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Wolfgang Weiss, John Harrison, Philipp R. Trueb, Jukka Juutilainen

International Evaluation of

THE RESEARCH ACTIVITIES OF THE FINNISH RADIATION AND NUCLEAR SAFETY AUTHORITY (STUK)

MINISTRY OF SOCIAL AFFAIRS AND HEALTH

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Wolfgang Weiss, John Harrison, Philipp R. Trueb, Jukka Juutilainen	Ministry of Social Affairs and Health
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International Evaluation of the Research Activities of the Finnish Radiation and Nuclear Safety Authority (STUK)

Summary

■ The Ministry of Social Affairs and Health invited a multi-professional panel of international and national experts to evaluate the research activities of STUK. The evaluation was based on written material, a site visit and interviews with scientists and the management. The site visit took place on October 12–14, 2011. This evaluation was the third international evaluation. The previous evaluations took place in 2001 and 2005.

The panel concluded that overall STUK presents a highly impressive research portfolio, with well educated, keen and committed staff provided with an excellent working environment. The physical condition of the experimental laboratories is exemplary. The 2011 panel felt that while its remit was specifically to evaluate research at STUK, it was important to make assessments in the context of the range of work and overall strategies for work programs. During the evaluation period and beyond, declining resources for research both nationally and internationally have posed new challenges to STUK and the scientific community in radiation research. Research is integral part of STUK activities and the success factors should reflect the overall success of laboratories and departments. The panel made several recommendations on management and scientific issues to reinforce the quality of research and activities in STUK.

Key words

Evaluation, management, organisation, radiation, radiation protection, Radiation and Nuclear Safety Authority, research, STUK

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PREFACE

The Ministry of Social Affairs and Health and Radiation and Nuclear Safety Authority (STUK) agreed that the scientific output of STUK will be evaluated by an international expert panel in 2011. The previous evaluations were conducted in 2000 and 2005.

The Ministry of Social Affairs and Health invited a multi-professional panel of international and national experts for the evaluation. The panel was chaired by Prof. Wolfgang Weiss (Federal Office for Radiation Protection, Germany). Other members appointed to the panel were Dr. John Harrison (Health Protection Agency, UK), Dr. Philipp Trueb (Swiss Federal Office for Public Health, Switzerland) and Prof. Jukka Juutilainen (University of Eastern Finland).

STUK – Radiation and Nuclear Safety Authority is the national authority in radiation and nuclear safety, expert organisation as well as the national research centre on various aspects related to radiation protection. The research areas of STUK relate to health effects of radiation, use of radiation in health care and industry, occurrence and mitigation of natural radiation, environmental research, preparedness for radiological threats and emergencies, dosimetry and metrology, non-ionising radiation and, to a lesser extent, nuclear safety.

According to the Terms of Reference, the evaluation of STUK was to address the following main issues:

- Appropriateness of STUK's activities in relation to relevant issues in radiation protection
- Social relevance and effectiveness of the activities
- Steering by information
- Prioritising STUK's various activities
- Quality of STUK's research activities
- The relation between costs and results

The Ministry of Social Affairs and Health was pleased to note that the overall research portfolio of STUK was considered impressive, and also to learn that the staff of STUK is well educated, keen and committed and the working environment is excellent. STUK has a great number of responsibilities. Research is integral part of overall function and the impact of research is often mediated via regulatory functions. The 2011 panel proposed to evaluate the overall success of the laboratories and departments. The following success factors were proposed by the 2011 panel:

1. Publication record
2. Development of knowledge and tools (software, hardware, standardization of procedures)
3. Input to the development of the state of science and technology
4. Improvement in public health status (e.g. indoor radon)
5. Improvement of public awareness on risk
6. Optimising working arrangements by reorganisation and co-operation in STUK, nationally, internationally.
7. Participation in international networks and expert organisations.
8. Raising the profile of STUK (population, scientific community)

I would like to thank warmly the evaluation panel for its efforts and constructive proposals to support the work of STUK. The actions on the basis of the evaluation will be a challenge for the years to come.

Aino-Inkeri Hansson
Director General

Department for Promotion of Welfare and Health
Ministry of Social Affairs and Health

MEMBERS OF THE EVALUATION PANEL

John Harrison

John Harrison joined the National Radiological Protection Board (NRPB) in 1974 having gained a B.Sc. in Biochemistry at University College, Wales, and Ph.D. in Biochemistry at St. George's Hospital Medical School, University of London. His Ph.D. was on the biological behaviour of indium and gallium radioisotopes and their use in radiopharmaceuticals. For many years, he was Head of the Radionuclide Effects Group of Radiation Effects Department within NRPB. More recently, he has been Head of Dose Assessments Department and is now Deputy Director for Research in the same institute which has a broadened remit as the Centre for Radiation, Chemical and Environmental Hazards (CRCE) of the Health Protection Agency (HPA).

His research background is in the biokinetics, dosimetry and effects of internal emitters and he has published extensively in this area. He is an author on over 150 peer-reviewed papers, about one-third as first author. Topics have included: absorption of ingested radionuclides; volunteer studies using actinide isotopes (^{239}Np, ^{242}Cm, ^{244}Pu); placental transfer of radionuclides and fetal dosimetry; *in utero* haemopoietic effects; bone cancer and leukaemia from bone-seeking alpha-emitters (^{239}Pu, ^{241}Am ^{233}U); intestinal cancer and mutation rates in stem cells; doses and effects from radioactive particles – ingestion and skin contact; doses and effects of Auger emitters and tritium; dosimetric modelling; and, uncertainties in dose and risk estimates. Review articles and book chapters have addressed topics including: quantitative comparisons of cancer induction by internal emitters and external radiation; polonium-210 as a poison; the use of the protection quantity, Effective dose; and the toxicity of ingested radionuclides. He has also contributed to a number of NRPB and HPA documents providing formal advice on a range of topics, including application of ICRP recommendations and limitation of radon exposures.

Dr. Harrison has contributed substantially over many years to the work of the International Commission on Radiological Protection (ICRP) and is currently secretary and vice-chairman of ICRP Committee 2, a member of three Task Groups, on Internal Dosimetry, Alpha epidemiology and Stem cells, and chairman of a Task Group on the use of Effective dose. He was involved in the production of a series of ICRP reports providing dose coefficients for radionuclide ingestion and inhalation by members of the public, and dose coefficients for exposures *in utero* and as breast-fed infants following radionuclide intakes by the mother. He was a member of a task group responsible for producing a new dosimetric model of the human alimentary tract. For the 2007 Recommendations, he was a member of the Committee 2 Task Group responsible for the main text and annex on dosimetry and a corresponding member of the Committee 1 Task Group responsible for main text and annex on effects.

He was a member of the UK Government Committee Examining Radiation Risks of Internal Emitters (CERRIE), which reported in 2004. This committee was set up to examine claims that radiation risks from internal emitters are being underestimated by orders of magnitude. The CERRIE report concluded that current dose and risk estimates for internal emitters make appropriate use of available data. Two committee members produced their own minority report reaching a different conclusion.

Dr. Harrison is coordinator of the EU FP7 SOLO project (Full title: Epidemiological Studies of Exposed Southern Urals Populations). This project runs until 2014 and is concerned with establishing dose – response relationships for cancer and non-cancer disease induced by radionuclides and external radiation as a result of working at the Russian Mayak plutonium production plant or living near to the Techa River into which radioactive waste was discharged. This project will also compare and combine analyses for Mayak and Sellafield plutonium worker cohorts. He is also HPA representative on the Board of the Multidisciplinary European Low Dose Initiative Association (MELODI), currently supported by the EU Network of Excellence, DoReMi. He is a member of the UK delegation of UNSCEAR.

Jukka Juutilainen

Dr. Jukka Juutilainen is a Professor of Radiation Biology and Radiation Epidemiology and Department Head at the Department of Environmental Science of the University of Eastern Finland. He obtained his MSc and PhD degrees in environmental science at the University of Kuopio. His PhD in 1989 was on biological effects and environmental measurements of low frequency magnetic fields.

Dr. Juutilainen's research and teaching cover adverse health effects and risk assessment of radiation (both non-ionising and ionising). His team conducts multidisciplinary research using all approaches from epidemiology and exposure assessment to cell and molecular biology. The main research areas have been assessment of possible developmental and carcinogenic effects of low frequency and radiofrequency (RF) electromagnetic fields, and combined effects with known carcinogenic/genotoxic factors such as UV or ionising radiation. Recently he has extended his research activities to genomic instability induced by radiation and other environmental agents, and to radioecology. He coordinated the 5th Framework Programme project CEMFEC on possible carcinogenic effects of RF radiation as well as three national research programmes (involving several universities and research institutes) assessing health risks of RF radiation, funded by the Finnish funding agency TEKES.

He has worked as an Associate Editor for Electro- and Magnetobiology in 1993–1997 and for Bioelectromagnetics in 1998–2001. He has been a member of the Editorial Board Electro- and Magnetobiology (current name Electromagnetic Biology and Medicine) since 1993, and in that of Bioelectromagnetics since 1998. He also worked in the Editorial Board of Experimental and Toxicologic Pathology from 2006 to 2011. He has reviewed manuscripts for 26 international journals and research proposals for 12 funding agencies in 9 countries.

Dr. Juutilainen has contributed as an invited expert in many international working groups and committees, including IARC's Working Group for evaluation of carcinogenicity of ELF and static electric and magnetic fields (Monograph 80, 2001), Task Group for WHO's Environmental Health Criteria on ELF fields 2005–2006, Independent Expert Group of the Swedish Radiation Protection Authority (SSI) on Electromagnetic Fields 2002–2008, Standing Committee II (Biology) of ICNIRP since 2005 (consulting member 2001–2004), Working Group on Possible Effects of Electromagnetic Fields (EMF) on Human Health of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) 2006–2009, IARC's Working Group for evaluation of carcinogenicity of RF electromagnetic fields (Monograph 102, 2010–2011).

Dr. Juutilainen was a member of the Board of Directors of the Bioelectromagnetics Society in 1992–1993 and 1995–1998, and a member the Council of the European Bioelectromagnetics Society in 2007–2011 and 2011–2014. He is Vice-director of the Finnish Doctoral Programme in Environmental Health since 2006 and was its Director in 2004–2005. In the North Savo Fund of the Finnish Cultural Foundation he was a member of the Administrative Committee in 2003–2010, its Chairman in 2008–2010, and Chairman of its Working Committee in 2004–2008.

Philipp R. Trueb

PhD Philipp R. Trueb is the Head of the Radiotherapy and Medical Diagnostic Section in the Radiation Protection Division of the Swiss Federal Office of Public Health. His main duty comprises the national licensing of the use of ionising radiation in radiotherapy as well as in radiology. In order to assure the best utilization of related technologies, his team is not only performing inspections within medical establishments, but is also active in the continuous education of medical professionals and is constantly cooperating with academic institutes.

After completion of his studies of physics and astronomy, he obtained his PhD in experimental nuclear physics for his work on the magnetic field of the neutron from the University of Basel, where part of PhD thesis had been performed at the Microtron MAMI of the Johannes Gutenberg University in Mainz, Germany and at the neutron beam facility of the Paul Scherrer Institute PSI in Switzerland. Afterwards he attended a post diploma study in medical physics at the Swiss Federal Institute of Technology in Zurich, obtaining a master in medical physics. From 1996 to 1999, he worked at the Radiation Protection School of PSI as a lecturer in the fields of physics, radiobiology and medical radiation protection. In 1999 he joined the Swiss Federal Office of Public Health in its Radiation Protection Division.

At the Federal Office of Public Health, Philipp R. Trueb is involved in different national and international projects dealing with the radiation protection in the medical field, with a strong focus on the optimisation of radiological practices in diagnostics. More precisely, he is putting effort in the introduction of national diagnostic reference levels DRL in fields such as computer tomography, interventional radiology and cardiology as well as in nuclear medicine, and he is also dealing with the dose optimization of the staff in interventional procedures. Another important topic of his work concerns the collection of patient doses and the frequencies of medical radiological examinations in order to estimate the collective medical dose of the Swiss population.

As a member of HERCA (Heads of European Radiological Competent Authorities), Philipp R. Trueb also acted in 2010–2011 as chairman of the medical working group, he was dealing with the implementation of harmonized radiation protection regulations in Europe, especially in the field of new medical applications and in the involvement of stakeholders in radiation protection issues.

Wolfgang Weiss

Director and Professor Dr. Wolfgang Weiss is Head of Department of Radiation Protection and Health of the Federal Office for Radiation Protection (BfS) in Munich, Germany. After obtaining his degree in physics (diploma and PhD) at the University of Heidelberg in 1975, he spent one year as a post-doc at the Woods Hole Oceanographic Institute, Mass., USA, to study the global distribution of the weapons' fallout (tritium and ^{14}C) in the world's oceans. In the following years he participated in related global marine research projects.

In 1980 he became the Director of the Institute for Atmospheric Radioactivity in Freiburg, Germany. His early work was on environmental surveillance with a strong focus on noble gas measurements (^{85}Kr, ^{133}Xe). The first automatic remote control dose rate monitoring system for NPPs in Germany was designed by the institute. It became a prototype for the site-specific surveillance systems of German NPPs, which is now mandatory.

After the Chernobyl accident, he designed – on behalf of the German government – a comprehensive national system for the surveillance of the radiological situation of the environment, early warning and decision support (IMIS). This work included the development of specific decision support systems like RODOS, which were developed at the EU level. In this context, he engaged in various aspects of emergency preparedness. Within several governmental cooperation projects between Germany and Russia he established on-line monitoring systems in the vicinity of Russian NPPs.

He was an adviser to the German government during the negotiations of the Comprehensive Nuclear Test Ban Treaty (CTBT) in the mid nineties. His institute hosted a global intercalibration exercise for all Xenon-measuring systems, which were developed globally to demonstrate that this technology is suitable for CTBT purposes. The Institute hosts an aerosol and a noble gas station of the global monitoring system of the CTBT organisation.

Since 2000 he is responsible for all health-related scientific issues of radiation protection at the federal level in Germany. This includes questions of risk quantification both for ionising and non-ionising radiation, risk communication, radiation protection at the workplace and the full spectrum of medical applications of ionising radiation. His department operates the national dose registries for workers and for highly radioactive sources as well as a national UV measurement network. It acts as a regulator for all applications of radionuclides and/or ionising radiation in clinical research. Radon epidemiology (dwellings and the WISMUT miner studies) is another important area of work. Between 2002 and 2008 he was responsible for the design and conduct of a major national research programme on the effects of EMF.

In 2008 he chaired the High Level and Expert Group (HLEG) which formulated and agreed the policy goals to be addressed by low dose risk research, developed a strategic research agenda and road map for low dose risk research in Europe, and specify the essential elements of and next steps for establishing a sustainable operational framework for low dose risk research in Europe. The recommendations of the HLEG have been taken up by the MELODI consortium which was established in 2010. He is acting as vice president of the platform.

Dr. Weiss is the head of the German delegation of UNSCEAR. In his function as chair of UNSCEAR he initiated a Fukushima assessments project in 2011 which is to develop a report with scientific annexes for the General Assembly of the United Nations, the scientific community and the public that assesses the levels of radiation exposure due to the nuclear accident following the Great East-Japan earthquake and tsunami, and the associated effects and risks by 2013.

He is vice-chair of Committee 4 of ICRP, and chairman of ICRP TGs on “Optimisation”, “Emergencies”, and “Waste disposal”. He is member of OECD/NEA/CRPPH as well as of the CRPPH Bureau. He is being involved in the definition and implementation of several EURATOM research programmes of the CEC. In 2011 he developed a vision paper on research needs for the EU 2020 strategy.

His contributions to science were honoured by the Federal President of Germany by the award “Order of Merit of the Federal Republic of Germany”.

1 SUMMARY AND PRINCIPAL RECOMMENDATIONS

This chapter summarizes the main findings and recommendations of the 2011 “Evaluation of STUK Research Activities 2005–2010”. Detailed recommendations on the work of the 10 units of STUK which have been evaluated by the 2011 panel are given in the chapter “Review of departments and laboratories”.

The 2011 panel considered that the main issues to be addressed at a general level are:

1. How does STUK measure the success of research in terms of impact? Important aspects to be considered are contribution to science vs. contribution to policy, interaction with other STUK functions.
2. How significant is risk communication for STUK? Important aspects to be considered are how to communicate science; which mechanisms are in place for dissemination of research results?
3. How to deal with declining resources and critical mass?
4. How to transfer knowledge from one generation of scientists to the next? Important aspects to be considered are the respective roles of programs for education, training, mentoring, etc.
5. How to develop research strategies and priorities at programmatic level?

The 2011 panel proposed the following success factors for the evaluation of the work performed by the departments and laboratories:

1. Publication record.
2. Development of knowledge and tools (software, hardware, standardisation of procedures).
3. Input to the development of the state of science and technology.
4. Improvement in public health status (eg. indoor radon).
5. Improvement of public awareness on risk.
6. Optimising working arrangements by re-organisation and co-operation in STUK, nationally, internationally.
7. Participation in international networks and expert organisations.
8. Raising the profile of STUK (population, scientific community).

The 2011 panel has been informed about the overall roles and great number of responsibilities of STUK as well as the labour organisation which is based on the core processes of STUK shown in the following Figure 1.

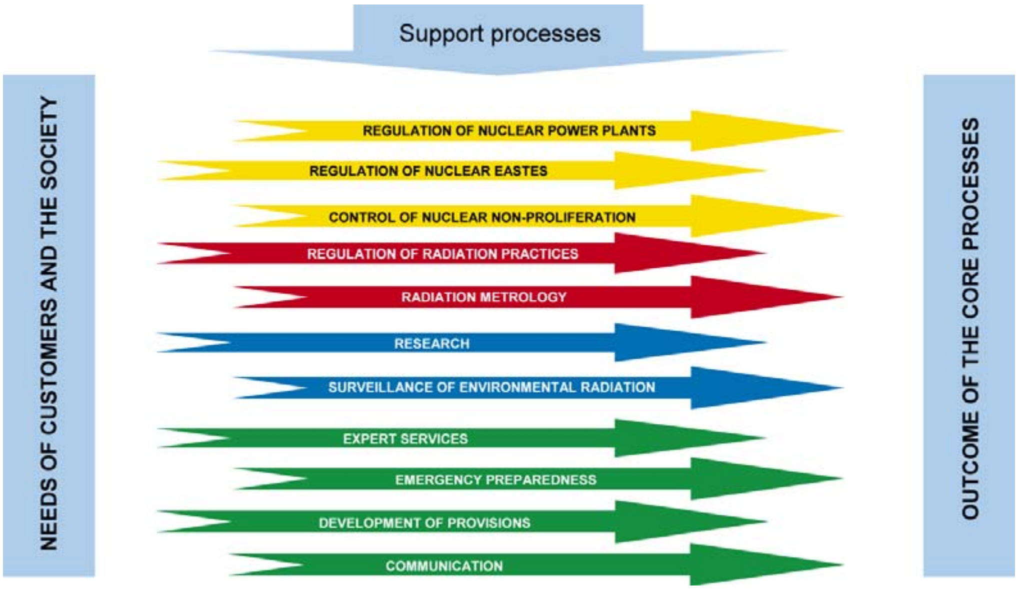

Figure 1. Core processes of STUK.

The resource allocation for research in STUK is another key aspect that had to be considered during the evaluation: In 2010, the overall effective working time allocated to research activities was 34.8 person years. The relative contribution to the total working time varied substantially between the various units (details are given in the following Figures). This is not surprising taking into account the various functions of STUK but it has to be taken into account when evaluating the research programmes of the various units. What is important at this strategic level is the fact that the resource allocation for research has continuously been reduced since the last evaluation. This fact underpins the increased need for strategic planning (see recommendations R 49 below).

Table 1. Effective working time as person years in 2010.

Unit	Research	TOTAL
Research and Environmental Surveillance (Department in STUK's organisation)	29.0	86.4
Radiation Practices Regulation (Department in STUK's organisation)	2.9	41.9
Non-Ionizing Radiation Surveillance (Independent Unit in STUK's organisation)	2.9	9.3
TOTAL	**34.8**	**137.6**

Figures are based on the effective working time that personnel (of above mentioned departments and units) registered in 2010 for different research areas and projects in STUK's follow-up system (SAP) of working time; so figures do not include any other activities.

Figures represent how much effective working time was used for research in 2010, not how many members of the personnel participated in research activities. Practically all members of the Department of Research and Environmental Surveillance and Unit of Non-Ionizing Radiation Surveillance are involved in research activities, some more, some less. However, the Department of Radiation Practices Regulation has personnel who participate only e.g. in regulatory activities and not at all in research.

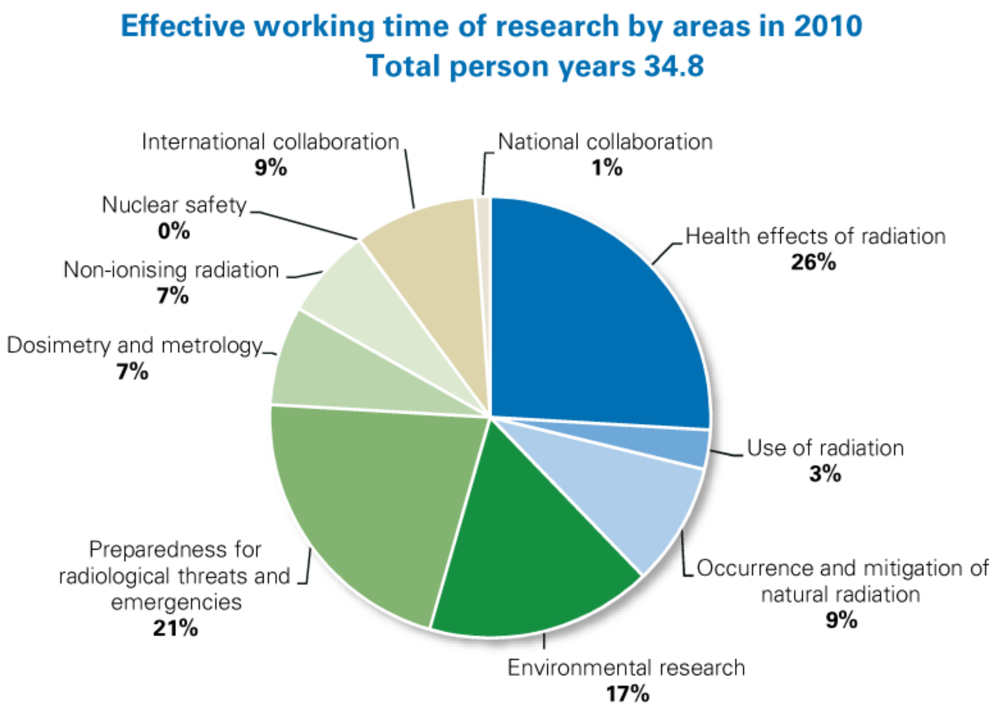

Figure 2. Effective working time in different research areas in 2010.

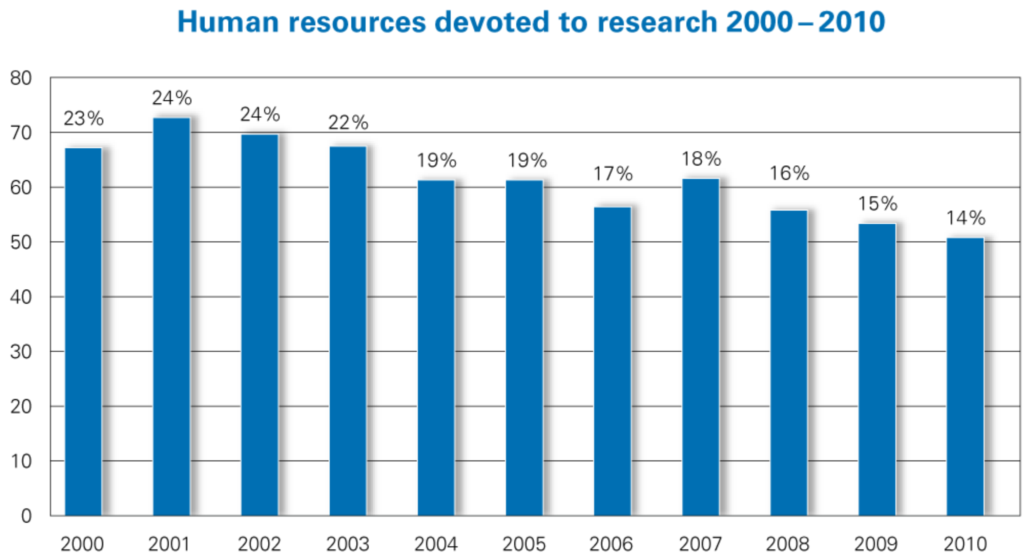

Figure 3. Person-years devoted to research at STUK in 2000–2010. The percentage in the figure indicate the proportions of STUK' total human resources.

Please note that the effective working time for research as person years in 2010 was 34.8 (at STUK level, based on units / departments conducting research). However, this figure that gives 50.8 person years devoted to research in 2010, that is, 14% of STUK's total human resources, is based on STUK level statistics where some share of administrative and other supportive actions needed in "production" of research function are included in person years. So that is why it is larger than the actual effective person years devoted to research.

1.1 FINDINGS / RECOMMENDATIONS AT STRATEGIC LEVEL

Overall STUK presents a highly impressive research portfolio, with well educated, keen and committed staff provided with an excellent working environment. The physical condition of the experimental laboratories is exemplary.

The 2011 panel felt that while its remit was specifically to evaluate research at STUK, it was important to make assessments in the context of the range of work and overall strategies for work programs.

Recommendation: The panel recommends that future review should have a broader remit because it is difficult in such radioprotection laboratories to assess research in isolation, there are areas of work that might not be included in a narrow definition of research but would be classed as R&D, and there are essential links between R&D and routine and operational aspects of the work.

There appears to be the potential for difficulties in top level decision making on research strategy and implementation because lines of responsibility between the Directorate and Department Heads are not completely clear.

Recommendation: There is a need for the senior management to work together to further develop the research strategy for the Centre with plans that explain the need for, and place of, research in the overall work program, from health effects research to implementation of technical developments.

Recommendation: The strategy at the Department and Laboratory level should consider research as part of the overall function, that is, all activities should be described and assessed, with a clear analysis of how and where research fits and what is achieved by the research undertaken. Annual reports should include forward plans as well as achievements. To make best use of staff and help in their development, efforts should be made to develop clearer joint ownership of research projects across laboratories from inception to completion.

In terms of presentation of research activities, detailed breakdown of commitments to research and other functions is clearly useful at the Department level but appears over-detailed and possibly misleading and counterproductive when given at the level of the individual laboratories. For example, the Security Technology Laboratory is essentially a research group with a small on-going commitment to administrative tasks and emergency preparedness but the analysis presented shows only 60% of time to research – this figure does not appear to be useful.

A problem encountered in assessing the research output was mismatches between the programs and achievements of the individual Laboratories being assessed and the headings used for the presentation of research findings in the written material provided. In some cases, it proved difficult to reconcile the different sources of information. Relatively little information was provided on future strategy and proposed work programs.

1.2 UPDATE OF RECOMMENDATIONS OF THE 2005 PANEL

The 2011 panel noted with satisfaction that the recommendations given during the 2005 evaluation, e.g. creating larger units (R 52), have been implemented to a high degree. The overall judgement of the changes by the staff members was positive. STUK considers that the previous recommendations R48 – R 53 are still valid; the 2011 panel strongly supports this position and updates these recommendations as follows:

Recommendation R48: ”*To seek opportunities for involving senior scientific staff of STUK in the work of UNSCEAR.....The panel recommends to the Finish authorities to engage an action in the UNO for re-discuss the member state participation of Finland....to the scientific Committee*”

General observations 2011: STUK has represented Finland as observer to sessions of the Scientific Committee since 2007 and made significant contribution to the scientific work of UNSCEAR. During the time of the evaluation no decision had been made on the status of the observer countries. A few weeks after the evaluation, the General Assembly of the UN has taken a decision to invite Finland to become a member of UNSCEAR. The 2011 panel noted with satisfaction that the recommendation R48 has successfully been implemented. This decision of the GA of the UN underpins the international recognition of the quality of STUK in radiation sciences in an impressive fashion.

Recommendation R49: “*To continue strategic planning of work with the aim of consolidation of resource allocation by substantially reducing the great number of projects*.”

General observations 2011: strategic planning for the next 5 years is missing in many areas and major efforts are required to close the gap. Planning of this kind should include the identification of key research areas as well as key projects related to the fulfilment of the obligations of STUK and to address knowledge gaps and technological challenges. This should be organized together with key (research) partners in the country and at international level.

The 2011 panel recommends applying the following criteria to prioritise key research areas and to identify research priorities:

- Strategies of STUK and of the Ministry of Social Affairs and Health.
- Research needs identified nationally and internationally.
- Unique conditions in Finland.
- Possibilities to prevent or mitigate radiaton exposure.
- Public health relevance and societal needs.
- Future research needs.

Recommendation R50: “*To continue to apply the policy to succession planning … to transfer knowledge of retiring experts to the new generation of radiation protection specialists.*”

General observations 2011: given the age structure of the personnel, succession planning will continue to be key issue; mechanisms like mentoring have been established and these should be used in an active fashion to secure the knowledge in the areas of key competence of STUK.

Recommendation R51: "*To regularly review the balance between services based activities and research activities.*"

General observations 2011: resource allocation for research is only a small fraction of the overall budget of STUK; therefore, any global reduction of the budget for personnel could lead to a serious situation in which the personal resources could fall short of the critical mass. This could be compensated by the exploitation of synergies between research and other functions of the available personnel. Some units have developed fall-back strategies for situations of this kind. It is generally recommended to develop suitable fall-back strategies for all units.

Recommendation R52: "*The previous panel gave recommendations on creating larger units that would develop critical mass and give more flexibility…*"

General observations 2011: The actions taken up to now seem to be sufficient to solve the problem of critical mass for the near future. Some of the decisions have only been taken recently. The new structures seem to be accepted by most staff members as good solutions of the problem and there seems to be no need for urgent actions of this kind in the near future.

Recommendation R53: "*The panel recommends that the Institute (STUK) will see that all data of general interest and relevance will be published by the units themselves or in collaboration with other STUK units or universities.*"

General observations 2011: most of the units have published the majority of their data and the publication record is of substantial size given the manpower involved. Some units have clearly identified the need to put more emphasis on improving their publication records (for details see specific recommendations in Chapter "Review of departments and laboratories").

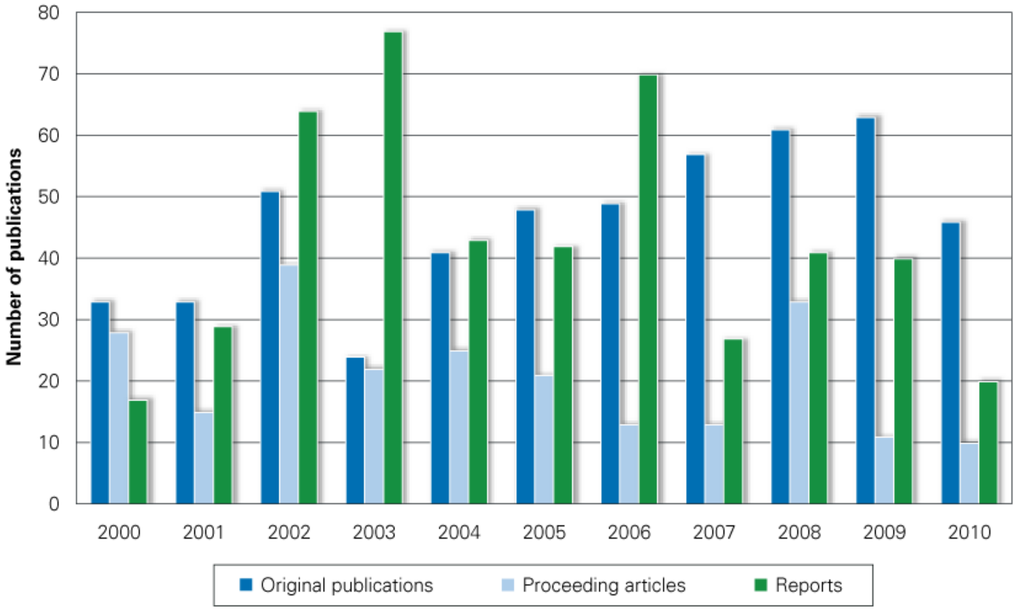

Figure 4. Number of research publications in three publication categories during 2000–2010.

1.3 GENERAL OBSERVATIONS / RECOMMENDATIONS 2011

R 1/2011: Training program for “Risk Communication”

All units expressed the need to re-establish a STUK training program for Risk Communication. The 2011 panel strongly recommends that such a course program be offered to staff members with frequent contact with media and the public. Specific issues of such training would be the communication of health risks of ionising radiation (particularly in emergency situation) and non-ionising radiation (EMF).

R 2/2011: National planning and provisions for emergency preparedness and response

There is the need to further develop the national planning and provisions for emergency preparedness and response based on the lessons to be learned from the specifics of the Fukushima accident and of recent exercises which addressed the intermediate phase of such an accident.

The 2011 panel recommends that such an evaluation at national level should re-define the various obligations STUK would have to fulfil should such a situation occur. Within STUK the procedures and obligations of all individuals and units should be re-evaluated and the emergency organisation should regularly be tested in realistic exercises.

R 3/2011: Optimisation of internal processes

The 2011 panel recommends that internal processes be optimised by enhancing interaction at department head / directorate level to develop integrated strategies that foster and exploit R&D. Effort should be undertaken to streamline administrative procedures for project planning. The information flow between units involved in a common project should be strengthened and the joint ownership across units should be clarified. At unit level strategies should be developed to include research as part of the overall functions and responsibilities of STUK, ie., describe all activities and the specific role of research as well as the added value of research. A process for the exploitation of research results should be developed. This process should provide clearer delineation between R&D and subsequent development and implementation.

R 4/2011: Clarification of the role of research and development in the context of STUK’s functions

The panel observed that there was uncertainty on the role of research and development across the departments and units. Research activities provide the basis for various STUK activities: it provides state of the art knowledge needed for providing consulting services for policy makers. It develops tools for the production, management and assessment of knowledge. While avoiding too strict definitions that may restrict innovativeness, mutual understanding of the role of research could be enhanced via dialogue between all hierarchic levels. The 2011 panel recommends that internal processes be established to intensify and maintain such a dialogue.

2 SUMMARY OF PRESENT RESEARCH ACTIVITIES

The research conducted by the Radiation and Nuclear Safety Authority (STUK) serves the whole organisation's mission: to protect people, society, the environment and future generations from the harmful effects of radiation. STUK's main research areas are health effects of radiation, occurrence and mitigation of natural radiation, environmental radiation, preparedness for nuclear and radiation threats and accidents, dosimetry and metrology, use of radiation, non-ionising radiation, and, to a lesser extent, nuclear safety.

The general objective for the research on health effects of radiation is that STUK addresses the needs of decision makers and citizens by providing information on the health risks of ionising and non-ionising radiation at the population level and by articulating the current understanding on the mechanisms of these health effects at the cellular and tissue level. Furthermore, STUK participates in national and international discussion on radiation protection principles and provides scientific (epidemiological and radiobiological) results for use by the radiation protection community.

Studies on biological and health effects of radiation cover both ionising and non-ionising radiation. Topics in epidemiological studies have included lung cancer induction by radon, lens opacities among interventional radiologists, chemical toxicity of uranium in drinking water, health consequences of Chernobyl accident, cancer among nuclear workers, cancer risk attributable to cosmic radiation, and effects of cellular phone use on health and well-being. Biological studies of ionising radiation have included radiation-induced genomic instability, radiation-induced bystander effect, individual radiation sensitivity and mechanisms of vascular disease. Topics in biological studies of non-ionising radiation included studies examining the effects of electromagnetic fields on living cells using high-throughput screening techniques, cellular stress response induced by RF-EMF and effect of UVA on melanoma metastasis in vivo.

The societal objective for the research on occurrence and mitigation of natural radiation is that the exposure of Finns to natural radiation reduces and the number of cancers caused by indoor radon and radioactive substances in drinking water will decline. Furthermore, STUK is expected to address the needs of decision makers and citizens by providing information on the occurrence and mitigation of radon in indoor air and radioactivity in the drinking water and to provide science-based estimates on exposure of Finnish populations to natural radioactivity. Furthermore, STUK provides scientific information on the occurrence and mitigation of natural radioactivity for use by national environmental, construction and health authorities and the international radiation protection community. Based on the expertise gained, STUK participates in the preparation of relevant legislation and guidance.

Exposure of the Finnish population to natural radionuclides via indoor air and drinking water is amongst the highest in the world. The research on radon has involved nation-wide surveys on radon exposure in homes and at workplaces, epidemiological studies, modeling of radon entry, indoor radon mitigation and prevention techniques as well as water treatment methods for removing radionuclides from household water. For preventive actions, information is acquired to promote radon-safe construction and mitigation of high radon concentration buildings. Based on research on radon-safe construction carried out by STUK in collaboration with technical universities and building companies, a significant reduction in the radon concentrations in new buildings has taken place during the last decade. Radon and uranium concentrations of water from wells drilled in bedrock are significantly high in Finland and the drilled wells are used more and more as the source of household water. Understanding the reasons leading to great regional differences in activity concentrations in Finland is among the current topics for research.

The overall objective for the environmental research is that STUK addresses the needs of decision makers and citizens by providing information on the occurrence of radioactive substances in the environment, biota and foodstuffs in Finland and the neighboring areas. STUK also provides science-based estimates on exposure of Finnish population and biota to ionising radiation and how it can be reduced. Furthermore, STUK provides scientific information on the occurrence of radioactive agents in the environment, biota and foodstuffs and participates in the preparation of legislation concerning the activity levels.

Radioecological studies have the objectives of modeling the transfer of radioactive substances in the environment and estimation of the subsequent radiation doses to man and, to a lesser extent, to biota. Special attention is given to the semi-natural environments and forest industry and possibilities to mitigate contamination levels in foodstuffs and forest products. After the Chernobyl accident, the radionuclide concentrations in agricultural products decreased rapidly as compared to those in natural and semi-natural products (mushrooms, berries and game). The average radiation dose via foodstuffs from artificial radionuclides is now well below one percent of the average annual dose of Finns. Research on radiation hygiene deals with kinetics of radionuclides in the human body and the consequent internal exposure to radiation. Concentrations of radionuclides in the human body are monitored with whole body counters and using other bioassay methods. Recent studies have included assessment of chronic incorporation of uranium and natural radionuclides from drinking water, as well as regional differences in the body content of cesium-137 in groups of people living in regions of higher Chernobyl fallout and consuming local natural foodstuffs. The international Polar Year 2008 promoted research related to climate change by using cosmogenic radionuclides as tracers of the movement of air masses.

The general objective of research on preparedness for radiological threats and emergencies is that STUK addresses the needs of decision makers, stakeholders and citizens by providing information on the safety aspects of various nuclear and radiological threats, prevents radiation hazards, acts promptly and expediently in radiological emergencies and provides recommendations that are based on sound science and advance planning. Another important aim is that STUK maintains and continuously develops its expertise and capability for field and laboratory measurements to ensure a fast response and efficient action in case of radiation emergency.

Development of tools for threat scenarios and emergency preparedness include surveillance methods needed in monitoring of radioactive substances as well as comprehensive decision support systems. Measurement strategies in radiation emergencies as well as late phase countermeasures and remediation of the environment have been among the key areas during recent years. Modern communication technology is exploited to develop real-time radiation monitoring systems and mobile radiation detection and field measurement techniques, allowing the management of large quantities of data and developing decision support systems, in particular map applications. Analytical algorithms have been developed for gamma spectrometry and direct alpha spectrometry. Managing the radiological hazards due to illicit and malevolent actions requires the co-operation of several authorities. Detection and analysis methods for safety and security applications and improved co-operation capability of different authorities include eg. direct alpha spectrometry, sampling from contaminated surfaces and localization of radiation source.

The general objective for the research on metrology and dosimetry is that the quality of measurements, analyses and dosimetry carried out by STUK at a high international level and provides a sound basis for the operation of STUK as supervisory authority and research centre.

Another objective is that STUK possesses a diversity of modern analytical capabilities and the quality and availability of analytical services fulfils the needs of customers and stakeholders.

For radiotherapy and radiation metrology, a variety of techniques for applied clinical dosimetry and calibration of dose-meters have been developed during the recent years. Computational models in dosimetry have been adopted and developed both for internal contamination and external exposure. In radionuclide analytics, new methods have been developed and adopted in use, such as fast methods and forensic (non-destructive) analyses. The new methodologies also include methods for sampling and sample processing that are major determinants for analytical quality.

Research on use of radiation shares the same objective with the radiation practices regulation: the ultimate objectives are that no serious accidents occur in the use of radiation in health care and industry that the doses to workers remain small and, in the medical use of radiation, patient doses are small as compared to the benefit obtained (optimisation).

Current research on the medical use of radiation is mainly focussed on X-ray diagnostics where the priority areas include the optimisation of X-ray examination techniques, examinations with high patient doses (CT, fluoroscopic procedures), doses to the most radiosensitive patients (children), screening of non-symptomatic patients (mammography), performance of new imaging technologies (digital imaging) and assessment of patient dose.

The general objective of the research on non-ionising radiation is that STUK addresses the needs of decision-makers, stakeholders and citizens by providing information on exposure to non-ionising radiation and by presenting well-founded positions on the risks and their control. STUK also participates in national and international scientific discussion on the principles of protection against non-ionising radiation, provides scientific information for use by the radiation protection community and participates in the preparation of regulations.

Research activities involving non-ionising radiation include the development of measurement techniques required to determine radiation exposure, as well as exposure measurements. During recent years, studies have addressed MRI scanners, dielectric heaters and distribution substations. STUK has also developed exposure systems and dosimetry for animal and human studies on effects of mobile phone radiation. The use of solaria and the resulting UV doses as well as the clarification of biological effects of UVA have also been among recent topics.

During recent years, STUK has not carried out its own research projects related to nuclear safety. In Finland, research on reactor safety and nuclear waste management are mainly carried out by the power companies, VTT Technical Research Centre of Finland and technical universities in Helsinki and Lappeenranta.

3 BACKGROUND TO THE EVALUATION

This is now the third time that all STUK's research activities have been subjected to external review by international radiation protection experts and scientists.

The evaluation of STUK research activities aims to address the following main issues: the appropriateness of STUK's activities in relation to relevant issues in radiation protection, the social relevance and effectiveness of activities, steering by information, prioritising STUK's various activities, the quality of STUK's research activities, and the relation between costs and results. The research carried out at STUK is related to radiation protection, covering both ionising and non-ionising radiation. In addition, STUK experts also supervise nuclear safety research projects (safe use of nuclear power and nuclear waste management) commissioned by the authorities and conducted by organisations outside STUK. However, the present review only covers the strategy, organisation and results of radiation protection research carried out by STUK itself and how this research supports the other functions of STUK and the needs of the society as a whole.

One key objective of STUK research is to extend professional knowledge that supports regulatory operations and the maintenance of emergency preparedness. The quality of the research done is under continuous self-assessment, and internal procedures have been set up to promote continuous improvement. Peer review of scientific articles in international journals is used as an external quality measure and independent reviews on the effectiveness and quality of research are carried out every five years.

During the evaluation period and beyond, declining resources for research both nationally and internationally have posed new challenges to STUK and the scientific community in radiation research. At the same time, new policy questions and paradigms have arisen that require multidisciplinary research efforts and joining of resources not only at the national, but also at the European and international level.

4 REVIEW OF INSTITUTIONAL OBJECTIVES AND RESPONSIBILITIES

4.1 MISSION AND VISION OF STUK

The Radiation and Nuclear Safety Authority (STUK) is a regulatory authority, research institution and expert organisation, whose mission is to protect people, society, environment, and future generations from harmful effects of radiation. Besides a research centre, STUK is also a regulator and inspectorate. In addition, STUK has the role of an emergency preparedness organisation in nuclear and radiation hazard situations. STUK is a national laboratory responsible for the maintenance of national standards for radiation metrology. STUK also provides expert services in the surveillance of environmental radioactivity and metrology. STUK's areas of operation cover the whole range of radiation and nuclear safety and ionising and non-ionising radiation.

The ultimate objective is to keep the radiation exposure of Finnish citizens 'as low as reasonably achievable' (the ALARA principle) and to prevent radiation and nuclear accidents with a very high certainty (Safety As High As Reasonably Achievable or the SAHARA principle). The confidence of the general public and stakeholders' views on the significance of STUK's operations in enhancing safety are also key indicators of the quality of its work.

The vision of STUK is:

1. The level of radiation safety and nuclear safety is high in Finland, and provides an outstanding standard for international benchmarking.
2. STUK is well known and respected as an expert organisation and research centre, as an independent regulator dedicated to safety, and as an influential national and international actor.

4.2 DEVELOPMENT OF RESEARCH POLICY AND STRATEGY

STUK has one strategic plan that is updated every fifth year. The current strategy encompasses the period from 2007 to 2011. The strategy describes the mission, vision, success factors, values, operational environment, focus areas (effectiveness, processes and structures, development and functional capability, resources and financing), topics elaborated further in specific action plans and performance indicators. The STUK-level strategy is complemented by action plans prepared for all core processes, such as research.

The process approach promoted by standard ISO 9001:2000 was adopted in 2002. Extensive work has been done since then, first by identifying and describing the main processes and then updating the respective manuals, and preparing flow charts. The work with the processes has continued for several years. There now exists, among other resources, a table for core processes and support processes identifying outcomes of the respective process, the process monitor, process owner and respective quality manual.

Implementation of the strategy takes place via action plans prepared for core processes. In addition to research, STUK has prepared action plans for: the regulation of nuclear power plants, nuclear materials and nuclear waste, regulation of radiation practices for ionising and non-ionising radiation, metrology, surveillance of environmental radioactivity, preparedness for emergencies, information and data management, public communication and rule making.

The strategy of STUK has been formulated according to the Balanced Score Card (BSC) which covers goals for effectiveness, processes and structures, working capacity and resources and financing. The success factors for each of these areas are derived from mission and vision. For research, the success factor states "Research of STUK is of high quality and it is focused on key issues in radiation protection". Basic values that direct STUK's operations are competence, co-operation, openness and courage. According to these, decisions, positions and other measures are based on professional knowledge, research and competence; co-operation within STUK is based on good partnership, participation and mutual respect and stakeholders are involved in the planning of actions; action is open and honest, both towards stakeholders as well as in internal communication; problems are identified, as well as personal views, and followed up rigorously. Responsibility for individual decisions and actions is acknowledged and possible errors are corrected.

Upon the updating of the STUK strategy in 2006/2007, a large number of national and international trends and changes were identified that could in one way or another affect the different activities of STUK. Many of them also impact on research either directly or indirectly, affecting the topics taken up or pointing out new partnerships. For research, the following challenges and possibilities in the operational environment were identified as important:

- Renewal of international radiation protection principles;
- EU directives and recommendations on radiation protection;
- National co-operation on emergency preparedness;
- Development of medical diagnostics and treatment methods based on the use of ionising radiation;
- Increasing the number of radiotherapy units;
- Increased use of equipment that generates electromagnetic fields;
- Increasing exposure of the population to non-ionising radiation;
- International terrorism;
- Uranium exploration in Finland;
- Building nuclear energy facilities nationally and internationally;
- Building and commissioning of Olkiluoto 3 NPP;
- 7th Euratom Framework Program and Security program;
- Evaluation of the risk paradigm of ionising radiation;
- Radon prevention and mitigation;
- Improved technologies for nuclide identification;
- Increasing international interest on STUK as a collaborative partner;
- Extension of UNSCEAR membership;
- Enhanced speed of communication globally;
- Citizens' demand for more information;
- Interaction with non-governmental organisations;
- Rapid development of information and communication technologies;
- Generation shift among personnel at STUK and other actors in the field;
- Recruitment of new employees is becoming more difficult because of the aging population;
- Government productiveness programme (more results with less personnel).

In March 2011, the Tohoku earthquake and tsunami led to a major nuclear accident at the Fukushima Da-ichi nuclear power plant in Japan. This event will impact on research worldwide. In terms of consequence analysis, special features of the accident were that several units were damaged in parallel and the role of spent fuel pools in the source term of a severe nuclear accident.

STUK strategy is implemented via action plans that are prepared for each core process, including research. Based on the analysis of changes in the operational environment, the need for new knowledge is identified for the coming years. Areas to be strengthened are discussed in strategy seminars and laboratory meetings. When STUK decides which new projects are prioritised and funded a two-step procedure is followed. First of all, the potential of the research idea is evaluated by considering if it is in line with STUK strategy and if STUK has the necessary resources for taking up the project. This initial step is to decide either to proceed with planning or to discard the idea or postpone the implementation (a Go/No-Go step). If the project idea is approved, a more detailed project plan is provided. The full plan is then evaluated according to specified criteria that consider the relevance (is the project in line with STUK strategy and action plan; societal demand; importance for radiation protection; actuality), the need for new knowledge (repeating old or creating new), the scientific and technical quality of the plan (competence of research group; quality of the plan; is the plan realistic; cost efficiency) and the potential impact of the proposed project (chances for prevention, reduction or optimisation of exposure/dose; taking into account the needs of stakeholders; quality of dissemination plan; a new method, procedure or equipment for the use of STUK or stakeholders).

4.3 THE INTERFACE WITH THE MINISTRY OF SOCIAL AFFAIRS AND HEALTH AND WITH OTHER NATIONAL STAKEHOLDERS

Administratively, STUK comes under the Ministry of Social Affairs and Health. The co-operation with the main research institutes under the Ministry of Health has been recently strengthened by creation of a new legal entity SOTERKO, Consortium of the Expert Authorities for Social Welfare and Health Care. However, several other ministries also deal with issues related to radiation and nuclear safety. The panel recognises that many STUK research results and development projects are of direct benefit to different ministries and authorities in Finland, such as the Ministry of Employment and the Economy, Ministry of the Interior, Ministry for Foreign Affairs, Ministry of the Environment, Ministry of Defence and the Ministry of Agriculture. Based on its core competence and leading role in the area of radiation and nuclear safety, STUK has a cross-sectoral role in Finland. This appears to be a cost effective model for a small country. Exploitation of the results by the relevant end-users is a key success factor for STUK and thus there needs to be mechanisms that ensure the co-operation with research institutes that are administratively under the different ministries.

4.4 INTERFACE WITH UNIVERSITIES AND RESEARCH INSTITUTIONS

In Finland, STUK is the main – and in many areas the only – research institute conducting radiation protection research. There are therefore no real competitors at the national level. Expertise complementing STUK’s know-how in radiation protection is actively sought via networking with other research institutes having their own specialisation. In some areas, especially in those related to emergency preparedness and environmental radioactivity analysis, the lack of other research units with expertise in radiation protection is becoming problematic, since there should be more capacity in that field in case of severe fallout situations. Radiobiology is another area where there is shortage of expertise in the Finnish universities. The number of employees in practically all government research institutes and universities is, however, continuously declining. This has made it more difficult to find resources for joint research activities, as each institute has to prioritise its own mission. In Finland, research related to ionising radiation protection is carried out in the medical physics departments of universities/university hospitals, at the Technical Research Centre of Finland (VTT), Department of Environmental Science of the University of Eastern Finland and the Laboratory of Radiochemistry at the University of Helsinki. Research related to non-ionising radiation protection is carried out at the Institute of Occupational Health, and the University of Eastern Finland, the Tampere University of Technology, and the University of Turku. In addition, technical development has been carried out with several companies and a number of domestic collaborators and corporations have acted as suppliers of samples or data.

STUK co-operates with educational institutions. In addition to joint research projects with universities, certain scientists of STUK act as permanent lecturers in universities. The new Radiation and Nuclear Safety book series has been welcomed as training material by several educational institutions.

In developing national co-operation, STUK actively consults stakeholders in order to obtain information that facilitates the direction of research to topics that address the needs of customers and the society. Via national co-operation, STUK can complement its own core competence by networking with research centers with expertise in other disciplines. STUK maintains close contacts with stakeholders to understand and anticipate their information needs and take these into account when planning and prioritizing research projects. Co-operation with universities and polytechnics and their supervision facilitates the recruitment of new employees. Preparing Memorandum of Understanding with key partners is one way to formalize joint objectives. During the evaluation period, a MoU was signed with the Department of Physics of the University of Jyväskylä in order to strengthen collaborative research with the Accelerator laboratory, exploiting the application of basic nuclear physics in radiation measurements.

4.5 INTERNATIONAL COLLABORATION

The international research collaboration of STUK is extensive and part of everyday work. About 40 percent of current research projects have international partners. Looking back in history, the first international collaborative contacts in research were with the Nordic countries in the 60s and 70s. After the Chernobyl accident and the breaking down of the Soviet Union, there were several research projects with Russia and the newly independent states. Today, research partners mainly come from the member states of the European Union. Since Finland joined the European Union in 1995, STUK has obtained a strong position in European research programmes, especially in the Euratom Nuclear Fission Programme.

During recent years, STUK has been actively developing strategic research agendas with European research organisations and funding bodies, with the aim of sustainable integration and long-term commitment to co-operation under joint research programmes. These multidisciplinary research agendas address priorities in low dose risk research as well as radioecology and emergency preparedness. Implementation of the integration process is supported by Networks of Excellence funded by the 7th Framework Program of Euratom. STUK is coordinating the Network of Excellence “Low Dose Research Towards Multidisciplinary Integration” (DoReMi) during 2010 to 2015. STUK is also chairing the NERIS platform on emergency preparedness. STUK also has a strong role in ESARDA, influencing the research priorities for improving the safeguards of nuclear materials.

International co-operation also serves other needs in addition to collaboration on research projects. The objectives for these activities are related to the international obligations of STUK, scientific review activities and STUK's ability to influence the content of regulations and recommendations that are relevant for Finnish radiation safety. STUK has provided a considerable input into the development of radiation protection standards of the European Commission via the Article 31 Group of Experts and commissioned services of DG TREN. STUK has also acted as a contracted support organisation to the EC in radiation and nuclear emergencies and nuclear security. STUK's collaboration with WHO are extensive, covering public health aspects of nuclear and radiological emergencies, medical radiation and radon. STUK also has representatives in the committees and working groups of the OECD Nuclear Energy Agency (NEA). More recently, STUK experts have participated in the work of the ICRP and UNSCEAR, thus ensuring the exploitation of Finnish knowledge by the international risk assessment society. Memberships in the Executive Council of IRPA and in the Main Commission of ICNIRP are other internationals recognitions. A major event during the evaluation period was the organisation of the Third European IRPA Congress in Helsinki in June 2010.

4.6 TRAINING AND CAREER DEVELOPMENT

A large number of the permanent staff was engaged in the 1960s and the 1970s when the functions of STUK were expanded due to the nuclear test fallout, the discovery of the radon problem and the construction of nuclear power plants in Finland. As STUK is the main institution for research on radiation protection in Finland, there was relatively little turnover of staff until recently. Now, many of the staff members with long experience have retired, but this retirement wave will continue for the next few years. Many of the newly recruited researchers already have a doctoral degree, while in previous decades this was often achieved only after a long career at STUK. The education level of permanent staff shows an increasing trend over time. During the evaluation period, 25 Master´s and one Licenciate degrees and 11 Doctorates were completed.

It takes several years to train as a scientist in a specialised field. A university education alone does not provide adequate expertise in radiation protection and, as Finland has no other strong research institutes in radiation protection, very few scientists with specialised training are directly available for the posts. External funding and shared-cost contracts have enabled the employment of fixed-term personnel, including students aiming at a Master's degree or doctorate. Many of these project researchers have later been engaged permanently by STUK, resulting in a more balanced age structure. Due to the recent limitation of the number of personnel, recruitment of students has been more difficult. Nevertheless, the transfer of knowledge from retiring experts to the new generation of radiation protection specialists continues to be important.

In Finland, there are no specialised PhD Schools in the field of radiation protection. However, postgraduate training has been provided by the Doctorate School on Public Health, Doctorate School for Environmental Health and Doctorate School on Systems and Risk Analysis.

STUK started an extensive internal training programme on different aspects of radiation protection and nuclear safety in 2002, along with the publication of the new book series that has been used as training material. Two more books in the series, concerning electric and magnetic fields and optical radiation, were recently published. Internal training on different aspects of radiation protection has been carried out on a frequent basis. The training modules are based on the new Radiation and Nuclear Safety book series. Internal training is also provided to improve working skills, and in management and communication.

A panel member took an initiative for the panel to interview doctoral students and recently graduated doctors at STUK. The meeting was with six young scientists from the Laboratories of Radiation Practices Regulation, Health Risks and Radon Safety, Radiation Biology Security Technology, Regional Laboratory in Northern Finland, and Non-Ionizing Radiation. The review panel interviewed the group on their attitudes on how they feel about STUK as a working and research training environment. The response was very positive with all agreeing that STUK provided an excellent working environment.

4.7 DISSEMINATION, EXPLOITATION AND IMPACT OF RESULTS

High-quality scientific publications are the key products of STUK research. They also form a solid basis for the conclusions and recommendations passed on to decision makers and citizens. Publications in peer-reviewed international journals provide the means for communication with the scientific community, including risk assessment organisations. Studies that are of interest mainly at the national or local level are published in a national report series, STUK-A series, in Finnish and/or Swedish. Municipalities and counties are active users of STUK's environmental surveys and databases, such as radon in indoor air or radon or uranium in drinking water.

In addition to scientific publications, a variety of new methods, improved study protocols, computer models and databases are products that enhance the capability of STUK to carry out its mission. STUK research also contributes to improved safety procedures that are applied by the users of radiation, for example in medicine. Although STUK carries out quite a lot of technical development, relatively few patents have been registered so far. Over the years, a few spin-off enterprises have been established by former STUK personnel.

The results and conclusions of STUK research are passed on to decision makers and society in several ways. The implementation involves several ministries and authorities at country and municipal levels that have responsibilities related to radiation protection (health, environment, rescue service, community planning etc.). Books written by STUK experts are used in universities and professional level education and several STUK experts also have posts as university lecturers (docent). Advanced professional training in radiation protection is provided both at national and international levels. Joint seminars and emergency exercises are organised with several stakeholder groups. Knowledge on radiation protection is also mediated via research networks and projects involving stakeholders that aim at improved procedures and practices or new methods to reduce radiation exposure. This two-way communication also ensures that STUK receives valuable information and feedback from the key actors in the field. Information on research results and radiation protection is actively distributed to the general public and stakeholders.

Over the years, increasing attention has been paid to the exploitation and impact of STUK's research results. The exploitation plan is an integral part of the research project plan. At the international level, many of the research results are communicated via research networks or different working groups. Expert knowledge of the research personnel of STUK covers all areas of radiation protection, i.e. from basic research on the health effects of ionising and non-ionising radiation at the molecular level to daily monitoring of levels of radiation. This broad expertise has also enabled STUK's own technical product development whenever it has been needed.

Research results are distributed not only to the scientific society but also to the general public by publishing a popularised summary of each research article or report. Regarding communication with radiation users and other stakeholders, STUK scientists submit articles to professional journals in order to distribute the latest news on radiation research and radiation protection. STUK also publishes its own journal on radiation protection and nuclear safety (ALARA journal), which is essentially directed to the domestic radiation protection society. Experts of STUK also give lectures in various courses dealing with radiation, health effects or environmental protection, emergency preparedness or nuclear safety. More recently, also social media such as Facebook has been applied by STUK for information exchange in specified areas (Fukushima, radon).

4.8 MANAGEMENT ISSUES

Financial and human resources

Research has earlier been STUK's biggest action area in terms of human resources, but with the planning and construction of new NPPs in Finland, nuclear safety has now become the largest area. About 14–19% of total human resources were devoted to research during the period 2005 to 2010, while in 2000 to 2004 this figure was 19–24%. The change is even greater when compared to the 1990s, when more than a quarter of the resources were devoted to research purposes. In addition to the increasing effort on nuclear safety, other reasons for the decreasing relative proportion of research have been the increase in other actions, such as internal development projects, expert service projects and environmental surveillance and preparedness, which have taken the time of researchers. The reduction in the number of fixed-term personnel has also meant that less time is now spent on time-consuming field and laboratory work. Much of this reduction has been dictated by the government productivity programme, which is limiting the number of employees. Since 2003, all government sectors have faced requirements for improved productivity. This has involved reductions in the number of personnel, which means that focusing of research activities and considerations of critical mass have become increasingly important. In STUK, the human resources used for research have declined by 20 percent since year 2000.

Research output and productivity

On a systematic basis, STUK measures the output of research as research publications, reports and presentations. The goal is to have at least 1 original publication per scientist-year. As more applied publications are also relevant for STUK mission, STUK follows the total number of research publications, using a weighted point system for different categories of publications (12-original papers, 8-proceedings, 4-reports, 2-abstracts), with the goal to have at least 900 points per year at STUK level. These two goals have been generally exceeded each year. There has been a steady increase in the number of original publications over a long time period. In line with the recommendations of the previous evaluation panels, publishing old data before the retirement of the senior experts has generally been successful. Summaries of all publications are passed to the Information Unit which is a good practice. While the dissemination procedures related to publications seem generally well developed, it is less clear how the various improved procedures, methods and technologies developed by STUK are exploited by the end-users and how this process is managed.

Project management

Since the previous evaluations, STUK has paid a lot of attention to project management, providing guidance and setting up procedures for the prioritization of new projects. However, taking into account the pronounced reduction in the human resources for research, the number of projects still appears to be quite large. Further efforts are needed to better translate strategies and objectives into organisational arrangements.

Organisational issues

In STUK, the units conducting research generally have various other duties in addition to research. This is also true at the level of individual experts. On one hand, the other duties such as emergency preparedness, services or regulation provide insight to the needs of knowledge. On the other hand, this may lead to problems with time management and coordination of activities within and between the units. Furthermore, the productivity of the units needs to be judged on the basis of the overall activities, not just research.

5 REVIEW OF DEPARTMENTS AND LABORATORIES

5.1 DEPARTMENT OF RESEARCH AND ENVIRONMENTAL SURVEILLANCE, MANAGEMENT UNIT

Personnel and resources

The management unit has a total of 9 staff members, led by Director Dr. Tarja K. Ikäheimonen. Two members of staff have either an MSc or PhD in radiochemistry or physics. One member of the staff is a project planner and has an MSocSc. The other members of the staff work for the secretarial service of the Management Unit. Direct research commitment is specified as 2.1 person-years per year.

Main comments

The primary task of the Management Unit of the Department of Research and Environmental Surveillance is to guarantee adequate operational preconditions in the laboratories of the department in order to perform the approved action plans and tasks of the laboratories. The Management Unit offers managerial and secretarial services to the laboratories and also performs tasks and projects themselves, which are related to the main topics of the department, in particular the emergency preparedness and the radioecology.

The goal of the Management Unit is to ensure that the resources of the department will not diminish and that the department is able to respond, without any delay, to all exceptional radiation observations and to other abnormal incidents. Within STUK, the Management Unit aims to strengthen the co-operation between different departments of STUK and to clarify the working procedures of joint projects with other departments.

The Management Unit of the Department of Research and Environmental Surveillance is also directly involved in the research activities of STUK, due to the Director's, Deputy Director's and the Senior Advisor's personal involvement in some research and development projects.

The overall responsibility for research activities in STUK should be defined more precisely. The current situation, in which the responsibility is split between the directorate of STUK and the relevant departments, has the potential to lead to confusing situations and misunderstandings.

Progress report

The evaluation panel has noted that substantial efforts have been made since the last evaluation in 2006 in the strategic planning of the research activities, in order to reduce the high number of small projects and to clarify the interaction, responsibilities and resources among those units that contribute to research activities in the Department of Research and Environmental Surveillance. The recommendations of the former panel have now been implemented. For the future, it would be useful for the Management Unit to play a role in delineating and specifying the essential contribution made by research in the context of overall work programs.

The panel recommends that the Management Unit put additional efforts in the review process of the current research activities and defines success factors for on-going projects. The evaluation of the projects with regard to their primarily defined goals, their expected impact on targeted groups and their performance should play an important role in the project portfolio management. The international review team considers this as one of the major future tasks for the Management Unit.

Publications

The statistics provided on publications show a fair involvement of the Management Unit as contributing authors for research publications: 12 original publications and 50 other publications during the years 2005–2010.

Future projects

In order to maintain a high level of research activities that are in line with the overall vision of STUK, the panel recommends that the Management Unit demonstrates the relation of the specific current research activities with the vision of STUK and plans the future activities closely linked to these, so that the needs of them can clearly be seen.

Conclusions and recommendations

The Management Unit of the Department of Research and Environmental Surveillance plays a central role in the planning, the decision process and the evaluation of all research activities in the department. In addition, the coordination of the activities with external units outside of the department is important. The strengthening of the leadership qualities of the unit can help to improve the management of the research activities in the department, and to align them with the vision of STUK.

R 1.1 The Management Unit should demonstrate how the specific goals of the research projects fit into the overall vision of STUK.

R 1.2 STUK should clarify the responsibilities for the research activities between the STUK directorate and the management of the relevant departments.

R 1.3 STUK should put more effort into the evaluation of projects and the definition of success factors.

5.2. HEALTH RISKS AND RADON SAFETY

Personnel and resources

As of 1.1.2010 the new unit “Health Risks and Radon Safety” was created by merging the former units Epidemiology (EPI) and Radon Safety (RAL). With a total of 13 staff members the new unit seems to have sufficient resources to continue the wide range of important work in the fields of research on health risks associated with ionising and non-ionising radiation occurrence and mitigation of radon in indoor air, the statistical support for research, the preparedness for radiological threats and emergencies, measurement services for indoor air radon and calibration as well as the communication and training on health risks of radiation and radon in indoor air.

Main comments

The spectrum of the work of the new unit includes activities related to the occurrence and mitigation of natural radiation in Finland, radon prevention and mitigation, environmental, occupational and medical radiation (ionising and non-ionising). There is an impressive interaction with the international scientific community and with international expert organisations such as EU, IARC, ICRU, IRPA, OECD, UNSCEAR, WHO.

The results of the work are used as independent, influential and science-based information for policy makers, authorities, society, and the media. Active collaboration exists with the units “Radiation Biology” and “Emergency Preparedness” (medical response, health effects, iodine prophylaxis, risk communication). A substantial fraction of the work is used for communication. Requests prove that the expertise is needed continuously and the messages are well understood and appreciated; the Radon sites of STUK (www.stuk.fi) are the most popular.

Progress report

The unit is actively involved in many major research projects recognized internationally. At the national level the work on radon prevention and mitigation is of high relevance from a public health perspective. It has an excellent publication record.

The recommendations of previous research evaluation have been fully implemented
“Epidemiology and Biostatistics”:

- To maintain its enthusiasm.
- Not to let its activities disperse too broad in spite of the many requests.
- To keep the contact with the laboratories having expertise in evaluation of the exposures and doses.

“Natural Radiation Laboratory”:

- Cooperation with universities in order to establish projects employing MSc and PhD trainees and to ensure recruitment of young talented scientists.
- More emphasis to be given to publish results in international peer-reviewed journals.
- To compare Finnish recommendations with those given in other European countries with a large experience in this field of activity.
- To continue the active role in the health studies, especially in epidemiological analyses. Establish cooperation with other European groups studying health effects of natural radionuclides in drinking water.

Publications

The publication record of the unit is very good.

Future projects

The priorities of future research projects are clearly defined. They include activities in the following fields:

- Low-dose risk: dose-response, non-cancer effect, individual sensitivity
  - Cancer risk among airline personnel COSMIC
  - Lens opacities among physicians occupationally exposed to radiation KAIHI
- Biobank samples collected from radiotherapy-treated prostate and breast cancer patients TERBIOPANK
  - Chernobyl fallout and cancer in Finland CHEFIN
  - Cost-benefit modelling in medical radiation TIEKKU

- Mobile phone use –prospective long-term follow-up
  - Cohort study of mobile phone users COSMOS
- Radon
  - Radon in workplaces
  - Mapping of radon in houses
  - Factors affecting indoor radon concentrations in Finland SIRA
  - Radon prevention and mitigation RADPAR
  - Radon mitigation measures in dwellings and work places
  - Radon prevention in new constructions
- Risk communication
  - STUK perspective on electromagnetic hypersensitivity SÄH
  - Radon campaigns

Conclusions and recommendations

Overall the laboratory’s planning and visions are very transparent and adequate for the future. The deliberations on how to cope with declining resources are worth considering further in STUK as a whole. These include measures to increase efficiency by prioritising topics, active information exchange between the units, mentoring, training, guidelines on documentation of previous work, the active acquisition of external funding and the further enhancement of international and national networking and collaboration -solution and opportunity.

R 2.1 Maintain the enthusiasm.

R 2.2 Maintain the active role in the health studies.

R 2.3 Continue active cooperation with universities in order to establish projects employing MSc and PhD trainees and to ensure recruitment of young talented scientists.

R 2.4 Options to best cope with declining resources in the coming years should be discussed and agreed with all units of STUK.

5.3 ENVIRONMENTAL RESEARCH

Personnel and resources

The personnel of the Environmental Research Laboratory consists of 3 PhDs, 3 MScs and 2 BScs. The size of the group appears small, but it should be noted that STUK has a separate laboratory for radionuclide analytics, so there is no need to have resources for radionuclide analysis in this laboratory. The Environmental Research Laboratory is well equipped for performing whole-body counting and other measurements of radioactivity in humans.

Main comments

The Environmental Research Laboratory focuses on radioecology and dose assessment. The laboratory also carries out research on countermeasures and restoration for agricultural land, foodstuffs, water supply networks and forests, and participates in the development of radiation protection of the environment.

The laboratory was formed in 2007 from the previous laboratories of Ecology and Foodchains and Radiation Hygiene, and it also adopted some research on drinking water previously carried out by the Natural Radiation Laboratory. At the same time, radionuclide analytics from these three old laboratories were merged into a specialized analytics laboratory.

Progress report

The laboratory has existed in the present form only from 2007. From the point of view of this laboratory, the organisational change appears to have been successful. During the years 2007–2010, the laboratory has published a total of 44 articles in international peer-reviewed journals. The number and contents of research projects seems to be appropriate given the stated focus areas of the laboratory.

As the laboratory did not exist at the time of the previous evaluation, the progress should be compared to the recommendations concerning previous laboratories. For the Ecology and Foodchains Laboratory, the recommendations of the previous evaluation were:

- To reduce number of projects to allow more time for the remaining projects
- To continue to participate in main European Projects
- To increase rate of publication in international peer-reviewed journals
- To prepare a succession plan because 3–4 senior staff will retire within the next 5–7 years.

It seems that there have been adequate responses to the three first recommendations. The reorganisation of the laboratories has at least partly addressed the fourth recommendation.

For the Radiation Hygiene Laboratory, the recommendations included the same recommendation about transfer of know-how to a new generation of scientists as for the Ecology and Foodchains Laboratory. In addition, it was recommended that the activities of the laboratory should be continued at a similar high level. It seems that these recommendations have been addressed adequately. This includes recruitment of new researchers and purchase of a new mobile laboratory.

Future projects

The plans of the laboratory include continued studies in radioecology, radioactivity concentrations in foodstuffs, radiation protection of biota and internal dosimetry. These plans are consistent with the stated focus areas of the laboratory. The number of projects is appropriate and they include international collaboration. Participation in the STAR Network of Excellence seems particularly promising, with its aim to maintain radio-ecological expertise and its key research themes (integrating human and non-human risk assessments, radiation protection in a multi-contaminant context, and ecologically relevant low-dose effects).

Publications

The total number of peer-reviewed international journal articles was 44 in 2007–2011 (11 per year on the average), which is a good output given the size of the group. The papers have generally been in good quality journals with impact factors typical to the research field, but there are only a few articles in high-impact journals. The balance between peer-reviewed international articles and other publications seems to be appropriate (about the same level as in STUK in general).

Conclusions and recommendations

Overall the laboratory’s results are good and it has adequate plans for the future. However, it might further benefit from a more clearly formulated research strategy with visions of what internationally unique results the group could achieve.

R 3.1 Maintain research at the current level and consider to further increase its quality.

R 3.2 Develop a research strategy with ambitious aims.

5.4 RADIONUCLIDE ANALYTICS

Personnel and resources

The Laboratory for Radionuclide Analytics was founded in 2007 by merging the analysis capability from several units into one Laboratory. The Laboratory has a total of 14 staff, led by Dr. Pia Vesterbacka. Six members of staff have either an MSc or PhD in radiochemistry or physics. Direct research commitment is specified as 1.5 person-years per year, 11% of total effort. The main function of the Laboratory is to provide analytical services for other units in STUK as well as for external customers. The laboratories are well equipped and excellently maintained.

Main comments

The Laboratory for Radionuclide Analytics is an impressive resource with an established program of analytical work that includes support for research projects. The laboratory also has an essential emergency response role.

It will be important to maintain and strengthen the involvement of this laboratory in research projects in order to attract appropriate staff, and ensure that this potential is developed and utilised fully. In particular, the more senior staff within the laboratory should be encouraged to participate in research projects from the planning stage through to completion and write-up. To ensure such collaboration between laboratories within STUK, Unit Heads and other senior staff should encourage scientists from other laboratories to involve members of Radionuclide Analysis as they plan research projects.

To maximise resilience for emergency response, consideration should be given to training staff from other STUK laboratories in the analytical techniques provided by Radionuclide Analytics, in both gamma spectrometry and radiochemistry. Such training should include regular practical experience so that the identified individuals could be redeployed immediately in the event of an emergency. Consideration should also be given to placing Radionuclide Analytics staff in other related laboratories to broaden their understanding of radiation protection and research projects.

It is important that this laboratory maintains and develops its links with other European centres carrying out similar work, to:

- ensure the reliability of current techniques through inter-laboratory comparisons.
- exchange information on the development of new techniques.
- develop links that could provide resilience/support in emergency situations.

Progress report

During the period 2005–2010, the Radionuclide Analysis Laboratory has participated in and supported a large number of research projects. These have included a number of international research projects financed in part by Nordic Nuclear Safety Research (NKS) and by the EC. The Laboratory has contributed to the development of radiochemical and sampling methods. A particular focus has been the measurement of natural radionuclides in connection with the mining industry. Methods have been developed for determination of polonium-210, lead-210 and uranium isotopes. In addition, the Laboratory has tested rapid methods for emergency preparedness. In gamma spectrometry, new analysis software has been adopted and a comprehensive new database had been established. Continuing R&D issues have been optimisation of sample sizes and consideration of uncertainties in sampling.

Radionuclide measurements are provided in support of research and in routine monitoring programs for a wide variety of environmental samples, including soil, food materials, building materials, industrial products, air samples and bioassay samples. Routine sampling programs around nuclear power plants and other environmental surveillance programs provide valuable data for scientific analysis. The Laboratory has a high throughput of samples for analysis. For example, in 2010, there were 2228 gamma spectrometry analysis and 533 radiochemical analyses.

The Laboratory maintains accreditation for analyses for which it is responsible and maintains national standards for activity and activity concentrations. The Laboratory participates in international comparisons in metrology, including: gamma spectrometry measurements at low energies; determination of efficiency of gamma spectrometry; assessment of uncertainties in gamma spectrometry; maintenance of radionuclide registers for unsealed and sealed sources; and participation in the certification of reference material with other national metrology laboratories. These initiatives and interactions are essential to ensure the maintenance of quality and reliability of measurement data.

Publications

The statistics provided on publications show a fair involvement of the Radionuclide Analysis Laboratory as contributing authors for research publications.

Future projects

Plans for the forthcoming 5 year period are essentially to continue to develop the current role of this relatively recently formed Laboratory (from 2007). As discussed above, there are R&D issues that are specific to the Laboratory but most of the research in which the staff of this Laboratory is involved is led from other Laboratories.

Conclusions and recommendations

This is a well run and well-staffed laboratory that provides an essential resource in an efficient manner. It has strong external links that should be encouraged and maintained.

R 4.1 Staff members from this Laboratory should be involved in research projects that originate in other Laboratories, from inception to completion and publication.

R 4.2 Rotation of staff between Laboratories should be considered as an approach to fostering collaborative working and realising the full potential of employees.

R 4.3 Resilience in emergency preparedness should be increased by training staff from other Laboratories in the measurement techniques used in Radionuclide Analytics.

5.5 ENVIRONMENTAL SURVEILLANCE AND PREPAREDNESS

Personnel and resources

The Environmental Surveillance and Preparedness Laboratory was founded in 2007 by splitting the previous Laboratory for Airborne Radioactivity into two parts, the other having a greater research focus (Security Technology). The Laboratory has a total of 9 staff members, led by Kaj Vesterbacka. Five members of staff have either an MSc or Ph.D. in physics, engineering or chemistry. Direct research commitment is specified as only 0.2 person-years per year. The main functions of the laboratory are surveillance of environmental radioactivity and development and maintenance of emergency preparedness capability.

Main comments

This laboratory has a small direct commitment to research but more of the work could be described as R&D. There are important interactions with other STUK laboratories with a greater research focus.

Arrangements for environmental surveillance are impressive as is the development of software for the integration and improved accessibility of information in emergencies. It would be helpful to further clarify interactions with other Laboratories and units involved in R&D related to emergency preparedness and response (EPR) so that results can be effectively implemented. R&D of relevance to EPR takes place particularly in the Security Technology Laboratory, but also in Environmental Research and Radionuclide Analytics in the Research and Environmental Surveillance Department, and also to some extent in the Department of Radiation Practices Regulation. As there is also a separate Department of Emergency Preparedness, it would be helpful to identify more clearly the lead responsibilities for advancements in EPR within STUK, in terms of overall strategy, definition of priorities and exploitation of developments. The overall strategy, including that for the Laboratory for Environmental Surveillance and Preparedness, should include the formulation and implementation of lessons learned during the response to the Fukushima incident.

While not directly related to R&D functions, an important aspect of this Laboratory's responsibilities in an emergency is the provision of support for communication with Government and public. It is suggested that the laboratory should play a role in the identification and provision of media trained scientists who can support Comms professionals.

Progress report

The Laboratory is responsible for the surveillance of environmental radioactivity, working together with the Radionuclide Analysis Laboratory, the Regional Laboratory in Northern Finland and the Environmental Research Laboratory. The Laboratory operates a nationwide real-time dose rate monitoring network with 255 stations. Ambient dose rate readings are made available through a custom-designed web-based system. In addition, monitoring stations around nuclear power plants are equipped with $LaBr_3$ spectrometry with low detection limits and the ability to identify radionuclides. Airborne radioactivity is monitored at eight sampling stations and there is a fully automated station at STUK in Helsinki.

The Laboratory has, in collaboration with the Finnish Meteorological Institute (FMI), created a software tool (KETALE) that enables the integration of data for the prediction of atmospheric dispersion of radionuclides for emergency response purposes. The system allows rapid dose assessments to be made for analyses of developing situation and as an input to decisions on countermeasures. The KETALE system has improved the quality of dispersion and dose assessments, streamlined information exchange between STUK and FMI and fostered better coordination of emergency arrangements in the two organisations.

KETALE can also display information obtained using RODOS software to continuously monitor the dispersion situation at nuclear power plants, in readiness in case a release were to occur.

Publications

The statistics provided on publications show a relatively low involvement of the Laboratory as contributing authors on research publications. This is as might be expected from the nature of the work but efforts should be made to maximise opportunities for publication of R&D material.

Future projects

Work in the next 5 year period will include maintenance and further development of the KETALE system to maximise its operational efficiency and ease of use in an emergency. Work will also be done to improve the monitoring networks and associated data handling. The overall aim is to provide the best possible tools, methods and procedures for emergency situations. An important aspect will be to learn from the experiences of the Fukushima accident. STUK is engaged in European networking activities in the area of emergency management. Raimo Mustonen (Deputy Director) is the president of the NERIS platform, an EC funded network of excellence with the objective of establishing a self-sustaining European association for the development of a joint approach for response to and recovery from nuclear and radiological emergencies.

Conclusions and recommendations

The work programme of this Laboratory is well defined and there is an appropriate focus on the implementation of technological developments, for measurements and data analysis and presentation.

R 5.1 Consideration should be given to strengthening and clarifying links between Laboratories so that relevant developments from other Laboratories can be more rapidly implemented and owned by this Laboratory.

R 5.2 Lead responsibilities for advancements in EPR within STUK and interactions with other organisations should be defined better.

R 5.3 The forward strategy for this Laboratory should be set in the context of NERIS and include formulation and implementation of lessons learned from Fukushima.

R 5.4 Plans should be developed for providing expert support for Comms for emergency situations, including the identification and training of spokesmen.

5.6 SECURITY TECHNOLOGY

Personnel and resources

The Security Technology Laboratory was established in 2007 when the former Laboratory for Airborne Radioactivity was split into two parts, the other part being the Laboratory of Environmental Surveillance and Preparedness. Security Technology has a strong research focus while Environmental Surveillance and Preparedness is more operational. Security Technology has a total of 10 staff, led by Harri Toivonen, with nearly all having an MSc or Ph.D. in physics, mathematics or information technology. Direct research commitment is specified as 6.1 person-years per year. The main functions of the laboratory are research on radiation measurement technology for emergency and security applications and associated development of novel analysis software.

Main comments

The work of this laboratory is of the highest quality and the ability and expertise of the research team is internationally recognised. They have an established track-record of developing novel measurement techniques and software applications.

The laboratory would benefit from a clearer delineation between the R&D for which they are responsible and the subsequent exploitation of the innovations. Examples are the SNITCH and VASIKKA systems which, once developed, might better become the responsibility of a more operational Laboratory. Greater interactions between laboratories at the researcher level would help foster understanding and more rapid adoption of new techniques as well as making full use of the expertise of those with practical experience. As discussed in R 5.2, the specific context of exploration of advancements in emergency preparedness and response, it is important that Department Heads and Directorate work together to develop integrated strategies that foster and exploit R&D.

Progress report

The Laboratory is responsible for a program of research on radiation measurement technology for emergency preparedness, safety, security and safeguards and connected R&D on analysis software. Methods on event-mode data acquisition and other coincidence measurement systems are the main R&D target. Impressive results have been achieved in the development of software for gamma and alpha spectrometry.

The Laboratory operates closely with the police, customs and other government organisations and this has led to in-field capability to perform high-quality spectroscopy. Measurements made are sent to a remote database for expert review in real-time.

During 2005–2010, research projects included: Spectral nuclide identification technology for counterterrorist and Hazmat units (SNITCH); direct alpha analysis of forensic samples; use of $LaBr_3$ spectrometers at monitoring stations; non-destructive analysis; rapid identification of alpha emitters; remote real-time monitoring for alpha emitters; and, detection and identification of neutron emitters. Other work included: upgrading of the mobile laboratory, which is equipped for gamma spectrometry and air sampling and relays results in real-time to STUK headquarters; development of spectrum analysis software for use in a back-pack for front-line responders, enabled for data acquisition from different detectors (VASIKKA); and development of an air sampler and real-time radiation measurement system for an unmanned aerial vehicle.

Publications

The Security Technology Laboratory has a good record of publication of results in the peer reviewed literature and production of other written material including readily understandable information sheets on their developments and achievements.

Future projects

Work in the next 5 years will include a project based on results from studies of non-destructive analysis techniques. The main research themes in this area will be: novel radiation detection and analysis concepts such as coincidence spectrometry with alpha particles and conversion electrons; complimentary particle analysis techniques such as nanotomography; and the development of electrostatic samplers.

The Security Technology Laboratory already has good established links with universities, and other national and international organisations. They are well placed to further strengthen these links and develop others as major contributors to national, European and global initiatives to improve security and emergency preparedness.

Conclusions and recommendations

The Laboratory has established expertise, a well developed program of work and a record of practical achievements.

R 6.1 A clear strategy is required for the development of the Laboratories work over the coming years, making appropriate use of external links and ensuring that STUK exploits its expertise in this area.

R 6.2 The main strength of the Laboratory is in research and technology development. More thought could be given to ways in which the Laboratory may be given greater support in the subsequent development of operational equipment.

R 6.3 The Laboratory would benefit from greater interactions at the researcher level to foster understanding and more rapid adoption of new techniques. Mechanisms should be developed in STUK to enhance such interactions

R 6.4 Specific consideration could be given to interactions at the Department Head / Directorate level to develop integrated strategies that foster and exploit R&D.

5.7 REGIONAL LABORATORY IN NORTHERN FINLAND

Personnel and resources

The personnel of the Regional Laboratory of Northern Finland include three PhDs, one BSc researcher and four other staff members. The laboratory seems to have adequate facilities and equipment for conducting its research and monitoring tasks.

Main comments

The Regional Laboratory of Northern Finland is the northernmost laboratory performing radioactivity analysis and monitoring of the environment in the European Union. The objective of the laboratory's research is to determine how radioisotopes are transported and accumulated in the Arctic and sub-Arctic food chains and the environment.

The studies conducted by the laboratory have included measurements of both natural and anthropogenic isotopes in a wide variety of samples representing northern food chains, including lichens, reindeer meat, soil, grass, milk, berries, mushrooms, natural herbs, water, fish and seals. Recent studies include research on the mobilisation of radionuclides from mining mill tailings and radiological baseline studies in the Talvivaara mine and the planned Sokli mine area. The laboratory participates in the Arctic Monitoring and Assessment Programme (AMAP).

The laboratory has international collaboration, particularly with groups in the neighbouring countries in the Arctic region.

Progress report

The laboratory appears to actively increase its network of collaboration. This includes participation in the EU funded project CEEPRA which was recently started to establish a cooperation network in the EuroArctic region.

The laboratory has successfully increased its efforts in research. During the years 2005 to 2010, a total of 9 peer-reviewed articles in international journals, and 7 of these articles were published in 2009 and 2010. The laboratory is very actively involved in a variety of environmental measurements, which is impressive given the small size of the unit. However, the large effort in collecting data has not yet resulted in a corresponding level of scientific output (measured as articles in international peer-reviewed journals).

The recommendations of the previous evaluation were

1. The objectives of the laboratory must be redefined as and international observatory of the health of a particular ecosystem of the earth.
2. The pressure from STUK to find external financing is not realistic in this case and should be reconsidered. The laboratory already has a sufficient workload corresponding to a well-targeted objective. It is difficult for the unit to diversify into other activities.

The second recommendation has apparently been considered by STUK. The first recommendation is still an excellent goal for the future of the laboratory.

Publications

The laboratory has published 9 international journal articles and 53 other publications during the years 2005–2010. The laboratory should continue its effort to change the balance towards more international journal articles.

Future projects

The future plans of the laboratory have been stated as follows: "In the Regional Laboratory of Northern Finland, the main emphasis will be moved from radiation monitoring to environmental research during the next five years. New research areas will include environmental impact studies on mining sites and the environmental aspects of the planned new nuclear power plant in northern Finland." (Research activities of STUK 2005–2010). This is certainly the right direction of development. Participation in the AMAP and CEEPRA programmes will also be beneficial for the development of the laboratory. However, it would be useful if the laboratory had a more clearly formulated research strategy with well defined scientific goals.

Conclusions and recommendations

The laboratory has been successful in changing its activities from monitoring to research and in increasing its international and national network of collaboration. The laboratory should continue efforts in this direction.

R 7.1 Develop a research strategy with well defined aims, vision and focus.

R 7.2 Continue improving the publication record, focussing on publishing in international peer-reviewed journals.

R 7.3 Keep the recommendation of the previous evaluation, “international observatory of the health of a particular ecosystem of the earth”, as a goal for the future of the laboratory.

5.8 RADIATION BIOLOGY

Personnel and resources

The personnel of the Radiation Biology Laboratory consist of four PhDs, 4 MSc or PhLic researchers and three other staff members (laboratory engineers etc.). Given the very demanding research area, the size of the group is relatively small and represents a relatively narrow spectrum of scientific disciplines: four of the eight researchers have background in genetics, two in cell and molecular biology and biochemistry, one in biotechnology and one in biophysics.

The laboratory seems to have adequate facilities and up-to-date equipment for conducting research on the biological effects of radiation. Help in physical and technical aspects is available from other laboratories in STUK. In the field of ionising radiation, the Radiation Metrology Laboratory provides irradiation services, development of irradiation systems, and dosimetry. Similarly, the unit of Non-Ionizing Radiation Surveillance provides expertise in exposure systems and dosimetry for non-ionising radiation.

Main comments

The Radiation Biology Laboratory is involved in research on the biological and health effects of ionising and non-ionising radiation and in doing biological dose assessment by chromosomal analysis. It also contributes to biological expertise for the assessment of medical consequences of exposure to radiation.

In research on the biological and health effects of ionising radiation, the focus is on effects of low dose radiation, particularly non-targeted effects, individual susceptibility and non-cancer effects. These (particularly non-targeted effects and non-cancer effects) are certainly important challenges of current radiobiology and relevant for improving the understanding of health effects of radiation.

Research on the biological effects of non-ionising radiation has included effects of UV radiation on skin, with particular focus on UVA radiation and melanoma. Various effects of mobile phone-type radiofrequency electromagnetic fields have also been studied. In this field, STUK’s main research effort has been driven by use of a methodology (proteomics) to study the effects of RF fields rather than by needs to address certain health endpoints or by specific hypotheses concerning effects.

The laboratory has a good network of international collaboration with many high quality research groups.

Progress report

The three research groups that previously existed in the laboratory have been merged. This is likely to a good decision and successful in increasing the use of human resources, methods etc. for the benefit of the whole Laboratory.

The Radiation Biology Laboratory is well respected in the international ionising radiation research community. This is demonstrated by STUK's leading role as a coordinator in the European NOTE (2006–2010) and DoReMi (2010–2015) projects. During 2005–2010, the research of the laboratory has included studies on individual sensitivity, non-targeted effects (bystander effects in a 3D model system, clastogenic in the plasma of irradiated subjects, individual sensitivity in non-targeted effects) and cardiovascular risk of low-dose radiation.

Given the apparent importance of low dose-effects (non-targeted effects, individual susceptibility etc.) in the strategy of the laboratory, the scientific output in this area has been relatively low: a total of 11 international peer-reviewed articles have been published during the period 2005–2011. The laboratory should analyze the reasons for not achieving better results in this area; one possible reason may be the combination of a relatively small group and the heavy workload associated with coordinating large international projects. During the same time, there have been 12 peer-reviewed papers on the effects of non-ionising radiation (of which 9 on RF electromagnetic fields). The group has been among the few pioneering groups in using proteomics to study the biological effects of RF fields. The disadvantage of this choice of focus is that the applicability of the results in health risk assessment is currently very unclear. The remaining 19 peer-reviewed papers of the laboratory included biological dosimetry and molecular epidemiology in collaboration with the epidemiology group.

The recommendations of the previous evaluation were:

- To keep the level of quality of research.
- To keep in mind the particular research needs for research in Finland.
- To maintain the collaboration with the Epidemiology laboratory, especially if molecular epidemiology research will be further enhanced.
- To evaluate the ethical applications of certain studies, for example, screening.

The most obvious success in responding to these recommendations has been maintaining collaboration with the epidemiological research; a major part of the laboratory's peer-reviewed publications have resulted from such collaboration. Also, studies on non-ionising radiation can be seen as addressing the particular research needs in Finland. No information was available to the current evaluation group concerning evaluation of ethical questions recommended by the previous evaluation group, but no apparent ethical problems were observed in current activities of the laboratory.

Publications

The total number of peer-reviewed international journal articles was 42 (7 per year on the average), which is acceptable given the size of the group, but it could be higher. The papers have generally been published in good quality journals with impact factors typical to the research field, but there are only a few articles in high-impact journals. The balance between peer-reviewed international articles and other publications seems to be appropriate (about the same level as in STUK in general).

Future projects

Concerning ionising radiation, the laboratory aims at continuing research on low dose risks. The research activities will focus on relevant research priorities identified by international groups such as HLEG. However, it is not clear what the unique role and scientific ambitions of STUK would be, other than just being involved in the internationally planned projects. The plans also include being involved in integration of epidemiology and radiation biology and continued involvement in molecular epidemiology; this is likely to be a fruitful direction to go.

Concerning non-ionising radiation the plans include just follow-up of some details of previous studies on RF radiation. There seems to be no clear vision or strategy on how to address major health-relevant questions of non-ionising radiation. There were no plans on other than RF electromagnetic fields (extremely low frequencies, intermediate frequencies, static fields) or on UV radiation.

Conclusions and recommendations

The Radiation Biology Laboratory is well respected in the international scientific community. To keep this status, strategic planning is needed to make sure that the scientific goals are at a sufficiently ambitious level and that the work addresses relevant issues in radiation protection.

R 8.1 For ionising radiation, develop a research strategy so that there is a clear vision on how STUK's contribution will be unique and have a high scientific impact in the international scientific community.

R 8.2 For non-ionising radiation, develop a research strategy that addresses scientifically important questions relevant for protecting people from adverse health effects of EMF.

R 8.3 Consider increasing integration with epidemiological research programmes.

R 8.4 Increase publication record in international peer-reviewed journals, and even more increase publication in high-impact journals.

5.9 RADIATION PRACTICES REGULATION (RADIATION IN HEALTH CARE AND INDUSTRY; RADIATION METROLOGY)

Personnel and resources

The Radiation Practices Regulation Department has a total of 42 staff members, led by Director Dr. Eero Kettunen. The majority of the members of staff have either an MSc or PhD in physics.

The panel also noted that the personnel resources were improved over the last 5 years. Younger scientists are now working in the department. The STUK-wide implemented mentoring system to train new collaborators has proven its effectiveness. It is recommended to continue the implemented succession planning and to transfer the knowledge of retiring experts to the new generation of radiation safety experts. The recruitment of new staff members is successful and shows the attractiveness of the department for job applicants.

Main comments

Radiation Practices Regulation is the department of STUK responsible for the supervision, the licensing and the regulation of the use of radiation. In addition, the department undertakes research in different fields, such as the use of radiation, dosimetry and metrology, but also maintains the national measurement standards for dose quantities of ionising radiation and provides education, training and expert services.

The research of the department aims to improve knowledge and expertise in general, to support the regulatory activities and to promote the justified and optimised use of radiation. The research on radiation metrology is mainly related to maintaining the national measurement standards for ionising radiation dose quantities and to developing new measurement methods. In addition to publications and presentations, reliable dosimetry methods are also communicated to the users of radiation, for instance during site visits.

Research on the medical use of radiation is often organised in joint projects with three units, namely the X-ray in Health Care, the Radiotherapy and Nuclear Medicine, as well as the Radiation Metrology Laboratory. The research on radiation metrology is mainly carried out by the staff of the last unit. The Management Support unit is responsible for the harmonisation of occupational dose monitoring in Europe and for the verification of the quality of dosimetric services. Research on the industrial use of radiation is mostly conducted by the unit Radiation in Industry; however, some projects are performed with the Radiation Metrology Laboratory. The overall coordination of the research at the Department of Radiation Practice Regulation is carried out by a person from the unit of Management Support, who has been nominated as the “process owner” for the research within the Department.

The review panel considers the implementation of this overall coordination position and the work of the “process owner” as very important to manage efficiently the research activities in the Radiation Practices Regulation Department. According to the panel’s evaluation, this is a commendable solution for the management of the projects.

During the review, the panel observed that the information flow in projects having contact to units outside of the Radiation Practices Regulation Department sometimes causes problems. The panel therefore recommends that consideration should be given to ways of improving existing communication channels and providing appropriate solutions regarding this issue.

Progress report

In the field of optimisation of the use of radiation in medical practices, the relevant units of the department play an important role, not only on a national level, but also in international projects and networks. Tremendous developments in technology took place over the last few years. The growing use of radiation related to this technology is a great benefit for individual patients and for the society as a whole. However, this also led to a large increase in medical radiation exposure that raises concerns about radiation protection issues. The quality of the STUK contribution in this area is high and widely recognized. The panel encourages STUK to keep its engagement high, to strengthen the existing projects and to maintain its enthusiasm.

Publications

The statistics provided on publications show a very high involvement of the Radiation Practices Regulation Department as contributing authors for research publications: 60 original publications and 123 other publications during the years 2005–2010.

The recommendations of the former review panel concerning the effort reinforcement to publish scientific results in peer-reviewed journals have been taken into account. The publication of results is already an important topic in the current project planning. Nevertheless, the panel sees potential for further improvement by introducing a general mechanism for the dissemination of the research results, giving guidance to the project leaders in the department. Furthermore, some previously unpublished results still remain due to a lack of human resources.

Future projects

The future research plan of the department is clearly defined and looks very ambitious. In each of the 4 research units between 2 and 6 research projects are identified and prioritised:

- **Medical use of radiation:** Advances in dosimetric techniques, justification and optimisation principles in CT, PET-CT and IR, diagnostic reference levels, population dose estimation, verification of modern treatments in radiotherapy
- **Dosimetry and metrology:** methods for novel radiotherapy techniques, metrological traceability in nuclear medicine, dosimetry in diagnostic radiology, dosimetry in radiobiological research, techniques in neutron measurements, occupational dose monitoring
- **Other use of radiation:** early detection of orphan sources in scrap loads, public exposure and pathways of the current use of unsealed sources, use of accelerators
- **Emergency management:** emergency procedures in metal industry, participation on the internal emergence preparedness guides revision after the Fukushima accident

Conclusions and recommendations

The work of the Radiation Practices Regulation Laboratory of STUK has a significant impact on the Finnish society in the field of medical and industrial application of ionising radiation. The Laboratory has a fine record in their research activities, in international collaboration and in scientific publishing. The integration in European projects is very good.

R 9.1 The Radiation Practices Regulation Laboratory should keep its engagement in research activities at a high level, strengthen the existing projects and maintain its enthusiasm.

R 9.2 Continuation of the participation in major Nordic and European projects is encouraged.

R 9.3 General mechanisms for the dissemination of the research results should be developed, with increased emphasis on publication of all results of scientific value.

R 9.4 A strategic plan should be developed to maintain the expertise in the medical and industrial areas within STUK for the future.

R 9.5 The research activities of the laboratory should be kept under permanent review.

5.10 NON-IONIZING RADIATION SURVEILLANCE

Personnel and resources

In 2010 a total of 9.3 person-years have been allocated to work in this field; 32% were dedicated to research. About 50% to the overall budget of the Laboratory (about 1 Mio. € in 2010) has been spent for research. Given the wide spectrum of this research area, the size of the group is small. The laboratory seems to have adequate technical facilities and up-to-date equipment for supporting research on the biological effects of non-ionising radiation as well as related epidemiological studies. Some of the work is dedicated to the development of measurement and calibration methods in the framework of the European Metrology Research Program.

Main comments

The Laboratory fulfils three functions, as a regulatory body, a research laboratory and an expert organisation. It develops radiation protection standards, disseminates public information on NIR and provides expert services. It is engaged in a multitude of surveillance and research activities in the areas of EMF and optical radiation with a clear focus on exposure assessment and metrology. The work in the laboratory is mostly on technically demanding measurement technology, and therefore contacts with partners working on effects are essential to maintain relevance. The unit has a high professional profile in the area of dosimetry. In the field of research of health effects the unit provides technical support to biological studies in EMF (see chapter 5.8. Radiation Biology).

Some orientation for the selection of the work of the unit seems to be provided by the research agenda of WHO and EU but a clear concept for the selection of the various topics is not obvious.

Progress report

During the evaluation period, research has been conducted on the assessment and restriction of magnetic fields from MRI scanners, assessment of induced currents and specific absorption rate (SAR) around RF dielectric heaters, dosimetry for indoor transformer stations, SAR and electric field measurements near mobile phone base station antennas, international metrology studies for SAR and field strength, and UV radiometry studies. The work also included several projects producing exposure systems and dosimetry for animal and human studies.

The recommendations given by the previous panel were:

- To continue the work of laboratory is highly important because it is either crucial from a health protection, or from public perception point of view.
- Interaction with biological research should be continued and further developed.
- The number of activities supported by the laboratory should be kept under permanent review.
- More publications in international journals are desirable.

These recommendations are still valid. Concerning the third recommendation, it seems that the activities of the laboratory are now rather well focused. Research on the biological and health effects will continue to be important, and the contribution of this unit (dosimetry, exposure assessment) will be important for the quality of such studies. Therefore, involvement in biological and epidemiological studies should be a high priority.

Publications

The publication record has been increased but there is still room for further improvement.

Future projects

The research plan of the unit (STUK-A248/August 2011; p 223–224) specifically mentions research on promotion of health and well-being of MRI workers, but is otherwise rather unspecific concerning further research. In particular, there are no visions on future involvement in biological and epidemiological work on electromagnetic fields. In the case of UV radiation, there is an opposite pattern: there seem to be plans on health effects studies (UV-induced melanoma), but nothing is mentioned about continuation of work in radiometry of optical radiation. During the evaluation, the laboratory presented a much wider spectrum of possible activities, e.g., improvement of measurement techniques and computational methods, metrology research, low frequency magnetic fields. Overall, a clear picture about the main directions and the structure of the future work of the laboratory has not become obvious during the evaluation. Given the increasing importance of the non-ionising radiation in daily life the work requires more strategic planning.

Conclusions and recommendations

NIR is an integral part of life and will continue to be so. Due to the rapid technological developments that are taking place, the work of the laboratory is very relevant to radiation protection at certain workplaces as well as for the population as a whole. Both NIR metrology and health effects of NIR require more scientific work because there are many open questions to answer. However, given the wide spectrum of challenges in this field and the limited resources available, thorough strategic planning and priority setting is required. This should be in the context and in close co-operation with national and international partners.

R 10.1 Clarify and better define the respective roles of the unit in terms of research, technical development, public information.

R 10.2 For the whole spectrum of non-ionising radiation, develop a research strategy that addresses scientifically important questions relevant for protecting people from adverse health effects of EMF.

R 10.3 Consider increasing integration with biological and epidemiological research programmes. STUK should establish a mechanism to assure that the research strategy of the laboratory be consulted with units that conduct biological and epidemiological research on NIR.

R 10.4 Increase publication record in international peer-reviewed journals, and even more increase publication in high-impact journals.

ANNEX A: TERMS OF REFERENCE FOR THE EVALUATION PANEL

The Ministry of Social Affairs and Health carries out evaluation of STUK research activities at an interval of five years. The Ministry of Social Affairs and Health now plans to invite a multi-professional panel of international and national experts to evaluate the research activities of STUK. The evaluation will be based on written material, a site visit and interviews with scientists. The mission is expected to take place in late September – early October 2011. This evaluation is now the third international evaluation. The previous evaluation took place in 2005 (see Reports of the Ministry of Social Affairs and Health 2006: 60).

STUK – Radiation and Nuclear Safety Authority is the national authority in radiation and nuclear safety, expert organisation as well as the national research centre on various aspects related to radiation protection. The research areas of STUK relate to:

- health effects of radiation
- use of radiation (in health care and industry)
- occurrence and mitigation of natural radiation
- environmental research
- preparedness for radiological threats and emergencies
- dosimetry and metrology
- non-ionising radiation

and, to a lesser extent, nuclear safety.

The evaluation of STUK is to address the following main issues:

- Appropriateness of STUK's activities in relation to relevant issues in radiation protection
- Social relevance and effectiveness of the activities
- Steering by information
- Prioritising STUK's various activities
- Quality of STUK's research activities
- The relation between costs and results.

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