental station Hestur on lowland mire. The EKO-2 project is being conducted at the experimental station Stóra Ármót on uncultivated dry lowland pasture. Thereby it is assumed that a wide range of the land types, used for sheep grazing, are covered.

AGRI has been responsible for providing animals and experimental sites, as well as monitoring of animals (live weight, live weight gain), estimation of standing herbage (biomass) and part of the sampling, as well as part of the sample preparation. Caesium analysis of all samples has been carried out at IRPI. Chemical analysis of vegetation are carried out at AGRI. Collected samples include soil, milk, vegetation and faeces.

Relatively high variation has been observed in caesium content, both in soil and vegetation, as well as between animals, due to heterogeneous distribution within the soil and vegetation. This emphasises the importance of connecting the data with the environmental factors on each site. Factors connected with the animals, i.e. grazing pattern, plant selection, intake and digestibility must also be considered. As the sampling for the RAD-3 project have been done on experimental farm where other experiments have been conducted at the same time, data on intake, digestibility and grazing behaviour are available. A broad information is also available on the genetic traits of the Hestur sheep flock, as the same herd has been bred there since 1951.

This study was a part of the NKS / RAD-3 project in the 1990-1993 and it now forms a part of the NKS / EKO-2 project.

Deterministiske skader og dosisreduction i interventionel neuroradiologi i Danmark

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Deterministiske skader i røntgendiagnostikken har igennem mange år været få. Med interventionsradiologien, der medfører meget lange gennemlysningstider og adskillige optagelsesserier, foreligger der oplysninger om skader fra flere lande. Der redegøres for de relevante skader, deres dosistærskel og latenstider.

Beregning af patientdoser i interventionsradiologien kompliceres af, at de moderne apparater er mikroprocessorstyrede og dermed giver mulighed for brugeren til at vælge mellem adskillige programmer til styring af højspænding, rørstrøm, filtrering m.m. Der bringes et eksempel på et sådant reguleringssystem.

I Danmark har én røntgeninstallation givet anledning til to tilfælde af epilation (håraffald) i forbindelse med interventionel neuroradiologi. Der redegøres for de dosismålinger der er foretaget, de tiltag og anbefalinger der er gjort med henblik på at reducere doserne fremover og dermed forsøge at undgå de deterministiske skader.

Strålrisk vid mammografscreening - försumbar eller ett stort problem?

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När för två decennier sedan direktfilmen ersattes med skärm-film-kombinationer med en kraftig dossänkning som följd var den allmänna uppfattningen att strålrisken inte längre var av avgörande betydelse för mammografiscreeningens vara eller icke vara. Sedan dess har allmän screeningsverksamhet introducerats i flera länder. Bortsett från enstaka kortvariga debattinlägg har det varit tyst om strålriskerna. År det en bedräglig tytsnad?

Utvecklingen under det senaste decenniet ger anledning till eftertanke, både vad det gäller stråldosen och riskvärderingen. När allmän screening startade i Sverige 1986 var standardtekniken en projektion, utan raster, och med ett intervall på 1,5 till 2 år. Den årliga genomsnittsdosen (mean glandular dose) i ett screening program, var då 0,3 - 0,5 mGy. Idag gäller tvåbildsmammografi med raster och tendensen går mot högre filmsvärtningar och för den yngre åldersgruppen diskuteras 1-års intervall. Den årliga genomsnittsdosen kan då utan vidare klättra upp till 7 mGy.

För 20 år sedan användes risksiffran 3 bröstcancerdödsfall per 1000 bröstSv för kvinnor i åldrarna 40 - 49 år¹. Enligt ICRP 60² är motsvarande siffra 5, och använder man resultaten från den svenska fibroadenomasstudien³ blir den 10.

Risken måste ses i förhållande till nyttan av verksamheten. Mest kritiskt är det för den yngre åldersgruppen, 40 - 49 år. Inte förrän nyligen har det kunnat visas med (nästan) statistisk signifikans att screening med mammografi kan sänka dödligheten även för dessa kvinnor, med ca 20 procent.

Utgående från vad som sagts ovan kan förhållandet nytta (= senarelagda dödsfall eller vunna levnadsår) till risk (= strålinduceraade cancerdödsfall eller förlorade levnadsår) beräknas för olika scenarion. I det sämsta fallet, dvs kombinationen hög stråldos, hög strålrisk och moderat reduktion av bröstcancerdödlighet blir nytta/risk förhållandet lika med 1 - förvisso en kontraindikation för screeningverksamhet.

Slutsatsen måste vara, att stråldosens begränsning ges en framskjutande plats vid planering och uppföljning av mammografiscreening, främst när det gäller kvinnor i yngre åldrar. Tekniken finns idag för att uppnå fullgod bildkvalitet med en standarddos per bild på 0,5 - 1 mGy, och den tekniken måste användas om mammografiscreening ska hjälpa och inte stjälpa kvinnornas hälsa.

¹ Baral E, Larsson L-E, Mattsson B: Breast cancer following irradiation of the breast. Cancer 40, 2905-2910, 1977

² International Commission on Radiological Protection, 1990 Recommendations. ICRP Publ. 60, annex B, (1991)

³ Mattsson, A, Ruden, B-I, Palmgren, J and Rutqvist, L-E: Dose- and time-response for breast cancer risk after therapy for benign breast disease. Brit. J of Cancer Vol 72, 1054-1061 (1995).

Persondoser fra medicinsk brug af Positron Emission Tomografi

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Abstrakt

Dette foredrag omhandler en undersøgelse og kortlægning af strålingsforhold og strålingsniveau i centret for Positron-Emission-Tomografi-skanning på Rigshospitalet i Danmark. Undersøgelsen omfatter en analyse af kilderne til de stigende strålingsdoser, der siden centrets opstart i 1992, ved overvågning med film- og lommedosimetre, er registreret til det stråleudsatte personale. Personælet modtager strålingsdoser i forbindelse med fremstilling af radioaktive injektionsvæsker forud for skanningen. Ligeledes udsættes personælet for stråling i forbindelse med, at patienter får foretaget injektioner.

Forhold vedrørende luft- og overfladekontaminering i centret er undersøgt, og strålingsdoser fra såvel gennemtrængende gamma-stråling som blød β-stråling fra de radioaktive præparater er blevet opmålt og vurderet. Til overvågning af luftkontamineringen blev en luftmonitor konstrueret, mens kendskab til overfladekontamineringen er opnået ved hjælp af aftørningsprøver. Helkropsdoser og helkropsdosishastigheder er registreret og analyseret, til tidspunkter under fremstilling og injektion af de radioaktive præparater, ved hjælp af et lommedosimeter. Dosis til personælets fingre/hænder ved håndteringen af de radioaktive præparater er undersøgt ved hjælp af termoluminescente materialer. Særligt er et fingerdosimeter, hvor der tages højde for både β- og gamma-strålingens bidrag til dosis, udviklet.

De opmålte doser er sat i relation til "Den Internationale Kommission for Strålebeskyttelse"s anbefalinger vedrørende beskyttelse mod ioniserende stråling. På grundlag heraf, er det vurderet hvorvidt, der i forbindelse med forskellige arbejdssituationer i centret er behov for en forbedret strålehhygiejne. I foredraget vil der blive givet forslag til, hvor der kan sættes ind, og hvilke forholdsregler der kan tages, hvis strålingsdosis til det stråleudsatte personale skal reduceres.

UPPFÖLJNING AV DATORTOMOGRAFIANVÄNDNING I SVERIGE

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Statens strålskyddsinsitut samlade 1991 in uppgifter om användningen av datoromografi i svensk sjukvård. Dessa komletterades sedan med dosmätningar och dosberäkningar. Resultatet från denna kartläggning redovisades bl.a vid Nordiska Sällskapet för Strålskydds förra möte i Kristiansand 1993.

Slutsatserna från kartläggningen ledde till att Statens strålskyddsinsitut efterlyste en mer individuell anpassning av exponeringsparametrar till kroppsstorlek, undersökt område m.m.

Under våren 1996 har en uppföljning gjorts med en enkät om maskinpark, antalet undersökningar och undersökningsteknik. Svaren visar en fortsatt ökning av datortomografianvändningen både i antalet tomografer som nu är ca: 110 st och antalet undersökningar som nära nog fördubblats sedan den förra kartläggningen. Vad gäller undersökningsteknik kan skönjas att införandet av anpassade undersökningstekniker kommit igång såsom sänkning av doserna vid undersökning av barn och i övrigt skillnad för olika kroppsstorlekar samt skillnad mellan undersökning av thorax kontra buk.

METODE TIL SEPARATION AF GENNEMLYSNINGS- OG FOTOGRAFERINGS- DOSIS VED AREALDOSIS MÅLINGER PÅ PATIENTER.

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Resumé.

I takt med den stigende brug af arealdosismetre til kvalitetskontrol på hospitaler, er det ofte nødvendigt at kunne skelne mellem dosis hidrørende fra gennemlysning og fotografering. Separationsprocesen er triviel når der kun benyttes almindelige filmkassetter. Ved brug af spotfilm og digitalteknik er problemstillingen en anden, idet arealdosis pr. tidsenhed fra henholdsvis fotografering og gennemlysning er af omtrent samme størrelse.

Ved hjælp af en computer kan data fra arealdosismeteret opsamles hvert sekund. På denne måde fås en kurve over arealdosis pr. tidsenhed ($\text{mGy} \times \text{cm}^2/\text{s}$). Disse data sorteres efter størrelse i stigende orden. Computeren analyserer nu disse sorterede data og finder således et sted hvor ændringen i arealdosis pr. tidsenhed er særlig stor. Dette punkt repræsenterer overgangen mellem data fra gennemlysning til fotografering. Niveauet for, hvor stor ændringen skal være, bestemmes ud fra målinger på et antal patienter, hvor antallet af billeder er kendte.

De data der er benyttet til at teste den nuværende version af metoden er indsamlet på fire danske hospitaler. Der er indsamlet data fra både colon og ventrikkel undersøgelser. Ialt er der på nuværende tidspunkt analyseret data fra undersøgelserne af ca. 40 patienter hvori der indgår fotografering og gennemlysning. Data er indhentet i forbindelse med et projekt, hvis formål er at kortlægge arealdoserne fra seks udvalgte undersøgelser. Disse målingerne vil med tiden blive foretaget på alle danske hospitaler.

Det har vist sig at metoden er i stand til at angive antallet af billeder meget nøjagtigt. Hvis der sammenlignes med det antal billeder man visuelt kan bestemme ud fra hastighedskurven, så er afvigelsen +/- 1 billede.

Alt tyder på at man langt nemmere kan bestemme antallet af billeder ved en kompleks undersøgelse hvis instrumentet kan samples hurtigere (op til 200 gange pr sekund). Dette er i øjeblikket ved at blive undersøgt.

Analyse av data fra arealdosemålinger av pasienter i röntgendiagnostikk.

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Abstrakt

Et landsomfattende program med målinger av arealdose av pasienter i röntgendiagnostikk har pågått i Island siden 1994. Data fra undersøkelser av mere enn 2000 pasienter fra 10 forskjellige röntgenavdelinger fordelt på 40 forskjellige eksaminasjoner foreligger. En har benyttet arealdosemetre med grensesnitt til dator, som har gjort det mulig å la personale ved de enkelte röntgenavdelinger selv utføre målingene, og som også har gjort det mulig å foreta en etterfølgende inngående analyse av innsamlet data.

Analyse av data er for en stor del automatisert, og består av både en separasjon av radiografi og fluoroskopi, og et estimat av usikkerheten av gjennomsnittsverdier fra de enkelte undersøkelser. Arealdoser fra radiografi og fluoroskopi separeres på følgende måte. Under eksaminasjonen registreres akkumulert arealdose hvert 0.4 sekund. Fra dette konstrueres et tidsbilde av eksaminasjonen (arealdose per tidsenhet). Radiografier kan så skjelnes fra fluoroskopi ved en korrelasjon med en kassebölgefunksjon med samme bredde som den radiografiske topp.

De overfor nevnte metoder vil bli gjennomgått. Eksempler på analyse av forskjellige röntgeneksaminasjoner fra den islandske undersøkelse vil bli gitt.

BEHANDLING AF GODARTEDE THYREOIDEASYGDOMME MED I-131 NATRIUMIODID I DANMARK 1990 - 1995

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ABSTRACT

Antallet af indgivne doser I-131 natriumiodid til behandling af godartede thyreoideeasygdomme i Danmark er godt og vel fordoblet i perioden 1990 - 1995. Den gennemsnitligt indgivne dosis var i 1995 ca 425 MBq - i 1990 var den gennemsnitligt indgivne dosis 390 MBq. Incidensen af godartede thyreoideeasygdomme i Danmark har i perioden været relativt konstant (ca 4000 nye tilfælde/år). Stigningen i antallet af indgivne doser forklares dels ved, at denne behandlingsform vinder stigende udbredelse på bekostning af (især) kirurgisk behandling, og dels ved, at man i Danmark i stigende udstrækning også behandler atoksiske strumaer med I-131.

Foredraget redegør for udviklingen i perioden og diskuterer de problemstillinger, stigningen giver anledning til. Foredraget vil desuden komme ind på de forhandlinger, der p.t. føres i EU med henblik på fælles regler omkring strålebeskyttelsen ved denne behandlingsform, herunder fælles tilladte grænser for restaktivitet/administrerer aktivitet i ambulante patienter.

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Apoptosis: Effects of ceramide and ionizing radiation

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Recent evidence suggests that ionizing radiation and various other stimuli such as tumor necrosis factor- α and the Fas antigen signal through the sphingomyelin pathway to induce apoptosis. The sphingomyelin pathway is initiated in the plasma membrane by hydrolysis of the phospholipid sphingomyelin to generate ceramide by the action of sphingomyelinase. Ceramide then acts as a second messenger to stimulate a cascade of protein kinases, protein phosphatases and transcription factors like NF- κ B to activate a common programmed cell death pathway.

To learn more about cell signalling in apoptosis and the cellular response to ionizing radiation we compared the effects of the cell membrane-permeable ceramide analogue N-acetylsphingosine with the response of the cells when exposed to ionizing radiation. Flow cytometry and agarose gel electrophoresis were used to detect cell-cycle effects and apoptosis. A brief review of the field will be given and a few early results will be presented.

FURTHER STUDIES OF RADIOACTIVITY IN DIALYSIS PATIENTS

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From radiation protection point of view, it is important to identify critical groups. Patients with end-stage renal disease might constitute a critical group due to intake of radiologically important nuclides. Dialysis could be an effective method of removing radionuclides from the blood-pool. Up to date there has been very few publications concerning this field. D. Josefsson et al (1995, SSI project 722.92. The Science of the Total Environment.) discussed the effect of dialysis on radiocaesium in man. Josefsson showed that there was a considerable reduction of ^{137}Cs among the haemodialysis patients compared to peritoneal dialysis patients and healthy persons.

Culpepper (Clinical Nephrology, 1992, 38, p. 110), however, focused on the reduction of ^{131}I by haemodialysis. He showed that the maximum clearance of ^{131}I was achieved 24-29 hours after intake. Verzijl et al (Health Phys., 1995, 69(4): 521-529) showed in simulations that extracoporeal clearance could diminish the committed effective dose, $E(50)$, of ^{137}Cs by more than 50% in a perspective of 50 years. The traditionally used Preussian Blue salt reduces $E(50)$ by approximately 30%. Furthermore, Culpepper and Cheng (Seminar in Dialysis, 1992, 5, p. 129), have studied the aspects of radiation protection for personnel categories working with dialysis, when treating patients who have received treatment with iodine-131 shortly before dialysis.

The objective of our research was to see how fast a dialysis patient could get rid of radiocesium after intake. For this purpose we used meat from reindeer mainly contaminated by radiocesium from the Chernobyl-accident. Dialysis fluid was collected fractionally every time of dialysis. One could observe a fast accumulation of radiocesium at the beginning and a slower at the end of each dialysis. The amount of accumulated radiocesium decreased for each occasion of dialysis both fractionally and totally.

Furthermore, the results show that haemofiltration is a more effective method than haemodialysis concerning ^{137}Cs .

It was also observed that the dialysis concentrate contained ^{210}Po and consequently a few hundreds of mBq of ^{210}Po was transferred to the patient at each dialysis.

An inexpensive phantom for quality control in dental radiography

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Abstract

The Icelandic Radiation Protection Institute has developed a postal package comprising a phantom and TLD chips, for routine quality control assessment of dental radiographic equipment and film processing.

The new package is based on an earlier postal survey of the dental x-ray units in Iceland, with a package consisting of an industrial radiographic film, TLD chips and a questionnaire on the use of each x-ray unit. This survey gave a fairly accurate picture of the use and of the radiation absorbed doses, concluding that a wide range of doses was used for similar examinations and equipment. Additional information of the quality of the imaging chain at each practise is thus of interest, and may together with information of the radiation absorbed doses be used in optimising the radiographic procedure.

The dental phantom is designed with the following criteria in mind:

- Low production cost
- Robust and light weight for easy transport by mail
- Shall give information of contrast and resolution of imaging chain
- Can carry TLD ribbons for dose measurements
- Be used with the most common size dental radiographic film (31 mm x 41 mm)
- Easy to use for routine QA assessment by the dentist or his staff

The phantom is made of perspex material, with an aluminium step wedge for visual and quantitative estimation of density and contrast, a section for low contrast detail evaluation, a section for high contrast resolution, and a lead stopper for measurement of background density of the film.

The phantom and its accompanying software for evaluation and registration of phantom images, will be presented. Examples from measurements will be given.

DOSES TO PATIENTS FROM NUCLEAR MEDICINE INVESTIGATIONS IN FINLAND IN 1994

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ABSTRACT

A country wide survey concerning the use of radiopharmaceuticals in diagnostics and therapy has been carried out in Finland. A questionnaire was sent to all hospitals and institutions using unsealed sources in nuclear medicine investigations and therapeutic treatments. The questionnaire was divided in three sections (i) nuclear medicine investigations to adults, (ii) nuclear medicine investigations to children and (iii) therapeutic procedures. Within each section the procedures were arranged according to the organ under investigation. For each procedure there was asked the radiopharmaceutical used, the number of procedures performed and the typical administered activity.

The survey gave detailed information about the types and frequencies of the nuclear medicine procedures performed in Finland in 1994. The number of the nuclear medicine investigations was 50900 and that of the therapeutic treatments 2150. The frequency of nuclear medicine investigations in 1994 was 10 investigations per 1000 inhabitants and 85% of the nuclear medicine investigations were made using ^{99m}Tc .

The effective dose from nuclear medicine investigations to patients and to the population was calculated. For calculating the collective effective dose the dose factors (mSv/MBq administered radiopharmaceutical) given in the ICRP Publication 62 were used. The collective effective dose to the patients was 220 manSv and the mean effective dose to the population 0,04 mSv/person in 1994.

Patient doses from CT examinations in Norway, with analysis of factors affecting the effective dose, including specific clinical indications.

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Abstract

The patient doses from seven CT examinations were assessed based on the reported scan techniques from 44 hospitals (49 scanners) in Norway. The dose assessments were done according to the data and method published by the National Radiological Protection Board. The mean effective doses were 2 mSv for examinations of the head, 10 - 13 mSv for examinations in the trunk region and 4.5 mSv for examinations of the lumbar spine. Factors of 8 - 20 were observed for the range of values of effective dose in a given type of examination over all scanners in survey. Variations in reported scan volumes and differences between scanner models in survey might each explain about 30% of this total spread in dose for a given examination type. A need for image quality assessments in CT was seen, in order to compare scanner performance.

The survey also included dose calculations for examinations done on twelve specific clinical indications. However, the reported scan techniques and resulting doses for a given clinical indication still varied considerably over all scanners in survey. This emphasises the need for a discussion on scan technique, both with respect to the number of slices, coach increment, tube load, and the use of contrast. It was also seen a need to review the scan technique in order to reduce the dose to radiation sensitive organs like the eye lenses and gonads, and for an overall discussion on the reasons for requesting CT examinations in preference to conventional radiological examinations or examinations not involving ionising radiation. The CT doses in Norway were about 50% higher compared to a similar British survey. This might possibly be explained by a larger part of scanners with shorter focus to axis distances presented in Norway.

There were about 70 CT scanners in Norway in 1994 (16.1 scanners per million inhabitants). Based on the frequency of CT examinations in 1993 (50 examinations per 1000 inhabitants per year) the contribution to collective effective dose from CT was estimated to 1000 manSv (0.2 mSv/inhabitant/year), it means about 30% of the contribution from diagnostic use of x-rays.

Reference : Olerud, H.M. and Finne, I.E. *Computer-tomografi ved norske sykehus. Undersøkelsesteknikk og stråledose til pasient.* StrålevernRapport 1995:1 l. Østerås: Norwegian Radiation Protection Authority (1995). (Norwegian text).

Individual radon exposure history measured by an etched track detector technique.

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ABSTRACT

The lung cancer risk from exposure to indoor radon is assessed in epidemiological studies where the radon exposure of the past is of considerable importance. The measurement of the long-lived decay products from ^{222}Rn remaining on indoor surfaces is an alternative or complementary method to the traditional measurement of the radon concentration currently used in assessing the previous radon exposure. A part of the short lived airborne radon progeny will plate out on surfaces in a room and a part of these decay products will be implanted into the surfaces due to the recoil effect associated with an alpha decay.

An autoradiographic alpha-track method to assess the ^{210}Pb activity implanted in glass surfaces by measurement of ^{210}Po alpha activity has been developed and tested under field conditions. One limiting factor at low exposure levels is the alpha background activity in the sub-surface material. In the search for a practical field method, the use of two different alpha track detector materials has been found to be successful.

The KODAK LR-115 cellulose-nitrate film is sensitive to alpha particles with energies approximately in the range 1.2 - 4.8 MeV while the CR-39 detector material is sensitive for alpha-particles up to much higher energies. The alpha-particles from ^{210}Pb have an energy of 5.3 MeV, and thus will not be detected in the LR-115 detector. By exposing one LR-115 and one CR-39 detector side by side on glass panes, the background of the glass is measured with the LR-115 and both the background and the signal by the CR-39 detector.

This combination of alpha track detectors, called RETRU-detector, can measure ^{210}Po surface activity below 1 Bq m^{-2} during field conditions. Measurements in dwellings show that a radon concentration of 50 Bq/ m^3 will give a surface activity of about 1 Bq/ m^2 on a plate glass which has been exposed to that radon concentration during 20 years. The RETRO-detectors will be extensively used to support the exposure assessment in the planned radon epidemiological study on non-smokers in Sweden starting in 1996.

Radon concentrations in new dwellings in Norway

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Results of a nationwide survey of radon concentrations in Norwegian dwellings conducted from 1987 to 1989 have shown that the year average is between 55 and 65 Bq/m³. All 7500 dwellings measured in this survey were built before 1980.

In the period 1980 - 1995 approximately 440000 new houses were built, and approximately 65000 old houses demolished or are no longer in use. The current number of Norwegian dwellings is approximately 1.8 million.

Some of the 2500 measurements of radon conducted by NRPA after 1990 included also these new dwellings. The results of these measurements have shown clear tendency of increased radon levels in the new compared to the old dwellings.

In this presentation, a comparison between radon data sets for houses built before and after 1980 is made. Houses from the same Norwegian municipalities were compared and the minimum difference in the age of the houses was chosen to be 10 years. Since both data sets were obtained using alpha track detectors over several months the error due to measurement is assured to be low.

It is also attempted to assess main causes for increase of radon concentrations in new dwellings. These include changes in building construction technique, reduced air exchange rates etc. The chance in the distribution of number of dwellings vs radon concentration is analysed in the light of the above mentioned factors. On the basis of these data the new dwellings are included in the estimation of past and present radon exposure of the Norwegian population.

Radonmätning på arbetsplatser i Sverige

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Förekomst av radon och radondöttrar i inandningsluft utgör en riskfaktor för lungcancer. Radon bildas genom sönderfall av radioaktiva ämnen i berggrunden och i byggnadsmaterial.

För bostäder och lokaler för allmänheten i Sverige har Socialstyrelsen fastställt gränsvärde 400 Bq/m³ som årsmedelvärde för radongas. För arbetslokaler har Arbetrarskyddsstyrelsen för underjordsarbete fastställt en årsdos på 2,5 MBq/m³, vilket motsvarar ett gränsvärde på 1500 Bq/m³ som årsmedelvärde. För övriga arbetsplatser ska 400 Bq/m³ gälla som gränsvärde. I båda fallen har man samrått med Statens Strålskyddsinstitut.

För gruvor och annat bergarbete har gränsvärde för radonexponering funnits länge i Sverige, liksom även krav på mätning av halten radon eller radondöttrar. För övriga arbetsplatser finns inget mätkrav. Det har därför gjorts ganska få sådana mätningar. Däremot har man gjort omfattande mätningar av radon i bostäder. De senaste åren har dock mätningar av radon i lokaler av typ skolor och daghem genomförts i vissa kommuner, men långt ifrån alla.

För att få en bättre uppfattning om radonsituationen på vanliga arbetsplatser har Arbetrarskyddsstyrelsen och yrkesinspektionen genomfört ett mätprojekt. Yrkesinspektionen är Arbetrarskyddsstyrelsens regionala organ, som bedriver tillsyn på arbetsplatser och kontrollerar att de följer arbetsmiljölagen och de föreskrifter som styrelsen har utfärdat med stöd av lagen.

Metodik

För att begränsa mmfattningen av projektet väljs främst arbetsplatser där man kan förvänta förhöjda radonhalter. Exempel på sådana är

1. lokaler i bergrum
2. lokaler i källar-, souterräng- eller bottenvåning av byggnader på radonriskmark
3. lokaler i hus som är byggda i blå lättbetong, främst om mekanisk ventilation saknas eller misstänks vara otillräcklig

För arbetsplatser på lermark eller liknande utan särskild radonrisk finns ingen anledning att förvänta några höga halter av radon. Det finns då ingen anledning att lägga mätresurser där.

Om höga radonhalter påträffas kan yrkesinspektionen förelägga arbetsgivaren att vidta åtgärder mot detta. Radonbrunn och mekanisk ventilation är vanliga åtgärder mot höga radonhalter.

För projektets genomförande har mätinstrument inköps, dels ett registrerande instrument (Alphaguard) med datorprogram för utvärdering och behandling av mätdata, dels av typ elektret (E-perm). E-perm ger bruttohalt under mätperioden, vanligen några dygn eller en vecka. Alphaguard kan ge diagram med radonhaltens variation under dygnet, max-, min- och medelvärden.

Resultat

Inom ramen för projektet har inspektörer vid sex distrikt disponerat mätinstrument under några veckor. Man har valt ut mätobjekt enligt ovan, genomfört mätningar och rapporterat resultat. Sammanfattande resultat kommer att redovisas vid mötet. Arbetrarskyddsstyrelsen publicerar resultaten i en rapport.

Criteria's in evaluating thorax counting results of uranium fuel fabrication operators.

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Abstract

During the manufacturing in a nuclear fuel fabrication plant the employees are exposed to uranium materials of various characteristics. Due to the low specific activity of commercial uranium (60 kBq/g) and most decays without significant gamma/beta contribution the Health Physics interest is mainly to minimise surface- and airborne contamination. All operators at ABB Atom are controlled at predetermined intervals by a specific thorax counting on determining inhaled uranium contamination. Assessment of uranium contamination due to inhalation comprises several parameters in determining a true lung burden. Some of these parameters influencing the result are:

1. Sources

Enrichment, chemical characteristics and particle (aerosol) size.

2. Contamination route

Acute or continuos intake (inhalation and/ or ingestion).

3. Timeliness

Equilibrium uranium/uranium daughters.

4. Measurement equipment and method

High or low resolution gamma spectroscopy, calibration practice and background subtraction.

5. Object characteristics

Male or female, fat or thin, tall or small, skin contamination on chest surface or other parts of the body, ingestion of food containing Cs-137 food prior to measurement.

This paper explains the decision taking for some of the object characteristics determining the thorax counting results at ABB Atom.

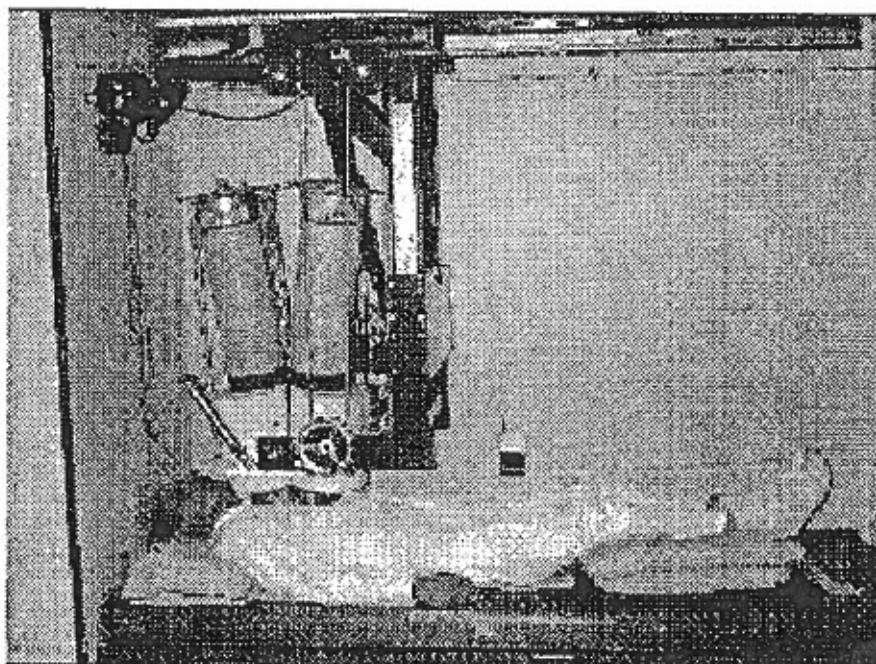


Figure 1. Detector set-up in the low background room used for the lung burden measurement of fuel fabrication operators.

NORM in Oil Production - Occupational Doses and Environmental Aspects

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Abstract

Radioactive deposits, often referred to as LSA (Low Specific Activity) scale, can under certain circumstances be formed inside production equipment in oil production. These deposits contain elevated levels of radioactivity, mainly ^{226}Ra , ^{228}Ra and their daughter products, and represents a waste problem for the oil industry.

Most of the radioactivity from the reservoir is disposed with produced water in to the sea. Extensive measurements of levels of radioactivity in produced water and LSA scale have been performed for several North Sea installations, and some of the results will be presented.

External exposure to workers has been measured during typical operations both off shore and on shore involving handling of contaminated equipment. Because of the low ALI values of the radionuclides in question, the potential internal exposure to workers is of particular importance. Release of dust from contaminated items is not found to be significant during normal operations, but internal hazards are still considered to be of major importance when discussing the potential exposures.

Several alternatives for waste disposal are under advisement by the Norwegian authorities, and consequences of these alternatives will be discussed along with evaluation of legislations and guidelines for treatment of LSA scale.

Future work will consist of development of reliable methods for classification of equipment as «radioactive» or «non radioactive», harmonisation of legislations and guidelines among the North Sea countries, and development of standard routines for handling contaminated equipment.

RESULTS OF RADON EPIDEMIOLOGICAL STUDIES IN FINLAND

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Abstract

Two Finnish epidemiological studies were completed recently:

The study of Auvinen et al. was a nested case control study. The base population comprised all persons (892 943) residing in the same single-family house (index dwelling) from January 1, 1967, or earlier until the end of 1985. All lung cancer cases (1973 persons) diagnosed from January 1, 1986 through March, 31, 1992 were identified from the Finnish Cancer Registry. An integrating radon measurement of 12 months was done in all index dwellings. Information concerning smoking and other exposures was collected from study subjects or their next of kins using questionnaires. Conditional and unconditional logistic regression methods were used to analyse the data. The final number of matched pairs was 517. After adjustment for smoking and occupational exposure to asbestos, the matched analysis gave OR of 0.01 (95% CI 0.94-1.08) per 100 Bq/m³. For indoor radon concentrations of 50-99, 100-199, 200-399 and 400-1277 Bq/m³ the matched ORs and their 95% CIs were 1.03 (0.84-1.26), 1.00 (0.78-1.29), 0.91 (0.61-1.35) and 1.15 (0.69-1.93) relative to concentration below 50 Bq/m³. The unconditional study gave almost similar results.

The study of Ruosteenoja et al. was a re-analysis of a former case-control study. Nineteen rural municipalities in southern Finland with high levels of radon exposure were included in the study. All 238 cases of male lung cancer diagnosed during 1980-85 were identified. Controls were selected from a random sample of 1500 men of same age distribution as the cases. After a smoking inquiry all 395 smokers and a random sample of 50 ex-smokers and 50 non-smokers were selected. Radon measurements of two months during the winter were performed in all identified dwellings of cases and controls from 1950 until 1975. Logistic regression method with two-stage analysis was employed to take fully into account the sampling design balanced with respect to smoking. The final number of cases and controls were 164 and 331, respectively. After adjustment for smoking intensity, quitting of smoking, and age, for indoor radon concentrations of 95-186 and over 186 Bq/m³ the ORs and their 95% CIs were 1.8 (0.9-3.5) and 1.5 (0.8-2.9), relative to the lowest tertile of radon concentration below 95 Bq/m³.

Both these studies failed to detect the risk of lung cancer associated with indoor radon exposure. The results of these and other recent radon epidemiological studies are discussed.

^{137}Cs in a large freshwater basin - A dynamic model

Mikael Moring

ABSTRACT

A dynamic environmental model has been made for the Asikkala water basin in Lake Päijänne. The Asikkala basin is of special interest both because of extensive fishing and because it supplies freshwater for the whole Helsinki region. The model predicts the behaviour of fallout caesium in water, sediment and fish.

As Asikkala is a large freshwater basin, the model differs from the most usual freshwater models, which tend to focus on smaller lakes. The model gives a previously non available possibility for calculations of behaviour of radiocaesium in an ecological system which has exceptional importance for dose to man.

The model takes into account the seasonal stratification and mixing characteristics of a large basin by dividing it in epilimnion and hypolimnion. For the runoff calculations, the drainage area is divided into arable and forest land. Seasonal variations in flow and transfer parameters are included.

The Asikkala basin has been thoroughly studied, and radioecological measurements have been made since nuclear weapon test fallout, and more frequently since the Chernobyl accident. Radiocaesium levels in water and sediment and sedimentation rates have been measured by the Radiochemical Department at University of Helsinki. Radiocaesium in water and fish has been extensively measured at STUK.

The substantial available knowledge of hydrological data and previous fallout behaviour provides a good base for model construction and validation. The model of the basin is built mainly on hydrological data and the calculated results are in good agreement with post Chernobyl measurements. Comparisons between model calculations and measured data will be presented in the paper.

The work is a part of the Finnish contribution to the NKS/EKO-2 limnic ecosystems project.

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Radiocesium in grazing sheep - A statistical analysis of variability, survey methodology and long term behaviour

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Abstract

In the two grazing units of Fåset and Fonnåsfjellet in the county of Hedmark, Norway live monitoring of sheep has taken place each autumn since 1987. As no countermeasures had been implemented in these areas, observations from these grazing units formed the basis for a study of the importance of fungi for radiocesium levels in sheep. Regression analysis of the observations from Fåset and Fonnåsfjellet gave the following estimated model for radiocesium concentration in sheep (A) t_c years after the Chernobyl accident:

$$A(t_c, t_p, F) = 370 \cdot e^{-0.09 \cdot t_c} + 190 \cdot F \cdot (1 - e^{-0.03 \cdot t_p}), \quad R^2 = 0.60$$

F is amount of fungal fruit bodies available as feed for the animals in year t_c and t_p is time on pasture with fungi available. The estimated biological elimination rate for radiocesium in sheep is 0.03 d^{-1} . When the influence of ingested fungi is separated, the total radiocesium concentration in sheep was found to have decreased with an effective half life of 3.9 ± 0.8 years. For ^{137}Cs alone the estimated effective half life was 7.8 ± 2.6 years. The estimated contribution from ingested fungi to the total radiocesium concentration in sheep in the studied areas was found to be up to 75-80 % in 1988 and 1991, during which years fungi were most abundant.

Observations from the grazing units of Vuludalen and Baklia, where whole herds were monitored in 1987, formed the basis for a study of sampling strategy and variability of radiocesium concentration within a herd. Analysis of variance showed a significant difference in radiocesium concentration in ewes and lambs, with lambs having approximately 20-40 % higher levels. The estimated average radiocesium concentration in a grazing unit is based on monitoring a sample of 8-10 animals. A study of the variability indicated that more than twice as many animals should be monitored if an estimate of the mean radiocesium concentration should be obtained with uncertainty less than 10 %.

Radioactivity of timber.

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ABSTRACT

In autumn 1993, Finnish timber was analysed for radiocaesium (^{134}Cs , ^{137}Cs) and potassium (^{40}K). ^{137}Cs originated mainly from the fallout of the Chernobyl nuclear accident in 1986. Traces of nuclear weapons fallout also contributed to the ^{137}Cs contents in wood, bark and phloem of trees. The analysed material consisted 87 samples of logs of Norway spruce, Scots pine and birch. The samples were collected when logs were received to the sawmills and when the origin of trees was known. The samples were from 47 municipalities.

The radiocaesium contents found in the study were used to derive the mean contents in logs cut in the felling season of 1993/1994.

Harvesting of trees removed about 10^{12} Bq of ^{137}Cs from the forests during the felling season 1993/94. The removed fraction was 1-2 % of the accumulated deposition of ^{137}Cs in the forest area treated with felling and about 0.03% of the ^{137}Cs inventory of the total forest area.

Radiation doses from ^{137}Cs in timber used as building material were estimated for loghouses constructed of domestic wood. The inhabitants were assumed to spend indoors 7000 hours in a year. The annual doses are only a few percent of the dose constraint of 1 mSv a^{-1} set for ^{137}Cs in building materials. The ^{137}Cs content in timber and collective doses thereof will probably increase slowly in the next few years. Especially the gradual removal of old, less contaminated trunks from the forests and the simultaneous growth of new, contaminated trees will increase the amount of ^{137}Cs in raw wood in the near future. No limitations for use of Finnish timber are needed for radiocaesium contents derived from Chernobyl fallout.

Transfer and long term behaviour of ^{137}Cs in sheep at Tjøtta, Norway, 1988-1995. Report from the NKS EKO2 experiment in Norway.

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ABSTRACT

3-5% of the radiocaesium released from the fire in the Chernobyl reactor in 1986 is estimated to have been deposited in Norway, mostly in rural and mountain areas. The use of these areas for summer grazing by domestic animals has resulted in high levels of radioceasium in reindeer, mutton, cows- and goat milk. The Norwegian government has put much effort into reducing the radiocaesium levels in food products in order to comply with the intervention levels. During the first decade the total cost for implementing countermeasures, research, monitoring and interdiction of meat in connection to sheep-breeding was 370 million NOK (60 million US\$). The corresponding costs for the reindeer-breeding was 18 million US\$.

The study of the long term behaviour of radiocaesium in sheep at Tjøtta was started in 1988 and has been funded by NKS and the Research Council in Norway. Tjøtta is located on the coastline in Nordland county (66.6°N) and the study area is a fenced area of 0.4 ha of a natural pasture on sandy soil and a vegetation dominated by *Poa spp*, *Festuca spp*, *Trifolium spp* and *Ranunculus spp*. Average deposition of ^{137}Cs is 35 kBq m^{-2} . Negligible amounts of fungi are available to the sheep grazing the study area. The animals were live monitored every week during the grazing season. The main findings:

- The effective ecological halflife of ^{137}Cs in sheep at Tjøtta in the period 1988-1995 range from 10 to 20 years.
- No significant decrease in activity levels of ^{137}Cs in mixed vegetation samples or in samples from separate species were found in the period 1990-1994.
- Levels of ^{137}Cs in sheep and vegetation decreased significantly in 1995 compared to previous years.

The reason for the decrease in activity levels in 1995 is not yet found but may partly be explained by increased biomass production due to an unusually high precipitation in August.

Transfer of radiocaesium via reindeer to man - the effect of countermeasures used in Sweden after the Chernobyl accident

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Large areas of reindeer pasture in Sweden were contaminated with radioactive material after the accident at the Chernobyl nuclear power plant in Ukraine in April 1986. Reindeer from these areas are still contaminated with radiocaesium. In Sweden, the upper limit for ^{137}Cs in reindeer meat sold for human consumption is $1\ 500 \text{ Bq kg}^{-1}$ (fresh weight). This limit has greatly reduced the transfer of radiocaesium via reindeer meat to man. Counter measures, as altering the time of slaughter and feeding reindeer uncontaminated feed, has also reduced the transfer.

In this paper I present an estimation of the actual intake of radiocaesium via reindeer meat, and the corresponding collective radiation dose, to humans in Sweden during the first ten years after the Chernobyl fallout. The transfer of radiocaesium and the collective dose is compared with the potential transfer, and corresponding dose to man, that would have occurred in the absence of activity limits and countermeasures.

Transfer of Cs-137 from Soil to Vegetation and to Grazing Lambs in a Mountain Area in Northern Sweden. Ecological Half-life of the Nuclide

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ABSTRACT

Within the research programme of NKS (Nordic Nuclear Safety Research) radioecological studies in the chain soil-grass-lamb were carried out in natural or seminatural areas in the Nordic countries in 1990-1993. Further studies are made in the same place during another 4-year period in order to i.a. get information on the ecological and the effective ecological half-life of Cs-137. The possible activity contribution by fungi and soil ingestion of the lambs will be studied. In Sweden the studies are located to a mountain farm in the Chernobyl fallout area in the country of Jämtland. The study lambs are grazing freely in a mountain area covering about 10 km². In the present paper the main study results obtained in Sweden in 1994 and 1995 are given. Comparisons are made with the published results of the previous study years.

Time-corrected (corrected to August 1990) means of Cs-137 concentrations were as follows: in soil (average of samples taken to a depth of 10 cm in the soil layer in five fixed localities distributed over the grazing area) 17.62, 14.56, 16.66, 14.07, and 13.69 kBq/m² in 1990-94, respectively; in herbage of the mentioned localities 1175, 1125, 960, 900, 879, and 779 Bq/kg dry weight (1990-95); in abdomen wall muscle of lamb carcasses 1090, 684, 538, 640, 509, and 684 Bq/kg wet weight (1990-95). The results indicated an ecological half-life of Cs-137 in herbage of 8.5 years and in lamb muscle of 8.0 years. During the period 1991-95 the concentrations in lamb muscle were, however, nearly unaltered, indicating a very long ecological half-life, >100 years, with a corresponding effective ecological half-life of 24.1 years (thus approaching the physical half-life of the nuclide). In all years all individual lamb carcasses exceeded the Swedish intervention level of Cs-137 for human consumption.

Values of transfer factors are given for the respective years: *TFsoil to plant* (Bq/kg d.w. plant per kBq/m² soil) 74.3, 72.3, 64.7, 57.2 and 68.6; *TFplant to muscle* (Bq/kg w.w. muscle per Bq/kg d.w. plant) 0.93, 0.61, 0.56, 0.71, 0.58 and 0.88; *TFsoil to muscle* (Bq/kg w.w. muscle per kBq/m² soil) 61.9, 47.0, 32.3, 45.5 and 37.2. The transfer factors except the *TFplant to muscle*, showed minor decreases. Further studies until 1997 will give more information on possible trends.

The effect of biotite and other minerals on the transfer of radiocesium to grass

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Abstract

Short-term pot experiments with peat soil were carried out to investigate the effect of biotite, heavy (illitic) clay soil, apatite, bentonite and zeolite on the uptake of ^{134}Cs by ryegrass. Further, a long-term effect of biotite on ^{137}Cs concentration of ryegrass was followed up in a five years field experiment on peat soil. Biotite and apatite are recommended as low soluble potassium and phosphorus fertilizers, respectively, for organic farming. Biotite is a byproduct of phosphorus mining and apatite is a raw material for phosphorus. The relative ^{134}Cs concentrations of plants are expressed as percentages of those of the control plants grown on pure peat soil.

The plant uptake of radiocesium was decreased most by zeolite. The average concentration of ^{134}Cs of the plant was in the case of zeolite 5 %, in heavy clay 30 %, in bentonite 70 %, in biotite 80 % and in apatite over 90 %. (The percentages are means of three cuts and the three applications of the minerals: 10, 20 and 40 g/litre of soil.) The effect of zeolite was not as persistent as that of biotite. When zeolite (1-8 g/l) was mixed in biotite (40 g/l), the plant concentration of ^{134}Cs of the three cuts were fairly low decreasing with cuts as follows: 30, 13 and 5 %. When the same amounts of zeolite were used without biotite the plant cesium was increased with cuts: 34, 67 and 50 %. Further, in the same experiment, the addition of biotite (40 g/l) without zeolite decreased the plant cesium with cuts as follows: 76, 20 and 6 %. In a field experiment on peat soil, application of biotite of about 30 tons per hectare decreased the concentration of the fallout ^{137}Cs of plants by factor of about 2.5. The average plant/soil concentration ratio of ^{137}Cs for the biotite field was 0.05 and that for the control field 0.12. The effect of biotite on the cesium concentration of plants was observable after five years since application.

A foodbasket investigation to assess the average intake of ^{137}Cs by the population in Sweden in 1994.

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Abstract:

During the autumn of 1994 an investigation of foodstuffs has been accomplished to assess the average intake of cesium-137 by the Swedish population due to the Chernobyl accident. A standardized foodbasket has been collected from two grocers in 10 localities, of which the majority came from areas with the highest fallout. The composition of the food basket will be described and the choice of sampling sites. The estimated maximum intake of cesium-137 was 815 Bq year $^{-1}$ in the inland of the county of Västerbotten. The population weighted average intake for the fallout affected counties was 435 Bq year $^{-1}$. The rest of the country received an intake of 235 Bq year $^{-1}$. The population weighted average of the intake for the whole country was estimated to 274 Bq year $^{-1}$. From this intake the calculated body burden would be 1.3 Bq kg $^{-1}$ for the average citizen. Whole-body measurements of a sample of the population gave 2.0 Bq kg $^{-1}$. A plausible explanation would be that 40 % of the intake of cesium-137 can have its origin from 10% of the consumption of foodstuffs that are home produced or collected for the average individual in Sweden. The average intake of 274 Bq year $^{-1}$ gives a committed effective dose equivalent of 3.6 μSv .

RADIOAKTIVA ÄMNEN I LIVSMEDEL PRODUCERADE I FINSKA LAPPLAND

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Redan på 1950-talet upptäckte man att halterna av radioaktivt cesium och strontium i mjölk var högre i Lappland än i södra Finland. Ända sedan dess har man följt med halterna också i andra livsmedel än mjölk och framför allt i renkött. Speciellt efter Tjernobylolyckan har radioaktivitetsnivåerna i livsmedel och naturprodukter från Lappland övervakats med årligen insamlade prover. Den numera omsorgsfullt undersökta näringsskedjan lav-ren-människa är den mest betydelsefulla ur strålskyddssynpunkt. Det finns fortfarande manliga renskötare som åtminstone tidvis äter ungf. 1 kg renkött per dag. Renköttets cesium-137 halt var högst år 1965, i medeltal $2,5 \text{ kBq kg}^{-1}$, sjönk till $0,3 \text{ kBq kg}^{-1}$ vintern 1985-86, men steg efter Tjernobyl-olyckan till i medeltal $0,7 \text{ kBq}$ 1986-87 för att nu ligga på nivån $0,3 \text{ Bq kg}^{-1}$ igen.

Eftersom det radioaktiva nedfallet i finska Lappland efter olyckan i Tjernobyl var litet steg halterna i andra livsmedel än renkött, fisk och svamp inte mycket. I insjöfisk i Lappland har förhöjda halter konstaterats: i abborre $0,2 \text{ kBq kg}^{-1}$ 1986-87, $0,1 \text{ } 1990-91$ och $0,05 \text{ } 1994-95$. I svamp har man konstaterat olika halter beroende på art, på växtunderlag etc, men ingen betydande förhöjning. En liten förhöjning kunde noteras i skogsbären hjortron och blåbär ($1986-1987 \text{ } 75 \text{ och } 35 \text{ Bq kg}^{-1}$, $1994-1995 \text{ } 25 \text{ och } 15 \text{ Bq kg}^{-1}$). I praktiskt taget alla livsmedel producerade i Lappland har aktivitetshalterna sjunkit till samma nivå som före olyckan och är lägre än i början av 1980-talet. I mjölk och grönsaker har under hela denna tid inga betydande förändringar skett. Variationerna på grund av olika jordmån var större.

I områden med högre nedfall än i Lappland var det speciellt cesium-137 och -134 i insjöfisk, som förorsakade förhöjda interna stråldoser under åren närmast efter olyckan. Gemensamt för hela Finland kan man nu säga att det är naturprodukterna från sjö, skog och mark, som är de dominerande källorna till interna stråldoser. I förhållande till radiocesium var tillägget till stråldosen från radionuklider med korta halveringstider litet. Den genomsnittliga interna stråldosen till finländarna från radiocesium har beräknats vara omkring $0,7 \text{ mSv}$ för perioden 1986-2006. För renskötarna i Lappland är motsvarande dos mindre än 5 mSv . Dessa doser är uppskattade med användning av resultat från helkroppsmätningar. Uppskattningar baserade på intag av födoämnen ger något högre doser.

Endast renkött produceras i finska Lappland i sådana mängder (3 milj. kg/år) att det står i en särställning ur strålskyddssynpunkt och behovet av motåtgärder i en eventuell medfallssituation är sannolikt litet utom för de renskötare högst i norr i vars diet mycket renkött ingår.

MEASUREMENTS OF AIRBORNE BERYLLIUM-7 IN NORTHERN FINLAND

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Abstract - Daily high-volume aerosol samples ($3500\text{ m}^3/\text{d}$) have been collected at the Sodankylä meteorological observatory ($67^\circ 22'\text{N}$, $26^\circ 39'\text{E}$) in northern Finland. The ${}^7\text{Be}$ contents of the samples were determined with semiconductor gamma spectrometry. The long-lived beta activity, i.e. total beta activity measured five days after the end of sampling (after the decay of ${}^{220}\text{Rn}$ progeny and short-lived ${}^{222}\text{Rn}$ progeny), was assessed with an automatic alpha/beta analyser. The long-lived beta activity consists mainly of ${}^{210}\text{Bi}$, the daughter nuclide of ${}^{210}\text{Pb}$, as the amount of artificial radionuclides in the air is negligible. The main goal of this project is to find the relative influence of stratospheric and upper tropospheric ozone versus the part from the continental boundary layer by the use of a ${}^7\text{Be}/{}^{210}\text{Pb}$ ratio index.

The air concentrations of both the beryllium-7 and the long-lived beta activity ($\sim {}^{210}\text{Bi}$) displayed a lognormal distribution during the study period July-December 1995. The arithmetic mean of the daily ${}^7\text{Be}$ concentrations was $2360\text{ }\mu\text{Bq/m}^3$, range $230\text{-}7600\text{ }\mu\text{Bq/m}^3$ and the geometric mean $1950\text{ }\mu\text{Bq/m}^3$. Corresponding values for long-lived beta activity were 280 , $9\text{-}890$ and $240\text{ }\mu\text{Bq/m}^3$, respectively.

Beryllium-7 is produced in the upper troposphere and stratosphere by nuclear reactions of atmospheric oxygen and nitrogen atoms induced by cosmic radiation. Compared to ${}^7\text{Be}$ airborne ${}^{210}\text{Pb}$ has a totally different source. It is formed in the atmosphere from the radioactive noble gas radon-222. High ${}^{210}\text{Pb}$ concentrations are found in continental air masses since ${}^{222}\text{Rn}$ sources at sea are practically non-existing. Despite the different origins the concentrations of both the beryllium-7 and the long-lived beta activity are partially correlated. Both have maximum concentrations during stable high-pressure situations. In Finland high-pressure situations often mean continental air masses with high ${}^{210}\text{Pb}$ contents. On the other hand the descending movement of air during high-pressure situations brings beryllium-7 downwards. Minimum concentrations are associated with cyclones travelling from the North Atlantic Ocean over Scandinavia to east. Within these low-pressure areas the subsidence rate is low and the maritime air masses contain very low ${}^{210}\text{Pb}$ concentrations.

User Specific Environmental Transport Analyses Code DETRA

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A fully modernized version of the earlier presented computer code DETRA (Doses via Environmental Transport of Radionuclides) is developed. The present version of the code permit for the user to perform analyses in Windows interface environment, and new features for the calculation possibilities of the code are added: e.g. applications of multiple calculation sequences for different compartment model structures are now also available for the user.

DETRA is a suitable tool for various types of environmental analyses problems. Radionuclide transfer models for aquatic fresh water as well as for marine environment, soil layers, domestic animals products and several other applications of consequences of radioactive depositions in general have been analyzed with the code. The new interface of the code makes it also easy for the user to save and utilize afterwards ready input files in subdirectories of relevant research areas. The recently developed Windows interface of DETRA include own displays for each of the segments of input file: nuclide chains, compartments, time grid, source term, initial values and formats for printout specifications. The numerical data and graphics of calculation results are shown in their own displays, correspondingly. Examples of the input and output displays of DETRA are shown below in the figure.

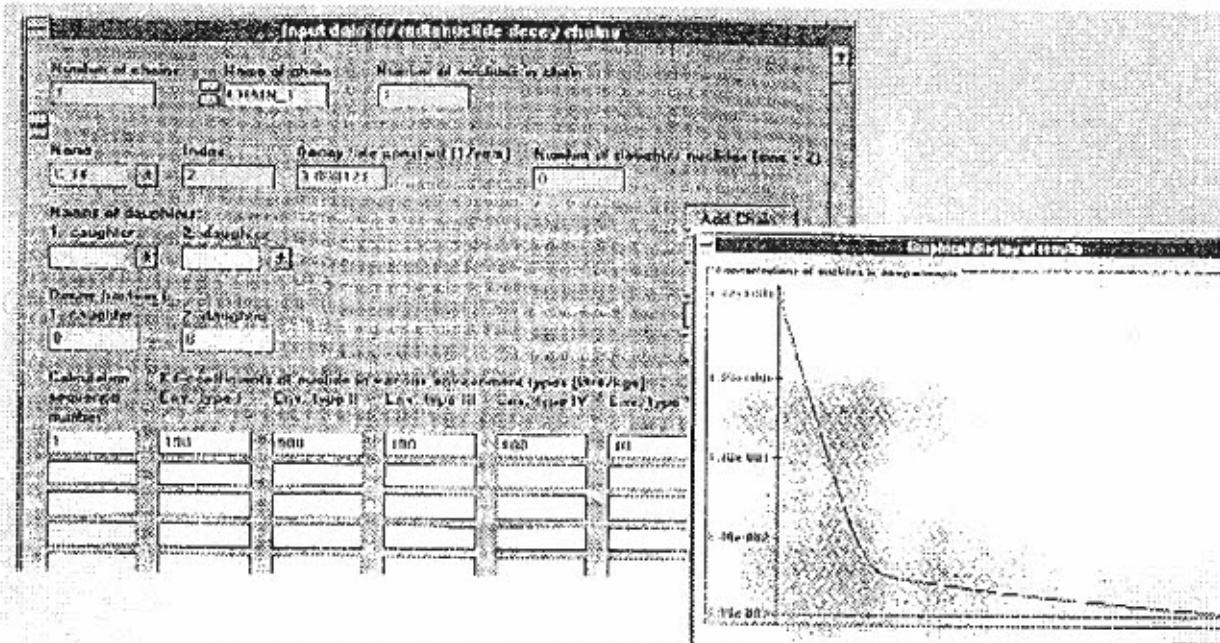


Fig. Examples of the displays of DETRA.

RETROSPECTIVE RADIATION DOSIMETRY USING OPTICALLY STIMULATED LUMINESCENCE ON NATURAL MATERIALS AND CERAMICS FOR ASSESSING POPULATION DOSES IN NUCLEAR ACCIDENTAL AREAS

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Abstract

Optically stimulated luminescence (OSL) techniques especially aimed at using natural materials and ceramics for retrospective reconstruction of accidental radiation doses in populated areas were developed and studied at Risø as part of an EU research project. Quartz and feldspars separated from building materials, such as bricks and tiles had their OSL signals measured using different light sources for stimulation to assess radiation doses received by material collected in nuclear accidental areas (Chernobyl). Radiation doses were reconstructed from OSL measured directly on unseparated samples i.e. directly from the surface of brick and tile materials. Automatic OSL scanning techniques were also developed for rapid assessment of depth dose profiles into bricks to give useful information about the energy of the accidental photon radiation. The lower detection level for e.g. quartz extracted from a modern brick measured using a green light wavelength band as the stimulation light source was found to be less than 1 mGy. An attempt was also made at characterising the OSL properties of widely available porcelain wares manufactured under a variety of conditions in order to establish the luminescence components vital for retrospective dosimetry. The OSL techniques developed and applied are described and results from measurements carried out on a variety of materials are presented.

Dosimetry of Beta and Low-Energy Photon Radiation: Standardisation, Individual Dosimetry and Monitoring of the Workplace

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ABSTRACT

In recent years considerable interest has been devoted to dosimetry of weakly penetrating radiation consisting of beta and low-energy photon radiation. In particular in connection with the Three Mile Island and Chernobyl accidents and the following clean-up work it was recognised that the dosimetry techniques used for measurements of doses from weakly penetrating radiation were inadequate. Since then, the need to improve dosimetry practices of beta and low-energy photon radiation has been acknowledged throughout the nuclear industry. During several years Risø has been engaged in studies and developments of techniques for standard dosimetry as well as personal and area monitoring of weakly penetrating radiations in mixed beta/gamma fields. Since 1990 a major part of this work has taken place as joint research projects within programmes of the European Commission with participation from a number of European laboratories.

The paper gives a review of recent progress in the field of dosimetry of low-penetrating radiation, in particular that obtained from the joint European studies. New developments of calibration facilities including both radiation fields from beta particles and low-energy photons with energies from 6-15 keV are described. Results from comparative measurements of dose rates from various beta radiation fields obtained at different laboratories are presented indication the general state of accuracy of measurement in the field. Dosemeters intended for individual monitoring for skin doses from low-penetrating radiations should contain detectors with a small effective thickness in order to give responses that are independent of energy and angle of incidence of the radiation. The paper presents performance data of new thin high-sensitive solid state detectors and furthermore new developments of electronic doseometers particularly suited for personal dosimetry of weakly penetrating radiation are discussed. In the field of area monitoring of workplaces the limitation of presently used survey instruments for monitoring for low-penetrating radiations is discussed. A more precise characterisation of beta radiation fields can be obtained by use of beta spectrometers and a new design of spectrometer consisting of three different silicon detectors arranged in a telescope unit is described and discussed.

Thirty-Seven Years of Dosimetry at Studsvik

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Abstract

Personnel dosimetry has been performed since 1959 at Studsvik situated at the Baltic coast in the county of Södermanland, 80 km south of Stockholm. Several small nuclear reactors have been used at the site. Today only one 50 MW high flux pool type reactor (MTR) and one 1 MW low-power reactor are used. In the R2 reactor, testing of nuclear reactor fuel, production of radioisotopes for medical purposes and neutron transmutation doping of silicon are performed. Plans for Boron Neutron Capture Therapy, BNCT, for medical treatment at the R2-0-reactor have recently been discussed. University of Uppsala has a department of neutron research at the reactor. Other types of nuclear work done at Studsvik are hot-cell handling, decontamination, incineration and recycling of low-level metallic waste.

Radiation doses are normally much smaller than the limit set by the authority. Since 1959 five persons have received more than 50 mSv in a year. Highest whole body dose for a single event was 115 mSv in 1982. These incidents will be described in the paper. The only still visible skin damage of a person occurred in 1978 when a person received more than 10 Gy to his hand when working for AB Kabi Diagnostica.

ÖKANDE MÖJLIGHETER TILL JÄMFÖRELSEMÄTNINGAR OCH INTERKALIBRERING AV SYSTEM FÖR DIREKTA MÄTNINGAR AV RADIONUKLIDER I MÄNNiska - FÖRBÄTTRAD KVALITETSKONTROLL

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Interkalibrerings- och jämförelsemätningar av olika provmaterial har länge utförts på nationell, nordisk och internationell nivå. För direkta mätningar av människa har möjligheterna till denna typ av kvalitetskontroll varit mindre. Forskare som besökt mätlaboratorier i andra länder har vid tillfälle utnyttjat möjligheten till jämförelsemätningar.

Inom Norden har två projekt inom ranem för NKA- och NKS-programmen slutförts. Båda projekten "Intercalibration of whole-body counting systems" har rapporterats i "Nordic Radioecology - The transfer of Radionuclides through Nordic Ecosystems to Man".

Inom EU har några interkalibreringsprojekt genomförts. Efter att Finland och Sverige blivit medlemmar har de nordiska länderna kunnat delta i ett projekt, där ett fantom tillverkat i St. Petersburg, Ryssland har mätts i ungf. 40 laboratorier i Europa. I Kanada tillverkades för några år sedan ett fantom representerande ett 4 år gammalt barn. Många europeiska och bland dem också några nordiska laboratorier kunde delta i den jämförelsemätningen. I vardera fallet var nuklidsammansättningen och aktivitetshalten i fantomen okända.

Resultaten har visat att man i de flesta laboratorierna har nått en tillfredsställande kvalitetsnivå. Detta betyder inte att man kan slå sig till ro tvärtom bör kvalitetskontrollen förbättras.

Installering av två helkroppsmätningssystem i nya laboratorieutrymmen

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För mätning av helkroppsaktiviteten med gammaspektrometri finns i Finland två stationära system med massiv avskärmning av stål. Båda systemen flyttades 1994 till nya laboratorieutrymmen, som kunde planeras med hänsyn till behovet att reducera bakgrundsstrålningen. Flyttningen gav också möjligheten att omkonstruera stålrummen för bättre mätgeometri.

För betongkonstruktionerna omkring stålrummen valdes en specialbetong, bestående av olivinsten och vitcement. Mätning av prover visade att halterna av gammastrålare i olivinbetongen var omkring en åttondedel av motsvarande halter i normalbetong. Samma förhållande erhölls för både ^{40}K och nuklider i de naturliga sönderfallsserierna.

Radonisotoperna och deras radioaktiva sönderfallsprodukter är speciellt problematiska vid konstruktion av utrymmen för mätning av små aktiviteter. Radonhalterna varierar med årstiden och med väderleken, vilket innebär oberäkneliga variationer i bakgrunden. De här beskrivna utrymmena försågs med dubbla väggar, golv och tak. Frånluften sugs från spalten mellan konstruktionerna, och ersättande luft leds dit från mätrummen, som i sin tur matas med filtrerad färskluft.

I samband med flyttningen omkonstruerades stålrummen. För att vara säker på attstålet inte innehåller ^{60}Co anskaffades gammal stålplåt gemensamt från en utrangerad gasklocka, konstruerad före 1930.

Urinary Excretion of Cesium-137 for Estimation of Body Content and Internal Absorbed Dose

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Abstract

Since 1987 we have performed regular whole body measurements on a group of about fifteen individuals living in the Malmö-Lund region in south-west of Sweden. At the same time collection of 24 hour urine has been performed on most of these persons. The aim of this study was to determine the ratio between the daily excretion in urine and the whole body content of cesium-137 for a south-Swedish population and later on use this ratio to estimate the Cs-137 whole body burden in other population groups.

Assuming that 80 % of the Cs-excretion takes part through urine, the ratio obtained yielded an equivalent biological half-time of 95 ± 4 d (range, 67 - 121 d) for females and 109 ± 4 d (range, 89 - 133 d) for males which is within the ranges established in earlier work. For the potassium excretion we assumed a fraction of 85 % passing via the urine and the corresponding values, 32 ± 2 d for females and 40 ± 2 d for males, agreed well with ICRP 23 ranges for the reference man, however large spread within the study group was found.

Taking the ratio between the potassium normalised body burden of Cs-137 and the potassium normalised daily Cs-137 urinary excretion we obtained a value of 3.6 ± 1.3 (averaged over both sexes). Applying this ratio from the Lund-Malmö group on urine samples from a group of adults from the Briansk area, Russia, we found that in 1995 the estimated average whole body content of Cs-137 was about 19 kBq (range, 4 - 60 kBq), which would result in an effective dose rate of 0.67 mSv y^{-1} per individual. The corresponding figures for 1994 are 26 kBq (range, 5 - 72 kBq) and 0.90 mSv y^{-1} respectively.

Whole-body Measurements at a Research Facility

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Abstract

Whole-body measurements were performed 3 times a year for a 3-year period on a group of 20 workers at Risø National Laboratory.

One of the aims of the project was to establish the "background" content of radionuclides in persons working at Risø. Both persons working at the different nuclear facilities and in non-nuclear departments were included in the group.

Another purpose was to "check" the normal procedure for detecting internal contamination, namely measurements on urine samples. One of the whole-body measurements revealed an incidence with uptake of ^{131}I . In this case the normal procedure of giving a urine sample for measurement after an operation, which turned out to be dubious, had not been followed.

Apart from that incidental uptake only small amounts of activity from radionuclides such as ^{60}Co , ^{65}Zn etc. were detected in the persons working at the nuclear facilities.

Studier av ^{137}Cs i befolkningsgrupper bosatta i Norrland, en uppföljning.

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Abstrakt

Efter Tjernobyolyckan 1986 har upptaget av ^{137}Cs studerats i ett flertal olika befolkningsgrupper i norra Sverige. Dessa grupper lever till stor del av livsmedelsprodukter från skogsekosystemet. Sådana livsmedel ingår i näringsskedjor som är effektiva transportvägar för cesium vilket, tillsammans med att man i denna region fick ett betydande nedfall av radioaktivt cesium från våtdeposition, gör att man här återfinner betydligt högre intern kontaminering än hos medelsvensken.

Under åren 1988 till 1993 har undersökningar av ^{137}Cs -halten hos befolkningen i Norrland genomförts genom mätningar av psoasmuskel från utvalda obduktionsfall vid den rättsmedicinska avdelningen vid Norrlands Universitetssjukhus i Umeå. Ur denna studie har vi beräknat en halveringstid för ^{137}Cs i populationen på 3,7 år. Vid det senaste mättillfället 1993 kunde dock en liten tendens till ökning av halveringstiden skönjas. För att undersöka detta samt om större relativ spridning av mätresultaten uppträddes vid ökat avstånd i tiden från olyckstillfället har provtagningen och mätningarna återupptagits.

Provtagningen påbörjades i december 1995 och beräknas pågå till utgången av juni 1996. Av de prover som hittills mätts (49 st.) har en viss ökning av spridningen hos mätresultaten kunnat ses. Detta leder då till att man kan misstänka en ökning av medelvärdet för cesiumhalten sedan den senaste mätningen 1993. Anledningen till detta antagande är att cesiumhalten i populationen visat sig vara positivt skevfördelad vid de tidigare mätningarna (1988 - 1993). Under våren och sommaren kommer fler mätningar att utföras för att ytterligare förbättra statistiken.

Förutom mätningar på psoasmuskel har helkroppsmätningar utförts på olika befolkningsgrupper från samma region. Mätningarna startade 1986 med en grupp samer i vilka ^{137}Cs -halten därefter regelbundet har kontrollerats. År 1991 startades en studie baserad på ett slumpmässigt urval av den allmänna befolkningen respektive samer boende i tre områden i norra Sverige med olika markdeposition av ^{137}Cs . Resultatet av de tidigare helkroppsmätningarna har bland annat visat på en halveringstid av ^{137}Cs hos samerna på cirka 5 år. Från år 1991 till 1992 fann vi dock en ökning av ^{137}Cs -halten i ett flertal av de studerade grupperna. Under våren och sommaren kommer mätningarna på dessa grupper att upprepas för att studera utvecklingen av ^{137}Cs -halten i befolkningen på längre sikt samt för att se om den iakttagna uppgången var tillfällig.

The dose to the Swedish population from caesium in the body, estimated from whole-body measurements on a representative group

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Abstract

The fallout from the Chernobyl accident contributes to the collective dose to the Swedish population through external and internal irradiation. The radionuclides giving the main part of the internal dose are radioactive caesium, ^{134}Cs and ^{137}Cs . In Sweden several investigations have been performed to study the behaviour of caesium in the body. As a part of these studies about 200 persons, representing a random sample of the Swedish population, were whole-body measured during the autumn of 1994.

In co-operation with SCB, Statistics Sweden, a statistically representative sample of the Swedish population of 1000 persons was selected to be interviewed regarding changes in their eating habits after the Chernobyl accident. From that group 200 persons were selected for whole-body measurements. They were divided into two groups, one consisting of persons from the five counties with the highest fallout and the other consisting of persons from the rest of the country. The two groups were subdivided into three subgroups, consisting of men, women and children. When the numbers of persons in each group were selected considerations were taken to the expected standard deviations in activity concentrations within that group, resulting in an over-representation of people living in areas with higher fallout.

163 people were whole-body measured at SSI in Stockholm, and 16 people at FOA, National Defence Research Establishment, in Umeå. The statistically weighted mean of the dose to the Swedish population is calculated to about 5 $\mu\text{Sv}/\text{year}$, 1994, and the activity concentration of ^{137}Cs is about 2 Bq/kg. The doses to the groups, consisting of men is about four times higher in the areas with higher fallout, while for women and children those doses are about twice compared to the rest of the country.

The results are compared with two similar investigations in 1987 and 1988. Combining these results with measurements of a reference group at SSI and measurements of other groups makes it possible to estimate the collective dose to the Swedish population. Over a 50 year period the collective dose to the Swedish population is estimated to be about 1100 manSv from internal sources as a consequence of the Chernobyl accident. The corresponding figure for the dose from the external sources has been estimated to be about 5000 manSv. The results from the investigation is also compared to a national survey of the contents of caesium activity in Swedish food, carried out during the same time.

MIGRATION OF RADIOCAESIUM IN SWEDISH SOIL PROFILES AFTER THE CHERNOBYL ACCIDENT, 1987-1995

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ABSTRACT

The study covers both temporary and permanent grasslands, of which some are fertilized and used for hay production and others are semi-natural or natural pastures used for extensive grazing. Eight soils representing different soil types and soil textures were investigated; five cultivated or semi-natural mineral soils (Dystrochrept, Haploboroll, Udorthents, Cryorthent), two cultivated organic soils (Sulfihemists) and one podsolized soil (unploughed) (Haplocryod). At the selected sites, the ground deposition was 14-184 kBq m⁻² (average 82). The ¹³⁷Cs-activities were measured in cm-sliced 25 cm deep soil cores as well as in the soil horizons (0.7-1.0 m). Soil cores were collected at two or three occasions between 1987 and 1994, and migration rates were calculated from the median depths. Grass samples were taken from the same locations for determination of the transfer of ¹³⁷Cs from soil to grass (TFg, m² kg d.w.⁻¹).

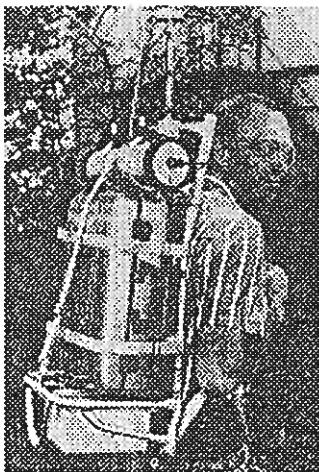
The study showed that after eight years the main part (50-92 %) of the ¹³⁷Cs fallout was still retained in the upper 0-5 cm (median depth 2.3-5.1 cm), although considerable amounts have migrated to deeper soil layers. This was most pronounced in the organic soils and in the podzol where ¹³⁷Cs was found to about 50 cm depth. In the podzol 40 % of ¹³⁷Cs was found below the O-horizon (0-5 cm), indicating a transport of ¹³⁷Cs within the soil profile. The migration rates (1987-1994) were in the range 0.2-0.6 cm year⁻¹, highest in one organic soil. The transfer of ¹³⁷Cs to grass was highest in the mountain region, intermediate in the organic soils, and lowest in the mineral soils. TFg decreased with time at all sites, except in the podsolized soil where the transfer was slightly higher in 1994 than in 1990.

The different distribution patterns in the studied soils, indicated differences in cation exchange capacities and in the occurrence of specific binding sites (illitic clay minerals). The results also indicate that differences in land use and management practices are of importance. ¹³⁷Cs seems to be more mobile in O- and Ah-horizons rich in decomposing plant residues than in Ah- or Ap-horizons dominated by well-decomposed and humified organic matter. The results can be further evaluated by means of mathematical models for transport of radionuclides as well as through additional analyses of soil and clay mineralogy.

A portable gamma spectrometry system for environmental applications

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Gamma spectrometry systems for radionuclide mapping and search have been in use for more than 30 years. Applications in the field of mineral exploration and geological mapping have resulted in large airborne systems often integrated with other geophysical equipment. Vast surveys have been performed all over the world. The usefulness of such systems for environmental applications has been proven many times, i.e. by the Swedish Geological Company in 1986 when mapping Chernobyl fallout in Sweden. The arrival of GPS and the general trend of smaller, less power consuming and more competent electronic equipment have opened new possibilities regarding system design. The Swedish Radiation Protection Institute has developed a small gamma spectrometry system for environmental applications. It is small enough to be battery operated and portable as a back-pack system and contains what is needed for both small and extensive surveys and search operations in radiation protection and environmental research. If the system is connected to a PC, software developed by SSI can be used for real time analysis and display of results. The system design principles, the hardware, calibration technique and the software will be presented. Two application examples will be given, one focused on radionuclide mapping and search in emergency situations and the other on radioecology research.



^{90}Sr in various matrices - speciation and analysis

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Abstract

Due to long half-life, high fission yield, high mobility in ecosystems and high radiological toxicity, questions concerning short and long term consequences of ^{90}Sr contamination of the environment from nuclear sources are frequently addressed.

In order to determine the degree of ^{90}Sr contamination, proper determination of the total concentrations in samples from various compartment of different ecosystems is needed. However, in order to assess the short and long term transfer within the ecosystem, the determination of physico-chemical form is essential, as information on the mobility and bioavailability of ^{90}Sr is needed. Hence, the analytical challenges include accurate determination of ^{90}Sr in various matrices, and the time-consuming radiochemical procedures should be simplified. Furthermore, fractionation techniques should be developed to categorise ^{90}Sr -species according to size (i.e. nominal molecular weight distribution) and reactivity (e.g. reversible or irreversible interactions with other components).

In the present work fractionation techniques for ^{90}Sr speciation in water, soil and sediments will be focused and the introduction of simplified procedures for ^{90}Sr in waters will be discussed.

Titrering med EDTA som alternativ metode for bestemmelse av yttriumutbytte ved ^{90}Sr -analyser

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Sammendrag

Bestemmelse av yttrium-utbytte ved ^{90}Sr -analyser har tradisjonelt vært utført gravimetrisk etter felling av yttrium. Ved IFE på Kjeller har en alternativ metode for yttriumbestemmelse vært under utprøving. Metoden, hvor yttrium bestemmes ved titrering med EDTA i bufret løsning, viser bedre reproducertbarhet enn den tradisjonelle metoden og har nå erstattet denne ved laboratoriets rutineanalyser av ^{90}Sr .

I presentasjonen vil tradisjonell og ny metode bli sammenlignet og diskutert med basis i resultater fra over to år med bestemmelse av yttrium-utbytte med begge metoder på de samme prøvene.

Radiocaesium Redistribution in a Swedish Pine Forest

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Studies on radionuclide transport in forested landscapes since the Chernobyl accident have demonstrated the high mobility of radioactive caesium within the forest ecosystem. To better characterize this phenomenon, the redistribution of radiocaesium in a Swedish pine forest has been studied by field experiments and modelling.

Data concerning the radiocaesium content in pine trees has been collected in three different forested locations near Gävle, Sweden. The forests differ by their ages, with one of the locations established after the Chernobyl accident. Radionuclide content from different fractions of the trees has been measured and the total biomass has been estimated at different time points starting in 1991. Samples from different soil horizons have been collected at all three sites.

The data describes the redistribution of radiocaesium over time in the differently aged forest stands, demonstrating the difference in the dynamics as a function of tree age and original contamination process. This information is used in the parameterization of the portion of a forest landscape model which describes the radionuclide movement between the soil and pine trees in a boreal landscape. This is the initial study of a project which will estimate natural landscape ecosystem exposures from radiocontamination.

En enklare metod att analysera strontium-90 testad på jordprover från Tjernobyl-området

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Vid SSI's radiokemiska laboratorium utförs regelbundet analyser av förekomsten av strontium-90 i olika provslag. Omgivningsprover såsom jord, gräs, träd, alger och sediment är de vanligaste provmatriserna. Dessa analyser har hittills baserats på den så kallade HDEHP-metoden, där yttrium-90 separeras från strontium-90 genom extraktion med komplexbildaren HDEHP - di(2-ethyl-hexyl)fosforsyra.

I syfte att förenkla och samtidigt minska tiden för den radiokemiska behandlingen av det studerade provet har en ny metod för analys av Sr-90 utvecklats. Förbehandlingen av proverna är densamma som vid gängse analysmetoder dvs våt- eller torrinaskning. Genom oxalat och hydroxidfällningar separeras yttriet. Liksom för HDEHP-metoden bestäms aktiviteten yttrium-90 genom mätning av Cerenkovstrålning i en vätskescintillationsräknare.

Metoden har testats på jordprofiler från tremilszonen runt den havererade Tjernobylreaktorn. Analysresultaten för de bågge metoderna visar god överensstämmelse.

Den förenklade metoden är kostnadseffektiv jämfört med tidigare metod och tidåtgången för den radiokemiska behandlingen är mindre än hälften av den för HDEHP-metoden.

Fallout from atmospheric nuclear tests in the sixties

- Review of data from Iceland

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Abstract

Fallout from the Chernobyl nuclear accident in Iceland was very small in comparison with the fallout from atmospheric nuclear tests in the sixties. The latter is still by far the dominant source of anthropogenic radionuclides found in the Icelandic terrestrial environment.

This paper summarises information published in the sixties in three Icelandic reports. The main emphasis here is put on values for Cs-137 in:

- cow's milk
- lamb meat
- reindeer meat
- whole body measurements

This data has previously had limited distribution (the last of the reports being in Icelandic), but it is still of interest because:

- comparison with data reported from other countries at the time
- comparison with recent Icelandic data. The source term is the same and thus the comparison is of value for estimating the long term behaviour of Cs-137 in the Icelandic terrestrial ecosystem.

Comparison with data from other countries in the sixties indicates closest relationship with data from the Faeroe Islands, especially for milk and lamb meat. In both countries the values for milk are very high compared to values commonly seen elsewhere. In the UNSCEAR compilation of 1977 ("Sources and Effects of Ionizing Radiation") citing data from 1972, the values for milk were by far the highest from the Faeroe Islands of all countries reported. A limited number of whole body measurements also indicate higher values than reported in many countries.

Comparison with recent (from 1989 onwards) data from Iceland shows similar geographical variations in the data for both periods. The levels decreased fairly rapidly during the time of the fallout, but subsequently the removal from the ecosystem has been very slow.

RADIOAKTIVA ÄMNEN I LIVSMEDEL PRODUCERADE I FINSKA LAPPLAND

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Redan på 1950-talet upptäckte man att halterna av radioaktivt cesium och strontium i mjölk var högre i Lappland än i södra Finland. Ända sedan dess har man följt med halterna också i andra livsmedel än mjölk och framför allt i renkött. Speciellt efter Tjernobylolyckan har radioaktivitetsnivåerna i livsmedel och naturprodukter från Lappland övervakats med årligen insamlade prover. Den numera omsorgsfullt undersökta näringsskedjan lav-ren-människa är den mest betydelsefulla ur strålskyddssynpunkt. Det finns fortfarande manliga renskötare som åtminstone tidvis äter ungf. 1 kg renkött per dag. Renköttets cesium-137 halt var högst år 1965, i medeltal $2,5 \text{ kBq kg}^{-1}$, sjönk till $0,3 \text{ kBq kg}^{-1}$ vintern 1985-86, men steg efter Tjernobyl-olyckan till i medeltal $0,7 \text{ kBq}$ 1986-87 för att nu ligga på nivån $0,3 \text{ Bq kg}^{-1}$ igen.

Eftersom det radioaktiva nedfallet i finska Lappland efter olyckan i Tjernobyl var litet steg halterna i andra livsmedel än renkött, fisk och svamp inte mycket. I insjöfisk i Lappland har förhödda halter konstaterats: i abborre $0,2 \text{ kBq kg}^{-1}$ 1986-87, $0,1 \text{ } 1990-91$ och $0,05 \text{ } 1994-95$. I svamp har man konstaterat olika halter beroende på art, på växtunderlag etc, men ingen betydande förhöjning. En liten förhöjning kunde noteras i skogsbären hjortron och blåbär ($1986-1987 \text{ } 75 \text{ och } 35 \text{ Bq kg}^{-1}$, $1994-1995 \text{ } 25 \text{ och } 15 \text{ Bq kg}^{-1}$). I praktiskt taget alla livsmedel producerade i Lappland har aktivitetshalterna sjunkit till samma nivå som före olyckan och är lägre än i början av 1980-talet. I mjölk och grönsaker har under hela denna tid inga betydande förändringar skett. Variationerna på grund av olika jordmån var större.

I områden med högre nedfall än i Lappland var det speciellt cesium-137 och -134 i insjöfisk, som förorsakade förhödda interna stråldoser under åren närmast efter olyckan. Gemensamt för hela Finland kan man nu säga att det är naturprodukterna från sjö, skog och mark, som är de dominerande källorna till interna stråldoser. I förhållande till radiocesium var tillägget till stråldosen från radionuklider med korta halveringstider litet. Den genomsnittliga interna stråldosen till finländarna från radiocesium har beräknats vara omkring $0,7 \text{ mSv}$ för perioden 1986-2006. För renskötarna i Lappland är motsvarande dos mindre än 5 mSv . Dessa doser är uppskattade med användning av resultat från helkroppsmätningar. Uppskattningarna baserade på intag av födoämnen ger något högre doser.

Endast renkött produceras i finska Lappland i sådana mängder (3 milj. kg/år) att det står i en särställning ur strålskyddssynpunkt och behovet av motåtgärder i en eventuell medfallssituation är sannolikt litet utom för de renskötare högst i norr i vars diet mycket renkött ingår.

Thirty-Nine Years of Environmental Monitoring at Studsvik

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Abstract

Environmental monitoring of radionuclides has been performed since 1957 in the scenic surroundings of Studsvik at the Baltic coast in the county of Södermanland, 80 km south of Stockholm. Several small nuclear reactors have been used at the site. Today only one 50 MW high flux pool type materials testing reactor (MTR) and one 1 MW low-power pool reactor are used. In the R2-reactor testing of nuclear reactor fuel, production of radioisotopes for medical purposes and neutron transmutation doping of silicon are performed. Plans for Boron Neutron Capture Therapy, BNCT, for medical treatment at the R2-0-reactor have recently been discussed. University of Uppsala has a department of neutron research at the reactor. Other types of nuclear work done at Studsvik are decontamination, incineration and recycling of low-level waste.

The most dominant source of radionuclides found in the surroundings of Studsvik comes from nuclear atmospheric tests performed between 1945 and 1980 and after the Chernobyl accident in 1986. Natural radionuclides are also easily found in all types of samples. Due to the changed background mentioned above only few samples indicate small outlets of radionuclides from Studsvik. Yearly emissions are much smaller than the limit set by the authority.

OPPGRAVING AV ET 25 ÅR GAMMELT DEPONI FOR RADIOAKTIVT AVFALL I NORGE

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Abstract:

I 1970 ble ca 1000 tønner med lav- og middels radioaktivt avfall gravet ned på området til Institutt for energiteknikk på Kjeller i Norge. Statens strålevern (NRPA, den gang Statens institutt for strålehygiene, SIS) ga tillatelse til denne deponeringen etter en sikkerhetsvurdering og med krav knyttet til deponiet.

Avfallet består av ionebyttermasse, avfall fra laboratorievirksomhet, flytende avfall og metallskrap. Etter avfallsbehandling ble avfallet lagt i 210 liters ståltonner. Tønnenes innvendige utforming varierte avhengig av avfallstypen og aktivitetsnivå.

De nuklidene som bidrar mest til aktiviteten er ^{60}Co , ^{90}Sr og ^{137}Cs . I tillegg inneholder avfallet ca 80 GBq (35 g) plutonium og 2,5 GBq naturlig uran (100 kg). Opprinnelsen til plutonium og uran var pilot anlegget for reprosessering av uran som var i drift ved IFE opp til 1968. Avfallet som inneholder plutonium er fordelt på 230 tønner med polyethylen belegg innvendig. Den totale aktiviteten i avfallet er beregnet til ca 9000 GBq når avfallet blir gravet ned i september og oktober 1970. På grunn av decay vil aktiviteten i avfallet rundt 1 juli 1997 være ca 3000 GBq. Hvis de eksisterende planer for etablering av et nytt lager og deponi for radioaktivt avfall i Norge følges, vil dette være det første mulige tidspunktet for oppgraving.

Tønnene er plassert i to lag liggende og det øverste laget er ca 2 meter under bakkenivå. Tønnene er begravet i leire og en drenskum er plassert i enden av deponiet. På grunn av terrengets helling vil regn og overflatevann renne gjennom deponiet og samles i drenskummen. Et tracer eksperiment som ble utført i 1975 viser at deponiet fungerer slik. Vann fra drenskummen føres i en ledning til IFEs avfallsbehandlingsanlegg. Det tas rutinemessing prøver av vann og slam fra drenskummen. Disse analyseres for radionuklidel.

Arbeidet med å etablere et deponi for lav- og middels aktivt avfall i Norge startet i 1989. I april 1994 besluttet Stortinget at det skulle bygges et kombinert lager og deponi for lav- og middels radioaktivt avfall i Himdalen i Aurskog-Høland kommune. I forbindelse med dette ble det bestemt at de nedgravde tønnene skulle fjernes og plasseres i det nye deponiet. Ca 230 av de nedgravde tønnene inneholder plutonium. Det ble bestemt at disse skulle plasseres i det nye anleggets lagerdel i påvente av en nærmere beslutning om fremtidig deponering. Resten av tønnene skulle plasseres i det nye anleggets deponidel sammen med de avfallsbeholdere som i dag lagres i lagerbygg på IFEs område på Kjeller.

Som en forberedelse til arbeidet med å fjerne de nedgravde tønnene, er det foretatt en nærmere undersøkelser av omfang og aktivitetsnivå av radionukilder i leire og vann i og rundt tønnefeltet og av tønnenes tilstand. Det ble gravet et hull i hver ende av tønnefeltet og fem tønne ble tatt opp fra hver av disse hullene. Resultatene viste at det meste av forurensingen satt i de nærmeste 2 cm av leire på tønnene. Beregninger viser at mengden forurensset leire kan være opp til 100 m³.

KOMBINERT LAGER OG DEPONI FOR LAV- OG MIDDELS RADIOAKTIVT AVFALL I HIMDALEN I NORGE

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Abstract:

Det foreligger planer om å bygge et kombinert lager og deponi for lav- og middels radioaktivt avfall (KLDRA) i Himdalen i Aurskog-Høland kommune i Akershus fylke i Norge. Anlegget skal bygges i fjell som fire separate fjellhaller med felles adkomst-tunnel. En hall vil bli benyttet som lager for plutoniumholdig avfall i henhold til vedtak i vårt Storting den 20. april 1994. De andre tre hallene vil være et deponi hvor avfallet vil bli støpt inn i betongsarkofager. Det er planlagt plass til 10 000 tonne-ekvivalenter med avfall i anlegget fordelt på 7 500 i deponidelen og 2 500 i lagerdelen. Avfall vil bli fraktet fra Institutt for energiteknikk med bil og bli lastet inn i lager og deponidel med traverskran.

Anlegget vil bliliggende ca 150 meter inne i fjellet med 50 meter fjelloverdekning. Fjellhallene og adkomsttunnellen bygges selvdrenerende med et fall på 1:50 mot tunnelåpningen. Dette skal sikre en tørr lagring og deponering av avfallet. Det planlegges to dreneringssystemer, ett for vann som trenger inn i anlegget fra de omgivende fjellmassiver og ett for vann som eventuelt trenger gjennom sarkofagene. Vann fra anlegget vil gå via dreneringskummer hvor det vil bli tatt prøver for analyse av radionuklider. Det er også planlagt et prøveprogram for vann, sediment og vegetasjon i anleggets omgivelser. Det vil også bli installasjoner for servicefunksjoner og besøksvirksomhet i anlegget.

I henhold til de nåværende planer skal anlegget stå ferdig i mai/juni 1997. Det skal være i drift fram til år 2030. Da vil det bli tatt stilling til deponering av avfallet i lagerdelen og anlegget vil bli stengt. Deponiet skal være under administrativ overvåkning i 300 - 500 år framover.

Anlegget vil bli bygget av Statens bygge- og eiendomsdirektorat som også vil være eier av anlegget. Driftsansvaret er tillagt Institutt for energiteknikk. Som bakgrunn for konsesjon for bygging av anlegget, foreligger det en sikkerhetsanalyse som er til vurdering hos Statens strålevern. For å få konsesjon for driften må Institutt for energiteknikk på sin side utarbeide en sikkerhetsanalyse for drift av anlegget.

IAEA-WATRPs VURDERING AV DET PLANLAGTE KOMBINERTE LAGER OG DEONI FOR RADIOAKTIVT AVFALL I HIMDALEN, NORGE.

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Prosessen med å finne et egnet deponi-sted for det norske lav- og middels-radioaktive avfallet startet i 1989 da en komité ble nedsatt. Denne komitéen så primært på deponering i nedlagte tunneler, gruver og lignende, og i mars 1991 fremla de sin rapport. De anbefalte at den nedlagte gruven i Killingdal i Sør-Trøndelag skulle benyttes som deponi, og som alternativ nr. 2 at man skulle bygge et fjellanlegg i nærheten av Kjeller, hvor behandlingsanlegget er.

I 1992 utarbeidet Statens bygg- og eiendomsdirektorat (nå Statsbygg) en konsekvensutredning i henhold til Plan- og bygningsloven. Killingdal gruve og to steder fra Kjeller-området, Kukollen og Himdal, ble evaluert. Konklusjonen i konsekvensutredningen var at Himdal ble anbefalt.

Under behandlingen i Stortingskomiteen ble det foreslått å lage et kombinert lager og deponi, hvor plutoniumholdig avfall skulle lagres inntil videre, mens det øvrige kortlivede avfallet skulle deponeres. På bakgrunn av denne informasjonen behandlet Stortinget spørsmålet om lokalisering av deponi for lav- og middelaktivt avfall i Norge. 28. april 1994 vedtok Stortinget at det skulle være et kombinert lager og deponi, og at det skulle ligge i Himdal. Stortinget anbefalte også at det ble bestilt en gjennomgang fra IAEAs "Waste Management Assessment and Technical Review Programme (WATRP)" før byggelisens ble gitt.

IAEAs WATRP-system og deres vurdering av anlegget.

WATRP er utviklet av Det internasjonale atomenergibyrå (IAEA) for å bistå medlemslandene med tekniske vurderinger og ekspertgjennomgåelser av deres nasjonale politikk, programmer eller anlegg forbundet med håndtering av radioaktivt avfall. På forespørsel fra en medlemsstat, eller en organisasjon innen en medlemsstat, påtar IAEA seg ansvaret for å sammenkalle et internasjonalt panel av eksperter for å utføre slik gjennomgåelse i henhold til referansevilkårene som er fastsatt av vedkommende medlemsstat eller organisasjon.

Statens strålevern ba i desember 1994 IAEA om å gjennomgå arbeidet som var blitt utført i forbindelse med etableringen av et kombinert lager og deponi for lav- og middelaktivt avfall i Norge. Som respons på denne forespørsel fra Statens strålevern sammenkalte IAEA en gruppe på fem internasjonale eksperter for å gå gjennom det norske arbeidet.

Mandatet for WATRP-gjennomgangen:

- Fremgangsmåten for valg av anleggssted.
- Det tekniske konseptet (fjellhall, kombinert lager/deponi).
- Langtids-sikkerhet for anlegget.

Dette inkluderte loverk, hydrologi/geologi, avfallsbehandling, involverte organisasjoner, scenarier og doseberegninger.

Gruppen, som inkluderte eksperter fra Canada, Frankrike, Tyskland, Sveits og USA, gikk gjennom et stort antall dokumenter vedrørende prosjektet som ble fremlagt på engelsk av de norske organisasjonene som var involvert. I september 1995 hadde gruppen evalueringsmøte i

Recommendations on Exposure to 50 Hz Magnetic Fields in Sweden

Enn Kivisäkk, Lars Erik Paulsson.

Abstract

The Swedish Radiation Protection Institute (SSI) has in 1993 issued recommendations on 50 Hz magnetic fields. The recommendations are based on a "prudent avoidance" approach. Several official authorities in Sweden are collaborating to further promote this issue. The recommendations state:

- * *When installing new equipment or new power lines that may cause high magnetic field exposures, solutions giving lower exposures should be chosen provided these solutions do not imply large inconveniences or costs.*
- * *In cases where the exposure levels exceed the normally occurring levels by more than tens of times steps can be taken to reduce the magnetic field, provided such reductions can be done at a reasonable cost.*
- * *In situations where the exposure levels from existing installations do not exceed tens of times the normally occurring levels, costly rebuilding should be avoided. "*

SSI has used its policy statement when responding to specific questions about actual situations. The SSI policy has at time being not been used for generating regulations or mandatory restrictions. Later during 1993 an information brochure was issued for use by the general public. The brochure was a result of an interagency collaboration with the following participants: National Board of Housing, Building and Planning, National Electrical Safety Board, National Board of Health and Welfare, and Swedish Radiation Protection Institute. The SSI recommendations were essentially copied in that brochure.

For the occupational environment there is a long tradition of mandatory regulations for identified risk factors. In Sweden such factors are usually identified and the basis for the regulations developed by so-called criteria groups within the National Institute of Occupational Safety and Health (now National Institute of Working Life) and in which SSI takes an active part. The Criteria Group for Physical Risk Factors (chaired by Prof. B Knave) concluded in 1995 that there was no scientific basis for traditional regulations regarding low frequency magnetic fields. This conclusion was based upon a comprehensive report from a working group on an evaluation of all the epidemiological and experimental studies on cancer and low frequency fields.

OPTICAL RADIATION FROM TWO INDUSTRIAL LASER STATIONS

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This work has been done as a part of an Eureka-project (643) concerning the working environment in general around industrial lasers, used for example for welding, cutting or surface treatment. The Swedish part of this project is run by the Technical University in Luleå. This paper deals with measurements and risk assessments of optical radiation that is emitted from different industrial processes.

Two powerful laser working stations have been studied. One CO₂-laser at the Technical University in Luleå, Sweden and one quadruple-coupled ND-YAG laser at Force Institute, Copenhagen, Denmark.

Several different types of processes were studied by the CO₂-laser, run at laser power from 1000 W to 4500 W. The Nd-YAG-laser was run at 2000 W in all cases.

Measurements were performed with an Optronic 742 for ultraviolet and visible radiation, scanning every 5th nm between 230 and 780 nm, a Laser Precision Rk 3440 Pyroelectric radiometer for reflected CO₂-laser radiation and a filtered UDT 40X Opto meter for reflected Nd-YAG laser radiation.

The results were assessed versus exposure threshold limits given by A.C.G.I.H. Radiation levels are calculated at a distance of 0.5 m. This may be an unrealistic viewing distance but the results are shown in order to allow comparison with data from conventional electric arc welding where 0.5 m is frequently used in literature.

The most impressive finding was the very powerful optical source created by plasma in CO₂-welding as well as surface alloying. Especially when argon was involved as shielding gas or carrier gas large emittance of ultraviolet and short-wave visible radiation was recorded. The shortest times giving the threshold ultraviolet exposure is around 0.5 second. Also the time limits for retinal burn hazards are very short, in the order of microseconds. In these processes reflected laser radiation are however not hazardous. Reflected CO₂-laser radiation, in the worst position exceeding MPEs of IEC 825 occurred rather in processes where the laser beam was not focused such as in surface treatments.

The Nd-YAG-laser did not create a plasma. What we saw were small glowing particles thrown out from the material of moderate temperature emitting a spectrum close to black-body radiation. No significant ultraviolet radiation was emitted, but in some cases visible radiation creating retinal burn hazards. In all cases a fraction of reflected Nd-YAG radiation exceeding the MPEs was found.

Testing of the Sunscreens on the Swedish Market

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Abstract

Different kinds of skin cancers caused by exposure to solar ultraviolet radiation constitute a steadily growing health problem in Sweden. A nation-wide campaign was started at the end of the eighties in order to reduce the incidence of such health injuries. Recommendations for sun protection form an important element in the campaign.

This survey was carried out as one element of the above-mentioned campaign. The objective has been to procure information on the testing of sunscreen products marketed in Sweden, and to form a basis for regulations or guidelines in this field.

The questionnaire inquired about respective company's number of products, their Sun Protection Factor (SPF), how the SPF was determined, if UVA-protection was assessed, production quality assurance, storage durability, declaration of contents and about toxic, allergenic or carcinogenic qualities of the product or of it's ingredients.

Information on the testing of the sunscreens marketed in Sweden 1993 was investigated by means of a questionnaire, sent out to all companies marketing such products. Also questions concerning the quality control of the products were included. Information was returned by approximately half of the companies.

The answers show that most of the sunscreens are tested for one or more properties relevant for the effectiveness and safety of the product. Different methods and standards are however employed, which among other things means that the results of the testing are not comparable. A majority of the companies express a desire for standardized guidelines for the testing and quality control of the products.

The authors suggest some recommendations to the Swedish authorities concerned to take steps in order to improve the testing and control of the products.

Use of the moss *Hylocomium splendens* for the mapping of radiocaesium fallout from the Chernobyl accident

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Mosses are useful biomonitoring tools for atmospheric depositions of trace elements, and are used on a regular basis to register heavy metal deposition in a number of European countries. The basis of this method is that mosses have no root system and hence absorb chemical substances mainly from air. Samples of the ground-growing species *Hylocomium splendens* collected during the summer of 1986 showed that this moss represented well regional differences in the deposition pattern of radiocaesium from the Chernobyl accident (E. Steinnes and O. Njålstad, J. Environ. Radioact. 21, 1993, 65). Moss samples from a national heavy metal survey in 1985 provided reference values of ^{137}Cs corresponding to the pre-Chernobyl deposition in different parts of Norway. Measurements of ^{137}Cs in *Hylocomium splendens* samples collected each year after the Chernobyl accident have demonstrated a certain "memory effect", i.e. samples from areas receiving high deposition rates in 1986 still show relatively high activity, in spite of the fact that the atmospheric deposition of ^{137}Cs after 1986 has been very low. This indicates that a certain translocation of caesium takes place within the moss plant.

In accordance with this observation, moss samples collected for another heavy metal deposition survey in 1990 still exhibit very high activity levels in areas of Norway that were strongly exposed to radiocaesium deposition from the Chernobyl accident. In this paper ^{137}Cs data for 300 samples from 1990 moss survey are presented, and the results are discussed in relation to previous mapping activities of radiocaesium in Norway. Reference is also made to experience from using this method to monitor stable trace elements by the moss technique.

CONSUMPTION OF MUSHROOMS AND SOME OTHER WILD FOOD PRODUCTS IN FINLAND

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Abstract

In 1995-96 consumption rates of mushrooms are surveyed in Denmark, Finland and Sweden and existing information will also be collected in Norway and Iceland. The study is a part of NKS/EKO-2 subproject for seminatural terrestrial environment.

People using much wild food products are more exposed to internal radiation than the rest of population. Regular dietary surveys have not given enough information for radiological assessments. The differences in concentrations of radioactive contaminants between different species especially in mushrooms are substantial and they should be considered. There are differences between Nordic countries both in consumption rates and tradition to use mushrooms. In Finland also subregions of the country may differ. The nordic cooperated study is important because of eventual differences between countries. The study completes simultaneous radioecological studies on mushrooms in the project EKO-2. In most western countries the use of natural products is nowadays more like a life style question than an essential part of nutrition. It seems to be connected with the amount of free time and outdoor activities.

Survey questionnaire was send to 1500 households in Finland spring 1996. The participants were selected from population register by areal divisioned population weighted random sampling. The country was divided into four parts: Northern, Eastern and western Finland and the metropolitan region. These parts were divided into big cities, medium-sized and small municipalities.

In the questionnaire the participants were asked about their consumption of mushrooms and berries. It was also asked about use of game meat, fish, and some minor food products from forests such as herbs. Foods other than mushrooms were studied to find out if the same households use several radiologically interesting food products. We asked also about age, profession, income and hobbies related to nature. The aim of the last category of questions was to reveal factors which explain the consumers intrest in the use of wild food products.

The main results of the study will be average consumption rates for different types of wild mushrooms and berries. The importance of the maximum consumers of these products to the collective internal dose will be analysed. The study will also give a view of the present cooking methods, which certainly have an effect on radiocesium content of the edible fraction of food.

Alltogether the nordic consumption surveys in NKS/EKO-2 will improve the estimation of human dietary radiocesium received ten years after the Chernobyl accident.

Importance of wild mushrooms for intake of radiocaesium by populations in Russia

Lavrans Skuterud, Irina G. Travnikova, Michael I. Balonov, Per Strand and Brenda J. Howard.

In a study of transfer of Chernobyl radiocaesium to man, dietary surveys and whole body monitoring were conducted at two sites in the Bryansk Region of the Russian Federation. The dietary survey confirmed that the inhabitants consume large amount of wild mushrooms. Based on the dietary survey and measured radiocaesium concentrations in mushrooms, consumption of mushrooms was estimated to account for 30-60% of the average intake of radiocaesium in the studied rural population 8-9 years after the Chernobyl accident. The correlation between dietary intake and observed body burdens also showed that wild mushrooms accounted for 20-40% of the variability of radiocaesium activity concentrations in the populations. Consumption of mushrooms was also the main reason for a 60-70% increase in radiocaesium activity concentrations in autumn. Long term dose assessments after accidental releases should therefore consider the contribution by mushrooms to ingested dose.

Fallout from atmospheric nuclear tests in the sixties - Review of data from Iceland

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Abstract

Fallout from the Chernobyl nuclear accident in Iceland was very little in comparison with the fallout from atmospheric nuclear tests in the sixties. The latter is still by far the dominant source of anthropogenic radionuclides found in the Icelandic terrestrial environment.

This paper summarises information published in the sixties in three Icelandic reports^{1,2,3}. The main emphasis here is put on values for Cs-137 in:

- cow's milk
- lamb meat
- reindeer meat
- whole body measurements

This data has previously had limited distribution (the last of the reports being in Icelandic), but it is still of interest because:

- comparison with data reported from other countries at the time
- comparison with recent Icelandic data. The source term is the same and thus the comparison is of value for estimating the long term behaviour of Cs-137 in the Icelandic terrestrial ecosystem.

Comparison with data from other countries in the sixties indicates closest relationship with data from the Faeroe Islands, especially for milk and lamb meat. In both countries the values for milk are very high compared to values commonly seen elsewhere. In the UNSCEAR compilation of 1977 ("Sources and Effects of Ionizing Radiation") citing data from 1972, the values for milk were by far the highest from the Faeroe Islands of all countries reported. A limited number of whole body measurements also indicate higher values than reported in many countries.

Comparing the new (1989 and onwards) and old Icelandic data shows a similar geographical variation of radioactivity for both periods. The levels decreased fairly rapidly during the time of the fallout, but subsequently the removal from the ecosystem has been very slow.

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A SENSITIVITY ANALYSIS OF A RADIOLOGICAL ASSESSMENT MODEL FOR ARCTIC WATERS

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Abstract

A box model has been used to calculate the environmental dispersion of radionuclides in Arctic waters and the subsequent exposure of man from a range of exposure pathways. A sensitivity analysis has been carried out to identify components of the model that are potentially important contributors to the predictive accuracy. The components investigated include features associated with water transport, particle scavenging, water-sediment interaction, ice transport, fish migration and biological uptake.

The Icelandic Marine Environment. Monitoring of Cs-137

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ABSTRACT

Iceland is located on the Greenland-Scotland Ridge where boundaries are formed between the relatively warm and saline Atlantic waters and the cold Arctic water. A branch of the Gulf Stream carries Atlantic water to the south coast of Iceland. This water flows clockwise along the south and west coasts. At the Iceland-Greenland Ridge the current splits into two parts: one swinging to the west and south-west and the other following the north shore to the east. This influx of Atlantic water to the north region appears as a tongue of relatively warm and saline water where the Atlantic component decreases due to mixing in the direction of the flow.

The East-Icelandic Current flows south-east along the Icelandic continental slope. Its origin is partly from mixed Atlantic water that flows east along the north Icelandic shelf area. Another contribution to this current is Arctic water from the eastern part of the East Greenland Current.

Because of the conditions north and north-west of Iceland, where the relatively warm Atlantic water meets the cold and low salinity water of the East Greenland Current, the conditions are highly sensitive to meteorological changes. Variable influx of Atlantic water and variable admixture of polar water in the surface layers may lead to large changes in salinity and temperature of this area in space and time.

Radiocaesium in samples from the Icelandic marine environment, has been monitored at Geislavarnir ríkisins since autumn 1989. Samples from surface water have been taken since 1990, and deep water samples since September 1994. Samples of fucus have been taken from six locations since 1989 and samples of fish from various species have been taken from that same period. Samples of marine sediment have been taken since 1995. Samples of seabirds and mammals (polar bear and seal) have also been collected.

The ^{137}Cs concentration in the Icelandic marine environment is very low. Levels of ^{137}Cs for samples monitored at Geislavarnir are: Seawater: 3 - 10 Bq/m³, Fucus: 0,2-0,8 Bq/kg d.w. and Fish: 0,1-0,4 Bq/kg f.w.. The levels south of Iceland represent the radiocaesium fallout from nuclear testing in the early sixties. The levels north of Iceland are higher due to releases from the European reprocessing plants. Temperature and salinity data can help tracing the origin of radioactive isotopes measured in seawater samples.

^{134}Cs is not detectable in samples taken from the Icelandic marine environment. Radiocaesium from the Chernobyl accident in 1986 is negligible in the Icelandic marine environment.

Tracer Studies on Sediment-Water Interaction Kinetics of Sr-90 and Cs-137

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Sediments can act as both sinks and sources of radionuclides in the marine environment. The mobility of any radionuclide in a water-sediment system will be limited by both the strength of sorption to the sediment, the reversibility of the sorption mechanism and the kinetics of the sorption processes. Hence, the main aim of the laboratory studies reported here was to provide some information on the kinetics of radionuclide water-sediment interactions and influencing parameters.

Tracer studies (^{134}Cs and ^{85}Sr) have been used to investigate the kinetics of sorption and mobilization of radionuclides from marine sediments. Distribution coefficients ($K_D \text{ ml g}^{-1}$) for ^{134}Cs in seawater-sediment systems varied with contact time, mixing conditions, sediment type, and salinity, and appeared to be correlated with cation exchange capacity. After 1 year contact time under static conditions, K_d for ^{134}Cs ranged from 740 to 1680 ml g^{-1} . Extraction studies showed that the majority of ^{134}Cs was strongly bound to sediment components, although a small fraction (1-10%) was easily displaced and remained in dynamic equilibrium with soluble species. Kinetic modelling using a simple box model indicated that the uptake of ionic Cs to sediments could be described by a two-component function. The relatively fast component probably reflects diffusion through the sediment-water microlayer followed by surface sorption to sediment (ion exchange). The slow component is thought to represent strong fixation within the mineral lattice.

Ionic ^{85}Sr was rather conservative in seawater, showing little transfer to sediments: K_d was $11 \pm 2 \text{ ml g}^{-1}$. Furthermore, ^{85}Sr bound to sediments by ion exchange was easily displaced. Sequential extraction of Irish Sea and Stepovogo sediments indicated, however, that ^{90}Sr was rather less mobile than the ionic tracer. This might reflect the presence of different ^{90}Sr species in the discharge (i.e. non-ionic) or a different water-sediment interaction mechanism in the natural environment.

For both radionuclides, K_D in freshwater was a factor of 100 higher than in seawater, indicating that exchangeable ^{137}Cs and ^{90}Sr can be mobilized if freshwater sediments are transferred to the marine environment. However, the increasing ionic strength in estuaries can also enhance flocculation and precipitation of colloids.

KÄRNKRAFTEN OCH MILJÖN I FINLAND - MED SPECIELL HÄNSYN TILL DEN MARINA MILJÖN

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ABSTRAKT

I Finland har man erfarenheter av kärnkraftens inverkan på miljön redan från nästan 20 år. Åren 1977 och 1980 startades två 330 MW reaktoreenheter i Loviisa, vid sydkusten, och åren 1978 och 1980 två 710 MW reaktoreenheter i Olkiluoto, vid västkusten.

Strålsäkerhetscentralen har redan från början varit ansvarig för utförandet av den radiologiska omgivningskontrollen i båda områdena. De omfattande kontrollprogrammen innehåller ca. 500 provmätningar/anläggningsplats/år. Dessutom har Strålsäkerhetscentralen utfört marinbiologiska utredningar i båda områdena för att utröna kylvattnets värme-effekter i havsmiljön.

Den mest betydande värme-effekten har varit kylvattnets inverkan på isförhållandena i relativt stora områden under vintern, vilket har försvarat vinterfisket. Den tydligaste biologiska effekten har varit vattenvegetationens kraftiga ökning i närheten av kylvattnets utsläpp.

Lokala utsläppsnuklider har konstaterats i den terrestiska miljön bara tillfälligtvis och i mycket låga koncentrationer. Däremot har i vissa provtagningsobjekt ur dem akvatiska miljön tecken på lokala utsläpp konstaterats nästan regelmässigt och även på längre avstånd från utsläppspunkten. Koncentrationerna har ändå varit låga också inklusive kraftverkens närområden.

De kritiska gruppernas stråldoser förorsakade av de lokala utsläppen har varit mycket låga i omgivningarna av de finska kärnkraftverken: mindre än $4 \mu\text{Sv a}^{-1}$.

Location and visual investigation of dumped nuclear waste in the fjords at the east coast of Novaya Zemlya.

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ABSTRACT

A Russian - Norwegian expert group for investigation of radioactive contamination is established under the joint Russian - Norwegian Environmental Commission. The expert group has commissioned three joint expeditions (1992, 1993 and 1994) to the Kara Sea and fjords along the east coast of Novaya Zemlya on board the Russian research vessel "Viktor Buinitksiy". The main objective of the expeditions was to locate and identify dumped nuclear waste and to collect samples close to the objects. In 1992 we were only allowed to sample in the Kara Sea and thereby obtain a general view of the radioactive contamination of the area. In 1993 and 94 we were allowed access to three fjords at the east coast of Novaya Zemlya, the Abrosimov Fjord, Tsivolky Fjord and Stepovogo Fjord where the main part of the radioactive material were dumped. In order to localise dumped objects, the areas were surveyed with the help of towed high frequency sonars.

Located objects was marked with buoys for its exact position and later investigated by use of a Remote Operated Vehicle (ROV). The ROV was equipped with a high frequency sonar, video camera, NaI gamma detector and a BF₃ detector. A sediment sampler on the ROV enabled us to collect samples very close to the objects.

A STUDY ON THE BEHAVIOUR OF CESIUM AND PLUTONIUM IN THE SEDIMENTATION PROCESS UNDER VARYING REDOX-CONDITIONS

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ABSTRACT

The effect of unoxid conditions on the behaviour and remobilization of cesium and plutonium isotopes in near-bottom waters has been investigated in the discharged area of Loviisa NPP, Hästholmsfjärden during the summer 1995. A total depletion of oxygen occurred in the hypolimnion of the deep area of Hästholmsfjärden during two periods, at the end of August and in the mid-September. In addition to redox conditions of water, its total phosphorus- and total nitrogen-concentrations, temperature, salinity and pH were measured. Water and sediment samples were taken five times for analysis of gamma-emitting radionuclides and plutonium isotopes. The results are presented in the paper.

This project is included to the NKS/EKO-1 Marine Radioecology Project.

DETERMINATION OF PB-210 SEDIMENT SAMPLES BY GAMMA RAY SPECTROMETRY: APPLICATION OF AN EFFICIENCY TRANSFER METHOD

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A semi-empirical method to obtain germanium detector efficiencies was applied to the analysis of Pb-210 by gamma ray spectrometry. The computer method was used to transfer a measured full energy peak efficiency of a standard geometry to various heights and densities of sediment samples.

The applicability of self-absorption correction was verified by measuring a standard source on top of sediment layers and by analysing reference material from IAEA.

The obtained efficiencies were utilized in the determination of Pb-210 concentration of Baltic Sea sediments. The results show a good overall agreement to those obtained by conventional alpha spectrometry of Po-210.

Determination of Po-210 and Pb-210 in river and sea sediments

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Abstract

Determination of unsupported Po-210 or Pb-210 in sediments has been used as a technique to determine the age of sediments, and thus determining the sedimentation rate at different sites. Sedimentation rates are important in cases where pollutants (such as radioactive waste or nuclear fall-out) are deposited on the bottom or sea bed, when trying to assess the availability of pollutants at a later stage.

Methods for radiochemically separating the alpha-emitter Po-210 followed by alpha spectrometry have been compared with gamma spectrometric measurements of Pb-210, assuming equilibrium between the two isotopes. Uncertainties and errors in the two methods are discussed.

Analysis have been performed on sediments from the Kara Sea (samples collected in 1992) as well as river sediments from the Techa River near Majak PA in the Southern Urals. Due to a high concentration of high energy gamma-emitters, gamma spectrometric analysis of Pb-210 in these sediments have not been possible.

Excluding sediment profiles that appear to be mixed (by turbulence, episodic events or strong currents), sedimentation rates are determined with good agreement with previous studies.

Mätning av radioaktiva ämnen i betesgräss och mjölk i händelse av en kärnenergiolycka. Förslag till beredskapsorganisation i Sverige

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I händelse av en kärnenergiolycka skall Statens strålskyddsinsitut (SSI) ge råd till övriga myndigheter, bl.a. Statens jordbruksverk (SJV) och Statens livsmedelsverk (SLV) angående åtgärder för att minska stråldosen till befolkningen. SSI bör därför i ett sådant läge snarast få en korrekt bild av den aktuella strålningssituationen, särskilt när det gäller lantbruks- och livsmedelssektorn. Här är näringskedjan betesvegetation (gräs)-ko-mjölk-människa av speciellt intresse, eftersom radioaktiva ämnen snabbt tas upp hos betande kor och utsöndras i mjölken. Mjölk och mjölkprodukter, som är viktiga baslivsmedel, kan därför ge väsentliga bidrag till internstråldosen.

Förslag till en beredskapsorganisation för provtagning och aktivitetsmätning har lämnats i en utredning i samråd med nämnda myndigheter och med Inst. för radiofysik, Malmö. Principen för den nya beredskapsorganisationen, som har dimensionerats för betesperioden, är att befintliga resurser och verksamheter skall utnyttjas och samordnas.

Utredningen föreslår bl.a. att:

- Ett beredskapsregister, baserat på ett urval av gårdar i Lantbruks företagsregister, upprättas för varje län (f.n. 24 st) över gårdar med mjölkproduktion. Beredskapsregistret skall omfatta tre kategorier av gårdar, benämnda registergårdar, provgårdar och försöksgårdar.
Registergårdar består av en förteckning över 5 % av antalet mjölkförgårdar i varje kommun, dvs totalt ca 900 st. *Provgårdar* (10-30 st per län) väljs ur registret vid ett radioaktivt nedfall. Vid provgårdarna tas betesprover för aktivitetsmätning. *Försöksgårdar* väljs vid ett radioaktivt nedfall ur registret för betesförsök med hela, alternativt delar av besättningen och med provtagning och mätning av betesgräs och mjölk. Antalet försöksgårdar bör vara 2 per kontraktslaboratorium (se nedan), dvs totalt 18 st.
- Lantbruksenheten vid resp. länsstyrelse upprättar registret. Jordbruks beredskapsorganisation (vars funktionärer är föreslagna av Lantbrukarnas Riksförbund) medverkar vid urvalet av gårdar. Lantbrukarna vid registergårdarna informeras. Avtal upprättas med försöksgårdarna i en nedfallssituation, då också åtaganden från försöksgårdarna uppmärksammades och ekonomisk ersättning garanteras.
- Statistiska centralbyråns provtagningsorganisation (Objektiva skördeuppskattningar) provtar betesgräs vid provgårdar, senast 4 dygn efter ett larm.
- Mjölkbedömningsorganisationen ställer mjölkprover från register- eller provgårdar till förfogande för aktivitetsmätning.
- SSI:s kontraktslaboratorier (f.n. 9 st, fördelade över landet) medverkar vid urval av prov- och försöksgårdar. Utför betesförsök på försöksgårdar. Provta betesgräs på provgårdar de första dagarna och utför aktivitetsmätningar. Beräknar aktuella samband mellan aktivitet i betesgräs och i mjölk. Utför fältgammamätningar. Rapporterar resultaten till SSI.
- SSI i samråd med SJV och SLV har det övergripande ansvaret för beredskapsorganisationen. Lantbruksuniversitetet i samarbete med SSI utarbetar planer och instruktioner för provtagning och uppgiftsinsamling vid försöksgårdar och vid provgårdar.

Provtagningsrutiner gällande betesgräs kommer att beskrivas i en följande del. Principerna för provtagning bör diskuteras för eventuell samordning inom de nordiska länderna.

Lokala referensmätningar av gammastrålning i svenska kommuner. Erfarenheter från fem års mätningar

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ABSTRACT

I Sverige finns ca 800 fasta referensmätplatser där mätningar skall göras med bärbara dosratinstrument om spridning av radioaktiva ämnen från en kärnkraftolycka eller kärnvapeninsats skulle inträffa. Hösten 1987 erhöll kommunerna instrument för dessa mätningar. Över 500 personer från miljö- och hälsoskyddsförvaltningarna utbildades för mätningarna och ett program för kvalitetskontroll fastställdes. Kvalitetsprogrammet innebar bland annat att varje kommun skulle genomföra återkommande mätningar i referensmätplatserna var sjunde månad. Referensmätningarna har nu pågått i mer än fem år och sammanlagt har över 10000 mätningar genomförts. SSI har gjort en utvärdering av de landsomfattande mätningarna. Rapporten belyser de erfarenheter och slutsatser som kan dras av mätprogrammet.

Kvalitetsprogrammet har givit kommunerna kunskaper och färdigheter att själva genomföra mätningar av den naturliga bakgrundsstrålningen och mäta dosraten från ett eventuellt tillskott av radioaktiva ämnen om en olycka skulle inträffa. Resultat från referensmätningarna har sammanfattats dosratkartor. Mätdata är tillräckligt omfattande för att kunna identifiera olika fenomen som t.ex. Tjernobylnedfalls avklingning, skillnader i dosrat mellan vinter och sommar, påverkan från markbearbetning mm.

Möjligheter att genomföra mätningar i kommunernas referenspunkter utgör idag en viktig resurs i den svenska beredskapen mot kärnenergiolyckor och radiaknedfall. Genom användningen av bärbara instrument i stället för en omfattande utbyggnad av ett fast mätsystem har kostnaderna kunnat hållas nere samtidigt som flexibilitet i mätinsatserna uppnås. Nackdelen är att rapporteringen av mätdata tar viss tid och mängden mätdata är mindre än i ett fast system. Övningar har emellertid visat att det nuvarande systemet har sådan hanterlighet att det inom delar av ett dygn går att sammanställa mätdata från hela landet och få bilder av dosrat och utbredning av en eventuell markbeläggning.

Overvåking av regulære utslipp ved IFE-Kjeller i perioden 1948 - 1994

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Sammendrag

I 1948 ble Institutt for atomenergi, nå Institutt for energiteknikk (IFE), opprettet med formål å drive virksomhet med sikte på anvendelse av atomkraft. Den første reaktoren (JEEP I) var i drift fra 1951 til 1967 og ble erstattet av den nåværende reaktoren, JEEP II, i 1969. Reaktoren brukes i dag utelukkende til forskning og isotop-produksjon. I hele driftsperioden har det vært små, kontrollerte utslipp av radioaktivitet til atmosfæren og via avløpsvann. Ved utslipp til luft finnes bare ^{41}Ar og ^{131}I i påvisbare mengder, mens følgende nukliser dominerer avløpsvannet: ^3H , ^{60}Co , ^{90}Sr , ^{129}I , ^{131}I og ^{137}Cs . Utslippenes har i hele perioden ligget langt under gjeldende utslippstillatelse. For utslipp til luft utgjør ^{41}Ar og ^{131}I henholdsvis 14 % og 0.4 % av tillatt utslippsmengde. Utslipp av radioaktive stoffer i avløpsvann til den nærliggende Nitelva ligger i gjennomsnitt på ca. 10 % av tillatt utslippsmengde.

I presentasjonen blir disse utslippene, som har blitt rutinemessig kontrollert i et eget overvåkingsprogram, diskutert i sammenheng med estimater over dosebelastning til utsatt befolkningsgruppe og nærmiljøet.

Decontamination in a Russian Settlement

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Abstract

Decontamination was carried out in and around three houses in Novo Bobovichi in Russia during the autumn of 1995. It was demonstrated that significant reductions in the dose rate both indoor ($DRF=0.34$) and outdoor ($DRF=0.20$) can be achieved when a careful cleaning is undertaken. The decontamination work carried out and the results obtained are described. The roofs of the houses were swept and cleaned by special roof cleaning equipment. The top soil around the houses was removed by hand while carefully monitoring the ground for residual contamination. By monitoring the decline in the dose rate during the different stages of the work the dose reducing effect of each action has been estimated.

A METHOD FOR ^{90}Sr DETERMINATION IN ENVIRONMENTAL SAMPLES SHORTLY AFTER A NUCLEAR ACCIDENT

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A method for the determination of ^{90}Sr in environmental samples, collected soon after a nuclear accident, has been developed. In such a case, the number of interferences are great and the importance of obtaining results reasonably quickly is stressed. The method consists of the following main steps: ashing, leaching, separation of the daughter ^{90}Y by solvent extraction, and Cherenkov-counting of ^{90}Y in the organic phase. The method was developed by, *inter alia*, using samples collected after the Chernobyl accident.

In order to simplify and speed up the analysis, the leaching process has been investigated. The chemical recovery of fallout $^{90}\text{Sr}/^{90}\text{Y}$ under different leaching conditions has been compared to that of complete dissolution.

The approximate activity ratios of interfering fission products, relative to that of ^{90}Sr , have been calculated as a function of reactor conditions and time passed since interruption of the fission process. It is clear that a fresh fallout calls for a second extraction of ingrown ^{90}Y with the intention of removing all extractable interferences in the first extraction. From calculated and experimentally validated distribution data, and from the calculated activity ratios, proper extraction parameters have been evaluated.

Because any interfering radioactivity can not be excluded, the β -decay curve must be followed by counting the sample a number of short time-periods. The data points are then least squares fitted to obtain the initial ^{90}Y and background count rates, and their uncertainties. A way to predict the expected relative uncertainty in the ^{90}Y count rate, as a function of time, number of samples and estimated initial activity and background, is presented. The practical use of detection limits is discussed.

Mobile equipment for preparedness purposes.

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Abstract

Sweden is a fairly large country. Therefore, there is a relatively great need in our country of mobile equipment for measurements of fallout in case of nuclear accidents. For this purpose and on assignment from the Swedish Radiation Protection Institute (SSI), the Radiometry team from the Division of Ionizing Radiation and Fallout, FOA NBC-Defence, Umeå, is part of the National preparedness program for Northern Sweden. Other tasks of the Radiometry team are analyses of radioactive material, development of methods and equipment for preparedness purposes, and simulation of the distribution of deposited radioactive matter after nuclear accidents and nuclear weapons explosions.

Field gamma-ray spectrometry

Two HPGe-detectors, with relative efficiencies of 50% and 36%, respectively, are available for field gamma measurements. The detectors have been efficiency calibrated within the energy interval 240 - 1500 keV and for angle of incidence. The measurement data evaluation is based either on a slice distribution model with homogenous density and activity distribution in one or more slices, or on a plane surface source distribution model.

Carborne measurements

We have recently mounted one of the two HPGe-detectors inside a four-wheel-drive vehicle for carborne spectrometry measurements. The vehicle also contains an air-sampling equipment, computers powered by 12 or 220 V, mobile phones and a fax. Other facilities are equipment for soil-sampling, dose-rate measurement and position estimation (GPS). To increase independence, the vehicle has both a heating system and a 220 V power-supply driven by gasoline.

Whole body counting

After the Chernobyl accident in 1986, a mobile whole body counter was constructed by FOA NBC-Defence and the Department of Radiophysics at Umeå University. It was built on an assignment from SSI. The whole body counter was placed in a standard ship-container and mounted on a truck trailer to facilitate transports. The whole body counter initially consisted of a lead-shielded geometry and a 5*5" NaI crystal with electronics. Recently, the NaI detector was substituted with the 50% HPGe detector. The detector is calibrated for photon energies between 500 - 1500 keV and for body-masses of 10 - 90 kg. For body-masses below 10 kg (babies), the detector has been calibrated for two specific nuclides (Cs-137 and K-40). The mobile whole body counter laboratory is also equipped with telephone, fax, electric heaters and air conditioning.

Simulation

A novel mathematical simulation method for activities and dose-rates in areas of fallout (MARS) has recently been developed. A microprocessor simulates the distribution of radioactivity based on a single mathematical expression, the geographical position and time. MARS can be used both in handheld and carborne applications. The simulator has been tested on a number of scenarios including the release of radioactive matter from nuclear reactors and the fallout after nuclear weapons explosions. The method is currently introduced in various simulation applications.

THE METEOROLOGICAL INSTITUTE'S CONTRIBUTION TO THE NATIONAL RADIATION SURVEILLANCE PROGRAMME IN FINLAND

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Abstract - The Finnish Meteorological Institute (FMI) participates in the nation-wide radiation monitoring system of Finland with a monitoring network for atmospheric radioactivity and with dispersion forecasts. The main purpose of the monitoring network is the use of natural radionuclides as tracers in air quality and climate studies but it operates also as a sensitive early detection network. The Institute is also, owing to its 24-hour duty service, the national contact point of the international radiation event notifications.

The FMI's radioactivity monitoring network consists of fourteen computer-controlled stations recording continuously aerosol β activity with a system where air is drawn alternately through one of two fixed filters wrapped around GM tubes. The discrimination between the short-lived ^{222}Rn progeny and artificial β emitters is based on different half-lives. The instrumentation detects an artificial β activity in the aerosol of a few becquerels per cubic metre. The filters are changed once a week and measured in the laboratory as weekly aerosol samples. All the measured data can be interrogated remotely with a few minutes delay at the network's central station in Helsinki.

Seven of the fourteen stations monitor also external radiation, rainfall intensity, and temperature of the air and five stations the electrical conductivity of the air. External radiation is measured with scintillation detectors. The older system (five stations) uses two NaI(Tl) detectors, one on top of the other separated by a 1" lead shield. This counting geometry distinguishes the gamma radiation of suspended activity from the gamma radiation of deposited activity. In the case of precipitation an increase of 0.01 $\mu\text{Sv/h}$ in the external dose rate caused by artificial radioactivity can be distinguished from natural sources. The newer system (two stations) has only one NaI(Tl) detector. Based on the pulse height spectrum measured with a multi-channel analyser an external dose rate of 0.001 $\mu\text{Sv/h}$ caused by artificial radioactivity can be detected.

Daily aerosol samples at four and daily precipitation samples at two stations are collected. These, and the weekly aerosol samples are measured with an automatic alpha/ β analyser for long-lived β activity (mainly ^{210}Bi and possible artificial β emitters) five days after the end of sampling when the ^{220}Rn and the short-lived ^{222}Rn progenies have decayed. The daily aerosol and precipitation samples are measured also as soon as possible, usually 1-2 days after the sampling.

In addition, the daily aerosol and precipitation samples of two stations are examined with autoradiography to reveal any hot particles. The three sounding stations operated by the FMI can also make radioactivity soundings of the upper atmosphere.

For operative use the FMI has two dispersion models. YDINO is a short-range dispersion model, which is used in case of emergencies at the Finnish nuclear power plants or at those nearest to the Finnish borders. It is a Gaussian surface trajectory dispersion model, which utilizes routine synoptic weather observations. TRADOS is an operational Gaussian long-range trajectory and dispersion model. Time-integrated air concentrations as well as dry and wet deposition forecasts for selected groups of radionuclides can be calculated. In the statistical mode also external dose rates and doses via several external and internal pathways can be estimated. The TRADOS model runs on the meteorological data from the Finnish version of the Nordic HIRLAM numerical weather prediction model or on the data from the European Centre for Medium-Range Weather Forecasts (ECMWF).

OLYCKSSKENARIO FÖR HAVERIBEREDSKAPSÖVNINGAR

Klaus Sjöblom,
Lovisa kraftverk,
NKS EKO-4

Bakgrund

De organisationer, som bör ha beredskap för strålnings-olyckor över nuförtiden mera regelbundet än förr. Då myndigheter och andra organisationer har utvecklat sin beredskap, har en stor del av förbättringsförslagen gällt själva övningsarrangemangen. Det har visat sig att

- Även kortvariga övningar kräver långvariga och arbetskrävande förberedelser
- Olycksscenariot behöver inte vara sannolikt men nog realistiskt
- Presentationen av olycksscenariot bör likna en verlig olycka
- Man behöver färdiga underlag för övningsarrangemangen

Därför har NKS aktiverat ett scenarioutvecklingsprojekt. Projektet är en del av EKO-4 och skall genomföras 1994-97. Syftet är att förbereda bakgrundsmaterial för en serie olycksscenarion, som kan användas i nordiska haveriberedskapsövningar. Därtill skall ett "verktyg" utvecklas som underlättar användningen av bakgrundsmaterialet då nationella, regionala eller lokala övningar förbereds. Delar av materialet bör kunna användas i verksamhets-övningarna 1996- 1997.

Nordiska myndigheter inom haveriberedskap, reaktorsäkerhet och strålskydd skall kunna utnyttja materialet i nationella och regionala övningar. Materialet bör innehålla reaktorsäkerhet (kraftverkshändelser och källtermet), strålsäkerhet (radioaktivitet, doser och skydds-åtgärder) och haveriberedskap (varningar och information). De nordiska länderna skall med detta material kunna arrangera egna och gemensamma övningar.

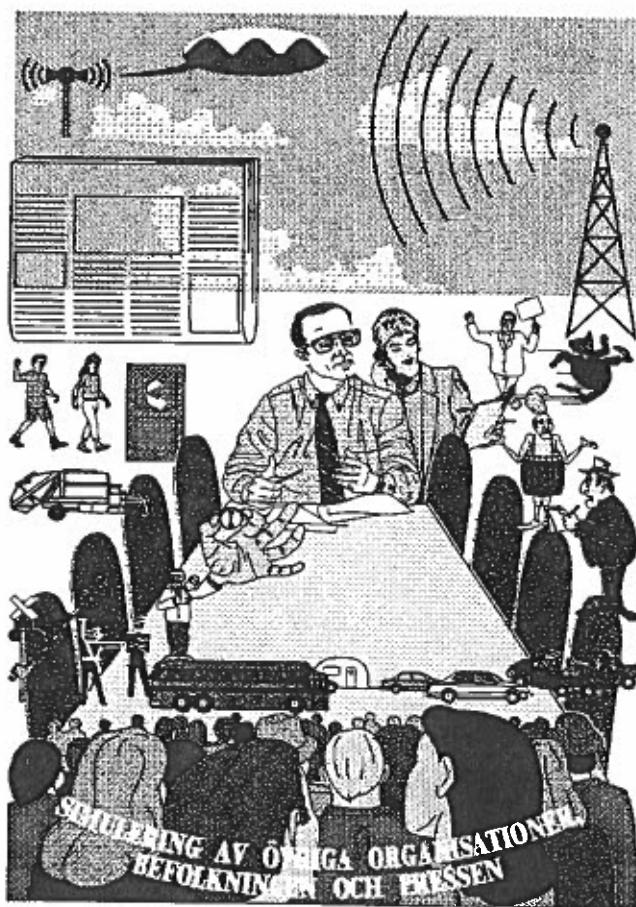
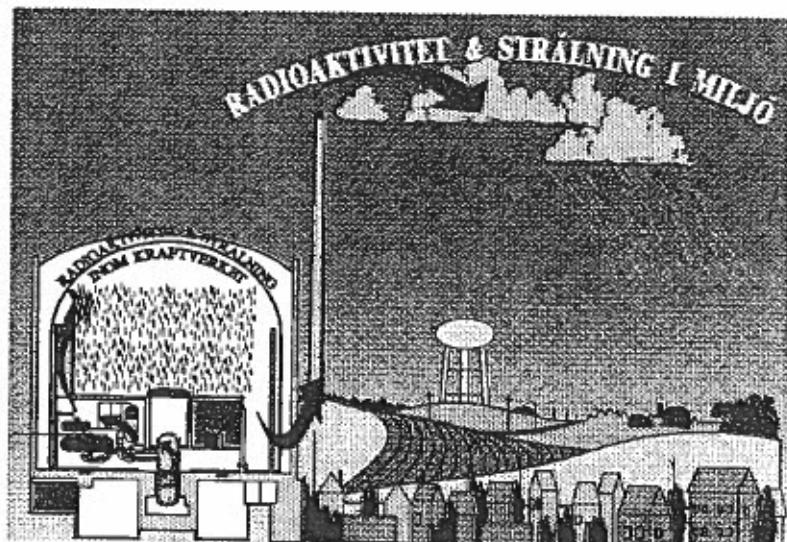
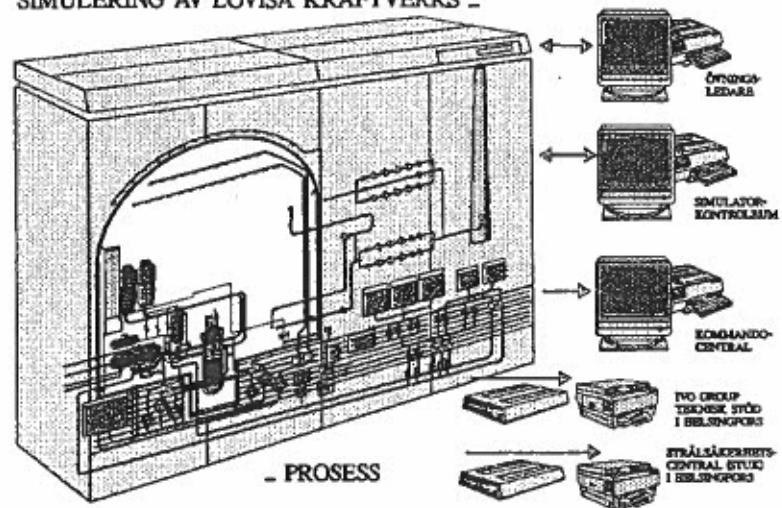
Ett olycksscenario består av olika delar

- Kraftverksprosessen
- Radioaktivitet och strålning innanför och utanför kraftverket
- Övriga världen: organisationer och människor som inte deltar men simuleras

Det finns goda fullskaliga kraftverkssimulatörer och utvecklade dataprogram för räkning av spridningen av radioaktivitet i atmosfären. De potentiella förbättringsmöjligheter gäller simulering av:

- Härskada och termodynamik vid en allvarlig reaktorolycka
- Radioaktivitetens spridning inom kraftverket
- Strålning inom kraftverket
- Övriga organisationer och människor

SIMULERING AV LOVISA KRAFTVERKS -



EMERCON & ECURIE - internationell rapportering vid kärnkraftolyckor med datorstöd

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Rubricerad poster skall kortfattat beskriva IAEA's rapporteringssystem EMERCON och EU's motvarande ECURIE och vad som skiljer dem åt. Vi presenterar även ett datorprogram som vi har utvecklat i Visual Basic för att förenkla rapporteringen från Sverige vid en olycka i ett svenska kärnkraftverk. Rapporteringen skall ske snabbt och det är en lång rad med frågor att besvara, varav en del kan besvaras redan i förväg. Vi lägger alla sådana kända uppgifter om de olika kärnkraftverken i en databas, där svaren sedan hämtas av vårt program när vi anger vilket verk som drabbats av olyckan. Programmet hjälper även till med omräkning av lokal tid till UTC, gör hopp i frågelistan när inte alla frågor skall besvaras och liknande för att snabba upp rapporteringen. När frågorna är besvarade genereras en kodad textfil som är klar att skicka enligt det format som föreskrivs. Man får även se svaren i klartext för att se vad som matats in i programmet. Vårt program skall lätt kunna anpassas till andra länders förhållanden är det meningen. Vi räknar även med att kunna visa hur datorprogrammet fungerar för dem som så önskar.

RADIATION MONITORING ON THE BORDER AND IN THE METAL SCRAP RECYCLING INDUSTRY IN FINLAND

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Abstract

The aim of the control of passengers and goods for radiation at customs is to prevent the illegal or unintentional import of radioactive materials. The customs has several stationary measuring systems with large plastic scintillation detectors locating at the eastern border of Finland. Fixed systems are also in some harbours and airport of Helsinki. The customs has also hand-held monitors with very high sensitivity to detect radioactive material. Today it is possible to measure all trains, autotrucks and cars crossing the border from the Russian Federal Republic. The metal scrap recycling industry has some fixed monitor systems and hand-held radiation monitors to prevent radioactive material getting into the melting process.

Radioactive material can be found in the metallic scrap. It may be true sealed sources, activated scrap or contaminated scrap. Smugglers may also try to transport sealed sources or nuclear material. Some industrial raw materials contain naturally occurring radioactive materials (NORM) in so high amount to be detected at the border control.

The main procedure when a radioactive source or cargo containing radioactive material is found is to halt transport and return it to the sender. Materials containing NORM may continue to its original destination. Additional measurements may also be carried out to identify the source and its origin.

During recent years some cases cargoes containing radioactive material has been identified on the border by the customs. Examples of radioactivity found include radium- and thorium-contaminated scrap, metallic uranium and old aeroplanes with luminous instruments. The metal industry which has had fixed monitor systems for some years has found some sealed Cs-sources with the activity of about 50 MBq and also many railway wagons containing contaminated scrap mostly from uranium mining industry.

In 1995 there were a total of 13 unusual incidents related to radioactive material found at the customs or industry. The incidents containing NORM are not included. Of these none caused any significant radiation risk for customs officers or other people.

Urlaknings effekter av ^{137}Cs , ^{40}K och ^{210}Po vid lutning av fisk och kött

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Sammandrag

Vi har studerat koncentrationerna av ^{137}Cs , ^{40}K och ^{210}Po i torkad långa, gädda och renkött efter det att man har lutat proverna i NaOH. Av dessa experiment har vi fått fram likheter mellan alkalinuklidernas uppförand i cellstrukturen och effekten på vävnad av lutning. Stråldosreduktionen vid denna metod har beräknats och utifrån detta har det utvärderats om denna gamla Skandinaviska tradition är en bra motåtgärd vid dekontaminering av livsmedel.

Vid lutning bryts lipidlagret i cellmembranet ner av luten till tvål. Detta möjliggör för de intercellulärt bundna jonerna att diffundera ut till den extracellulära vätskan och vidare ut i lutlösningen. Det visar sig att efter fyra dagar så har man nått en jämvikt i lösningen av ^{137}Cs och ^{40}K . Extraktionshastigheten (procent av totala innehållet av isotopen som extraheras ut per dag) var samma för cesium och kalium både i lutlösningen och sköljvätskorna. Av detta kan man dra slutsatsen att cesium befinner sig intra cellulärt liksom kalium och i jon-form. Proteinerna uppvisar en lägsammare nerbrytning under påverkan av hydroxidlösningen och bildar protinater. Det var förväntat att poloniumet skulle följa proteinextraktionen, eftersom Polonium är starkt associerat till partiklar i basiska lösningar.

Det visade sig att om man torkade varan före lutning så fick man större reduktion av alkali isotperna. Detta beror sannolikt på att man snabbt får en hög koncentration av lutlösningen i hela provet. När det är torrt så behöver inte lösningen diffundera, som i färskt varor, in, utan bara "sugs" in av kapillärkrafter.

Reduktionen av alkalinukliderna ^{137}Cs och ^{40}K varierade mellan 80 - 100%. ^{210}Po urlakades mellan 0 - 100 %, men i medeltal 20 % och i vissa fall ökad koncentration. Stråldoserna reducerades mellan 60 - 90%, där den stora delen av dosen kom från ^{210}Po i de lutade proverna.

RaMona, Radiation Monitoring and Alarm System for the IFE-Kjeller Site

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Abstract

The IFE-Kjeller site hosts several installations handling radioactive material, namely the isotope laboratory, the JEEP II research reactor, a waste treatment and storage facility, an irradiation plant and laboratories for re-instrumentation of fuel rods.

All installations have continuous monitoring of air-activity, external gamma-radiation and of offgas released to the atmosphere. The planned combined low- and intermediate waste repository and storage facility in Himdal will also be covered by this system.

A new monitoring system is currently under development. The main objectives of the system are:

- Provide audible and visible alarms in order to evacuate the building if the radiation level exceeds a preset limit
- Provide information on radiation levels under normal operation condition for ALARA purposes
- Provide background information to be used in reports to the authorities on releases to the atmosphere

Basic functionality is implemented in software, allowing for a high degree of flexibility. The data acquisition system runs on PCs coupled to the GM counters through a commercially available counter interface card, each PC can accommodate a multiple of 8 detectors. The LabView instrumentation software package has been chosen for program development.

The PCs are connected through a network. A central read-out system is designed to make all data continuously available for the radiation protection staff. The measured air concentration or dose rate is presented in graphs, average and extreme values are calculated. The locations of buildings and the placement of sampling points are presented as maps. Based on air-sampler efficiency, radionuclide contents and filter replacement intervals, it is possible to calculate the air activity concentration. It will be used to calculate doses resulting from intake of radionuclides. A computer program, LUDEP, using the respiratory tract model of ICRP publication 66 is chosen for this purpose.

Additionally, we plan to interface a simple Gaussian plume dispersion model to the system to be able to predict on- and off-site consequences of a possible accidental release of radionuclides.

Probabilistic assessment of doses and depositions after a hypothetical accident at the Barsebäck nuclear power plant, using 2 years hourly meteorological data.

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Abstract

In 1995 the Swedish Radiation Protection Institute (SSI) was asked by the Governmental Energy Commission to investigate doses and ground deposition following hypothetical accidents at all four Swedish nuclear power plants. In this connection the Swedish Nuclear Power Inspectorate published figures on source terms for "typical" accidents with a melted core, covering the range from a fully functioning consequence mitigating system to no mitigation whatsoever.

This study uses these source terms combined with hourly meteorological data from Sturup for a full 2-year period in a probabilistic study (PSA 3) of external doses and ground deposition after a hypothetical accident at Barsebäck. This is the first time a true, albeit limited, level 3 NSA has been performed for a Swedish power plant.

International Intercomparison of Criticality Accident Dosimetry Systems at the Silene Reactor

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Abstract

The Silene Reactor at the Valduc Centre near Dijon in France can be operated to give a short intense neutron pulse. This is very useful for testing criticality accident dosimeters. In 1993 IAEA and EU jointly arranged an intercomparison of criticality accident dosimetry systems at the Silene Reactor. 18 laboratories from 14 countries with about as many different dosimetry systems participated. Each laboratory had the possibility of placing dosimeters at the front of a phantom and in the "air". Liquid from the phantom could be obtained after the irradiation for "biological" dosimetry. The Silene reactor provided two sets of neutron pulses, one from a bare reactor and one with the reactor shielded with 10 cm of lead. After each neutron pulse the laboratories had two days to produce a first estimate of the neutron kerma. The agreement between the results obtained by the different laboratories was quite good.

International Exchange of Information in the Event of Nuclear Accidents.

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Abstract

It is today recognised that nuclear accidents may have considerable cross border consequences. It is therefore important also for neighbouring countries to have as much information as possible in order to assess consequences for their own countries.

Computerised decision support systems are now being developed for implementation in many countries. Their capability of collecting and processing information has improved considerably and will add a new dimension to the term decision support.

Rapid exchange of information between decision support systems therefore becomes important for the emergency preparedness organisation in order to establish the best possible background for decisions and information to the public in the event of a nuclear accident.

This exchange of information requires international consensus on strategies and methods and tools. This has not yet been achieved. The views from the Norwegian side on the principles and methods for this co-operation will be presented.

Radiation Risk Information to the Public: Principles or Common Sense?

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ABSTRACT

Risk information strategies of radiation protection authorities and experts failed to a large extent after the Chernobyl accident, giving a raise to mistrust and deafness from the public. In some countries the mistrust can be explained from purely political reasons, but the information failure also occurred in open and democratic countries. As the radiation risk message did not get through, even to well-educated people, we so-called experts have to reconsider our former information strategies, especially in the low-dose case, where the ALARA principle collides with the public's need for meaningful countermeasures and efficient risk reductions. What can be done in the future in order to regain the confidence of the public? In this contribution the following changes and strategies will be discussed:---1. Utilizing the common sense of people at the expense of intricate radiation protection principles.---2. Putting individual risk in the foreground and societal ditto, i.e. people-sievert calculations, in the background.---3. Withstanding the pressure from politicians, non-expert authorities and mass-media to measure/control trivial radiation levels. ---4. Emphasising averted dose/risk ambitions, i.e. mSv/y or yearly intakes of activity, concerning food restrictions, at the expense of the secondary action levels in form of specific activity concentrations.---5. Applying Non-information Levels in the same spirit as operative Non-action Levels.---6. Avoiding quantification of small radiation risks.---7. Educating strategic groups of people, i.e. teachers, medical staffs, journalists and local health authorities.

Oslo med de norske ekspertene, hvor uklarheter og spørsmål fra gruppen ble diskutert i detalj . Evelueringsmøtet inkluderte et besøk på stedet for det planlagte anlegget i Himdal og avfallshåndteringsanleggene ved IFE på Kjeller.

Innen de rammer som var satt for gjennomgangen, var teamet (WATRP) tilfreds med den totale tilnærmingen de ansvarlige norske organer hadde tatt i utviklingen av et lagrings- og deponeringsanlegg for lav- og middelaktivt avfall. Med grunnlag i de informasjoner som finnes, mente evalueringsteamet at det utpekte anleggsstedet i Himdal, i kombinasjon med det tekniske konseptet (sarkofager), kan egne seg for lagring og deponering av de relativt små mengdene av norsk lav- og middelaktivt avfall. Evalueringsteamet understreket at det kun er nødvendig å finne et egnet sted, og at det i realiteten ikke er mulig å finne det beste stedet. Teamet oppfordret de ansvarlige myndigheter til:

- å velge et konsept for lagring og deponering ut fra de forskjellige foreliggende alternativene og utvikle detaljerte planer for dette konseptet,
- å spreng ut de respektive lager- og deponirom og samle inn detaljerte stedsspesifikke data fra byggearbeidet,
- å oppdatere sikkerhetsberegningene i samsvar med disse, og
- å stadfeste egnetheten av det stedet som er valgt for anlegget.

Konklusjoner og anbefalinger som WATRP-teamet har gitt i sin rapport, har blitt brukt av Statsbygg i deres avsluttende arbeid med sikkerhetsrapporter og utforming av anlegget. Rapporten er også til stor støtte og hjelp når Strålevernet gransker sikkerhetsrapportene. IAEAs rapport kan brukes som en "sjekk-liste".

28.05.1996

Järnvägsvagn kontaminerad med Cs-137

Tord Larsson, Statens strålskyddsinstitut, Sverige, 1996-05-30

Inledning

Efter Sovjetunionens fall i början av 90-talet och Tjernobylkatastrofen för 10 år sedan, har svensk stålindustri i allt större omfattning utrustat sig med automatiska detekteringssystem för joniserande strålning från gammastrålande radioaktiva ämnen. Systemen kallas allmänt gammaptor och placeras vid järnverkens infarter för järnvägs- och vägtransporter. Avsikten är att kontrollera återvinningsbart skrot.

Gammaportarna har under senare tid givit larm vid upprepade tillfällen, men de flesta händelserna har kunnat härledas till enskilda metallstycken i lasten. Oftast har det varit naturligt förekommande radioaktiva ämnen som givit upphov till larmet. Som exempel kan nämnas beläggningar av radium-226 och uran-238.

Larm i gammapot

I augusti förra året larmade en gammapot vid Fundia Steel AB i Smedjebacken när en järnvägstransport med fragmenterat skrot passerade. Förnyad kontroll utfördes med handinstrument varvid kunde konstateras an en enstaka järnvägsvagn med last (ca 60 ton) strålade. Ytdosraten visade sig vara ca 30-50 $\mu\text{Sv}/\text{h}$.

Vagnen återsändes til leverantören för undersökning. Lasten togs ur skopa för skopa och allt skrot kontrollerades med känsliga handinstrument. De sista skrotresterna skrapades samman med skyffel så att vagnen blev helt ren. I skroten fanns ingen påvisbar förhöjd gammastrålning.

Det stod nu klart att det var vagnen själv som var orsaken till strålningen.

Järnvägsvagnen är inhyrd av Statens Järnväger från Tyskland sedan april 1994 tillsammans med ytterligare ca 150 vagnar. Underdet (boogie) tillverkades i Tyskland 1984.

Oregelbundet utspridd aktivitet

Vagnen togs omhand av Statens järnvägar och ställdes upp på ett avgränsat område i avvaktan på en kontroll av personal från Strålskyddsinstitutet. Kontrollen visade att vagnens ena boogie var kontaminerad med Cs-137. Aktiviteten var oregelbundet utspridd och återfanns på de flesta ställen på ramkonstruktionen. Prover togs från metallen i boogien och från ytan. Proverna visade att aktiviteten fanns i rost och smuts på ytan. Mängden radioaktivt ämne Cs-137 i beläggningen var ca 20 kBq/g. Ytdosraten på motsvarande ställe uppmättes till ca 100 $\mu\text{Sv}/\text{h}$.

Tjernobyl uteslutet

Det fanns inga spår av radioaktivitet på vagnkorgen eller den andra boogie. Vidare kan konstateras att det inte fanns några spår av Cs-134 vars halveringstid är två år, vilket skulle ha varit fallet om boogien blivit utsatt för nedfall efter Tjernobylkatastrofen. Det har ännu inte gått att klarlägga på vilket sätt eller när kontaminationen har skett. Strålskyddsinstitutet har begärt att järnvägsvagnen skall undersökas ytterligare hos den tyske ägaren i samarbete med den tyska strålskyddsmyndigheten.

Radiological Consequences in Denmark from a Severe Reactor Accident in the Ignalina Power Plant.

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Abstract

The radiological consequences in Denmark are assessed, following a hypothetical severe reactor accident in the Lithuanian nuclear power plant at Ignalina. The release of radionuclides and subsequent spreading in the atmosphere is initially assumed to be similar in magnitude to that of the Chernobyl accident in April 1986. The atmospheric transport and deposition of radionuclides from the Ignalina power plant is modelled as a stochastic process, and a probability distribution is estimated for the deposition on Danish territory, based on the deposition pattern of radio caesium after the Chernobyl accident. At the 1% probability level of the atmospheric transport and deposition, the collective radiation dose to the Danish population amounts to 100,000 manSv, assuming the accident to happen in the summer months shortly before harvest. The most important pathway for radiation dose to the population will be ingestion of contaminated food, and restrictions on foodstuff are likely to be required.

On the ethical issues in radiation protection

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Abstract

The author surveys existing international radiation protection recommendations and standards. After outlining previous work on the ethics of radiation protection, professional ethics, and the ethics of human radiation experiments, the author review ethical thinking on seven key issues related to radiation protection and ethics.

"Potential exposure" i praktiken

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Tidigare har strålskyddsfilosofin varit starkt inriktad på doser som med stor sannolikhet verkligen drabbar berörda personer. En annan situation är när jämförelsevis osannolika förlopp, t ex olyckor, leder till doser till personer som annars inte skulle blivit utsatta (åtminstone inte på det sättet). Det senare fallet kallas i ICRP 60 för "Potential exposures".

Tankarna kring potential exposures utvecklades först i diskussioner om slutförvaring av långlivat radioaktivt avfall. För ICRPs del återfinns tankegångarna först i ICRP 46, som dock inte använder uttrycket "potential exposure". Efter detta har mycket uppmärksamhet ägnats åt stora olyckor i kärntekniska anläggningar, för ICRPs del i ICRP 64. Båda dessa typer av potential exposure är komplicerade att analysera och bedöma, och båda kan leda till omfattande kostnader utöver skada för många personer ur allmänheten.

Det finns emellertid en tredje situation, nämligen begränsade olyckor vid arbete med strålning (på kärntekniska anläggningar eller annorstädes). Varje sådan olycka drabbar ett fåtal personer, främst bland anställda även om vissa scenarier som förlust av stora strålkällor också kan drabba personer ur allmänheten. Ofta är olyckan relativt enkel att analysera och bedöma. Kostnaderna vid sidan av strålskador är ofta begränsade.

ICRP överväger att ge ut rekommendationer om sådana begränsade potential exposures. I avvaktan på sådana rekommendationer kan man konstatera att en god analys av potential exposures, och därmed en möjlighet till skydd, måste börja med en strukturerad analys av scenarier. Sådana säkerhetsanalyser med felträd eller händelseträd är välbekanta för ingenjörer men inte alltid för strålskyddare.

Med sannolikhetsstal för steg i sådana fel/händelseträd och nominella koefficienter för skadesannolikhet kan man beräkna detrimentet till följd av potential exposures. På samma sätt som normalt väntade doser kan jämföras med ALARA-krav och dosgränser, kan även detrimentet från potential exposures jämföras med risk constraints. För de begränsade händelser som behandlas här bör det inte vara alltför svårt att formulera och tillämpa sådana risk constraints. Den enda väsentliga skillnaden mot normala exponeringar är att en metod att väga in deterministiska effekter i risk constraint måste till. För långa tidsintervall och stora olyckor uppstår dock emot invecklade och ännu långt ifrån lösta problem.

Några speciella situationer bör uppmärksamas. Den mänskliga faktorn kommer ofta till korta "i fält" där modifieringar av utrustningar plötsligt kan te sig angelägna. Den från kärnkraften kända djupförsvarsprincipen med flera barriärer kan mycket väl tillämpas även på "enkla" system, med god framgång.

Problem, möjliga lösningar och tillsynsåtgärder kan belysas med några exempel på utrustningar för bestrålning och för radiografering.

European Basic Safety Standards Directive 1996

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Abstract - The Euratom Treaty from 1957 prescribes that uniform Basic Safety Standards shall be laid down within the European Community to protect the health of workers and of the general public against the dangers arising from ionizing radiation. The first European Directive was issued in 1959, and a new revised Directive was adopted by the Council of the European Union in May this year to replace the previous directive from 1980/1984.

The objective of the revision of the Basic Directive has primarily been to assure that European national legislations on radiation protection are in line with the new recommendation from the International Commission on Radiological Protection from 1991 (ICRP No 60). The new Directive therefore introduces the distinction between practices and intervention and the concepts of dose constraint and potential exposure. The dose limits are with minor editorial changes identical to the recommendations in ICRP No 60.

The Directive retains the system of reporting or prior authorization of practices although with some changes in the grouping of types and classes of practices into the two schemes. New radionuclides specific exemption levels for reporting, expressed as quantity or concentration, are given based on well established dose criterias and generic scenarios.

The Directive do not apply to radon in dwellings and to uncontrollable exposures to natural radiation sources, e.g. K-40 in the body, cosmic radiation at ground level. However, work activities within which the presence of natural radiation sources can lead to a significant increase in the exposure of workers or members of the public are covered by the Directive. The Directive introduces a new general obligation on the Member States to be aware of the possibility of such exposures and to react if necessary. The circumstances and possibility to apply protection measures regarding exposure to natural radiation sources can vary within and between Member States, and the Directive therefore allows a considerably flexibility in implementing this new area of concern.

Subsidiarity and flexibility has been key words during the negotiations of the Directive in the Council and being a minimum directive the new Directive offers a high degree of freedom for the Member States for the implementation of the Directive into the national regulations. In order to help the Member States during this process the Commission with the assistance of the Article 31 Expert Group is preparing a general Communication on the implementation of the Directive and advice and recommendation on more specific issues, e.g. natural radiation sources. The Members States shall comply with the Directive before 13 May 2000.

9 August 1996

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