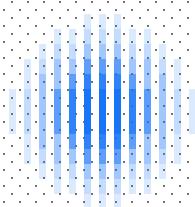


NSFS XX CONFERENCE

August 27- 29 2025, Lillehammer
Learning by Sharing



DSA



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NOTES from NSFS Lillehammer 2025 Jack Valentin

The venue, Scandic Lillehammer, was a magnificent hotel in the scenic area with history dating back to 1911 and with all modern conference facilities, and all practical aspects of the meeting worked flawlessly. At the start of the meeting, our host Tore Ramsøy (president of NSFS, principal scientist at IFE) welcomed us and said that the 123 participants would hear 40 oral presentations and a panel debate and see 18 posters. He thanked DSA, NND, and IFE for generous support of the meeting. DSA Deputy Director Kristin Frogg added her words of welcome, underlining the importance of scientific input for the work of a regulatory authority.

Kjetil Longva (DSA) gave an overview of nuclear preparedness in Norway. DSA uses 6 planning scenarios and aims to give at least 7h advance warning of any nuclear attack, A direct attack on Norway is regarded as very unlikely but not impossible. Nuclear attacks in other countries are regarded as unlikely but, in any case, not a radiological threat to Norway (I did not hear him discuss psychological/social effects due to nuclear warfare abroad). There were however several nuclear threats apart from intentional nuclear weapons attacks, including e.g. incidents with nuclear powered vessels, nuclear emergencies in neighbouring countries (e.g. at the Kola peninsula), events due to decommissioning of the Norwegian nuclear installations, or incidents related to possible new build of nuclear installations in Norway. Norway has invested heavily in nuclear safety and emergency preparedness, and he described the organisation and role of the Crisis Committee for Nuclear and Radiological Preparedness which plays a crucial role in managing incidents.



Kjetil Longva from the Norwegian Radiation and Nuclear Safety Authority presented an overview of nuclear preparedness in Norway

The Bo Lindell Prize was then awarded to Hanne Waltenburg (SIS, Denmark). Hanne delivered a prize lecture on *From X-rays to AI: 20 Years of Radiation Protection in Medicine and Beyond*. In keeping with the Congress theme of Learning by sharing, she described dose trends in Danish

medical radiation usage, with average doses rising from 1 mSv in 2015 to 2 mSv in 2025 but stressed that ‘average is not everybody’. A major driver behind the increased doses was increased diagnostic capabilities, but an aging population also contributed to the trend, she saw potential for AI to lead to reduced doses but still had some concerns regarding justification of examinations.



Hanne Waltenburg, Danish Health Authority, received the Bo Lindell award in acknowledge for her great merits in the field of radiation protection and contributions to achieve the objectives of the Society

Lars Klæboe (DSA) then discussed whether exposures from wireless transmitters could be a cause for concern. He claimed that environmental levels of non-ionising radiation have not increased dramatically in recent years, mentioning emissions from existing equipment like old TV sets. However, the communication explosion will likely lead to increasing levels. Current scientific understanding is that this is not likely to lead to any increase in radiogenic diseases, but an increased level of societal anxiety is probable. The case of electro-hypersensitivity shows the dilemma – such sensitivity appears to be a contagious psychogenic condition, but the symptoms experienced by victims are real and very distressing and must be respected.

Einar Dale, Oslo Univ. Hospital, presented Nordic co-operation and clinical trials in proton therapy. Due to the Bragg peak, protons deposit their energy at a more defined depth in tissue than photons, theoretically permitting less damage to organs surrounding the tumour and less deleterious side effects. However, while this is seen in e.g. head-neck patients, particularly paediatric cases, the resource-demanding protons offer little advantage for e.g. lung or prostate

cancers. Thus, patient selection and continued clinical trials are important. Excellent Scandinavian cross-border collaboration helps to achieve these advantages. (I did not hear him mention collaboration with Finnish proton therapy clinics. I believe there is no proton therapy in Iceland).

Svein Nøvik provided a fascinating description of the formation and origin of elements. Taking the audience along on a journey from inside atoms through to stars and galaxies, he explained briefly the four forces, fusion, fission, and the birth of elements, all richly illustrated with beautiful and at times almost gaudy pictures. His talk was a thought-provoking reminder of the basic processes underlying, not just the environment but life itself.

At the end of the session, former ICRP Secretary Jack Valentin talked about Nordic influences on ICRP. He rehearsed briefly the history of the organisation and described with a sprinkling of anecdotes about significant personalities, how it has evolved from an ivory tower into a modern open and global body. He stressed that a great number of people from the Nordic countries have been involved in ICRP and its recommendations, and expressed his desire that the audience would wish to continue this tradition.

The day ended with a much-appreciated meal and tour of the local lake Mjøsa on Skibladner, the world's oldest active paddle steamer.

On the second day, two sessions of proffered papers focused on decommissioning, reflecting the closing-down of all four research reactors in Norway, one at Halden and three at Kjeller. Norwegian Nuclear Decommissioning (NND), a state-owned company, is taking over responsibility for these installations and their management.

Jonas Nikolaisen and Ingeborg Mørk-Knudsen of DSA mentioned some of the difficulties, like exotic spent fuel from old installations with no waste management solutions and a need to recruit more expertise. International co-operation e.g. with Ignalina was key to achieve safe radwaste management using emerging new technologies. Ari Ikonen (EnviroCase) talked about stakeholder perceptions of radiological impact assessments. Building societal confidence was vital but it was easy to be trapped in myriad details. The MEREIA programme of IAEA was useful for a graded iterative approach. Experience from the Finnish former U mine at Paukkajanvaara provided a case study. Maria Due-Hansen (NND) described a different challenge, removal of the Co-60 source from the gamma irradiator at Kjeller. Tore Ramsøy (IFE) explained how IFE's highly enriched uranium was downblended with depleted uranium in Mobile Melt-Consolidate campaigns to obtain 3.5 % LEU ingots, avoiding atmospheric releases. Siiri Salupere (Univ of Tartu) described a very demanding and ambitious decommissioning of the Tammiku legacy waste disposal site with 97 tonnes of solid radwaste ($7 \cdot 10^{13}$ Bq, C, Sr, Cs, Ra, Am) with hundreds of tonnes of concrete walls and cover, aiming at $<10 \mu\text{Sv y}^{-1}$. She mentioned that similar difficult cases exist in Ukraine.

Tony Skovli (IFE) talked about simulations to assess depletion and neutron activation in the old JEEP-1 reactor at Kjeller, which was shut down in 1967 and has not been opened since. Radiation levels and isotope compositions must be determined for decommissioning. NSFS Secretary Ingunn Løvik (Trondheim University Hospital) described her hospital's decommissioning plan for their PET cyclotron vault, with huge amounts of activated material causing a non-trivial problem in spite of low specific activity in the concrete. Viktor Lehmann (Barsebäck NPP) explained the many measurement methods used to assess contamination in the Barsebäck plant. Kristin Ramberg (Sykehusbygg HF) highlighted the importance of

planning for decommissioning of proton therapy rooms already at the building stage. Using expensive materials like low-cobalt rebar and marble concrete to reduce activation by the large surplus of neutrons will reduce future decommissioning costs enormously.

A next session focused on NORM and radon, and Ingvild Finne (DSA) presented the recent 'Nordic flagbook' on radon management. Measurement methods and comparisons with reference levels differ between our countries so country surveys must be judged and compared with caution. Mila Pelkonen (NMBU) reported in the environmental radionuclide impact and uranium mobility at the Taraldrud alum shale legacy site. Siiri Salupere gave a second presentation, now on a nationwide Estonian survey of radon in dwellings. Reference levels were used for dwellings and workplaces, but outright limits applied to kindergartens and schools.

At the end of the day NSFS had its General Meeting which went smoothly in spite of some administrative items like updating of the statutes, and it was decided that the next NSFS conference will take place in Reykjavik in August 2027 with the theme Nordic co-operation, stronger together. Then, there was a successful Young Scientist Mingling followed by a delicious Conference Dinner.

The last day began with a panel debate between senior representatives of STUK, IFE, NND, DSA, and SSM, on competence and challenges in RP. Key issues were certification and training requirements, and recruitment. The panel felt that requirements were clear for hospital and nuclear work, but more complicated in other areas. Recruiting foreign experts was seen as problematic in that candidates may have advanced certifications and great knowledge but do not know local regulations and practices.



Panel debate on competence and challenges in radiation protection

In the ensuing joint session, Justin Brown (DSA) summarised very eruditely the Norwegian involvement in the PREDICT Euratom project of fallout modelling in case of nuclear detonations. In view of the apparent increased threat of tactical nuclear weapons in the Nordic

area, Norwegian authorities focus on enabling decision systems (ARGOS, SNAP, FDMT) to simulate and predict fallout consequences and prepare for mitigation. Using public bomb test data from old Nevada 1.7-44 kton tests yielding 2×10^{19} Bq kton⁻¹, he can test and validate computer modelling of food chain transfer of radionuclides, take account of 'new' detonation-related nuclides, particle weathering and other factors, Radioactive cloud characteristics is an entire science of importance for particle solubility, migration, and uptake. Superimposing published dose distributions on maps, he finds that modelling overpredicts dose rates substantially. Contributory factors to this include uncertainties, and that the actual explosion may change the local meteorology, He concluded that improved preparedness is necessary and that source terms should be 'reduced', permitting faster simulations.

In the final Young scientists and future of RP session, Kevin Cappa (IFE) reviewed their worker contaminations 1998-2024. 21 events were recorded as important with potential for significant doses. Most cases concerned dry contamination, and most were due to lacking or incorrect use of protective gear. For decontamination, the first handwash was important. Then, chemical sanitation methods could be effective but often also irritating. As a last resort, mechanical abrasion with sandpaper can help but causing wounds must be avoided. When further washing does not help, gloves or plastic sheets should be used to avoid cross contamination. Anja Schroff (Univ of Gothenburg) then discussed murine thyroid response to I-131 exposures at low to intermediate doses and the impact of age at exposure on gene expression studied with tandem mass spectrometry of proteins, finding inhibited proliferation in a few individuals. This complicated exercise in molecular genetics also rendered her the Society's Young Scientist Award.

The board of the NSFS had decided to award a price for the best presentation, oral or poster, given by a young scientist defined as below the age of 35. The committee had a hard time evaluation a number of excellent contributions. The diploma was awarded to Anja Schroff for her presentation "Thyroid response to low- to intermediate-dose ¹³¹I exposure: Impact of age at exposure on gene expression".

In conclusion, this was a useful and very pleasant meeting that certainly facilitated networking and reinforced the links between our countries. After a long period of meetings only every four years, this move towards a biennial meeting schedule was a very welcome step towards revitalising an IRPA Society which in spite of great historic traditions has recently been somewhat dormant, The only (minor) criticism that could be raised is that it was a pity that we did not receive the abstracts that had been submitted – this would have been simple with the digital facilities available.



Report from the 20th conference of Nordic Society for Radiation Protection (NSFS)

NSFS, which is an IRPA AS for all Nordic countries: Denmark, Finland, Iceland, Norway and Sweden, held its 20th Conference in August 27-29, 2025 in Scandic Lillehammer Hotel in Norway (the head quarter for the 1994 Winter Olympics). The theme was "Learning by sharing". There were totally 123 participants from 9 countries. The program is available at www.nsfs.org.



The conference was opened by the NSFS President Tore Ramsøy followed by a welcome speech by Kristin Frogg, DSA). Altogether 40 oral presentations and 18 posters related to most aspects of radiation protection were selected.

Invited presentations were given by Einar Dale (Nordic cooperation and clinical trials in proton therapy), Lars Klæboe (Exposure from wireless transmitters – is there cause for concern?), Erlend Andersen (New methods and new tools for measuring dose to personel), Svein Nøvik (Nucleosynthesis - The formation and origin of elements), and Jukka Kupila (Emergency preparedness in SMRs).

The Bo Lindell Lecture was given by Dr. Hanne Waltenburg, Danish Health Authority, Denmark, with the title "From X-rays to AI: 20 years of radiation protection in medicine and beyond", focussing on an overview over the last NSFS conferences dedicated to dosimetry of patients and population.

Dr Hanne Waltenburg received the Bo Lindell award diploma from NSFS President Tore Ramsøy

Jack Valentin gave an interesting talk about his experience of participating in ICRP and the Nordic influences on ICRP, a topic valuable both for present, new and potential NSFS members.



The oral presentations were given under different sessions, e.g. Decommissioning, Emergency preparedness, Accidental exposure & waste management, NORM including radon, Pregnant worker and radiation protection, Environmental radiology and monitoring, Radiation protection in medicine, research and industry, Education, competence and certification of professionals working in radiation protection.

The posters were on display in the conference room during the entire meeting, but were also orally presented during poster walks.

The NSFS board has the last years noticed that the mean age of NSFS members have been increasing during last years. Therefore, we were very happy that many young scientists attended the conference and also gave excellent presentations. Thursday evening, a networking session was dedicated to Young Radiation Professionals, organized by Viktoria Herzner from Austria, who is involved in YGN in IRPA. The Young Scientist Award was given to Anja Schroff from Gothenburg, who gave a presentation entitled Thyroid response to low-to-intermediate-dose ^{131}I exposure. impact of age at exposure on gene expression.



Viktoria Herzner



Anja Schroff

The NSFS General Assembly was held on Thursday afternoon, and included activity, financial and audit reports, updating of the NSFS statutes, and election of a new board. The next hosting country is now Iceland, and Sigurdur Magnusson was elected as new NSFS President.

Tanja Holter, Kari Helland og Karolina Berg held a workshop about "Radiation protection for pregnant workers in healthcare". One panel debate was dedicated to "Competence and challenges in radiation protection", where representatives from regulators, educational institutions and industry participated.

On Wednesday evening we had a very nice trip with Skibladner, which is the oldest paddle steamer in the world still in timetable service during the summer period. It was produced already in 1856, so ca 170 years old. The conference gala dinner was held on Thursday evening, where the entertainer was a memory artist challenging us in many ways.



Lastly, the special issue presenting papers from NSFS Congress 2023 is now published online with open access (Rad Prot Dosim, Vol 201, issues 13-14).

We now look forward to the upcoming NSFS activities and the next congress that is planned to be held in Reykjavik, Iceland in August 2027.

On behalf of the NSFS Board 2023-2025
Eva Forssell-Aronsson

Young Scientist Mingling at the 20th NSFS Conference

At the recent 20th NSFS Conference, held from 27–29 August 2025 in Lillehammer, Norway, a *Young Scientist Mingling* event was organized by the IRPA Young Generation Network (IRPA YGN). The initiative was led by IRPA YGN member Viktoria Herzner, with special thanks to NSFS members Skjalg Are Fagerjord and Tore Ramsøy for their invaluable support.

The NSFS (Nordic Society for Radiation Protection) is a regional scientific association that brings together experts and professionals from five Nordic countries: Norway, Sweden, Denmark, Finland, and Iceland. Its biennial conference is one of the most important scientific events in the region's radiation protection community, providing a platform for sharing knowledge, discussing current developments, and strengthening professional networks.

Within this framework, the Young Scientist Mingling session welcomed 21 early-career participants. After a brief introduction to IRPA, the IRPA YGN, and the Nordic scope of NSFS, the participants engaged in guided “speed networking” rounds in small groups. Carefully prepared conversation starters encouraged lively and personal exchanges, ranging from professional challenges and future research interests to broader reflections on career development. The dynamic atmosphere allowed participants to connect quickly, and these new connections carried on into the conference dinner and even the informal evening gathering.

The feedback was very positive, underlining the importance of creating dedicated spaces for early-career professionals. The session demonstrated how valuable networking opportunities are for the next generation in radiation protection, who represent not only the future of the field but also an essential part of the societies today. Strengthening their involvement is key: by offering visibility, participation, and tailored activities, societies can become more attractive to young members and ensure continuity and innovation in their professional communities.

Looking ahead, the IRPA YGN plans to encourage participants to stay connected through an online follow-up meeting, possibly including a technical presentation and an experience-sharing session with another young generation network. For the next NSFS Conference in Iceland, it has been suggested to expand the concept into a full Young Scientist Mingling evening on the day of arrival, providing even more time and space for early-career networking.



A group photo captured the enthusiastic spirit of the event!

Time	Wednesday 27. August
	Location: Weidemann
10:00-11:00	<i>Nordic Board meeting</i>
11:00-12:00	Registration opens
12:00-13:00	Lunch/check-in
13:00-13:15	Opening Ceremony Moderator: Tore Ramsøy
	Welcome on behalf of NSFS (Tore Ramsøy) Welcome speech (Kristin Frogg, DSA)
13:15-13:45	J1-1 Nuclear preparedness in Norway (Kjetil Longva, DSA)
13:45-14:15	Bo Lindell Prize Award and Talk
14:15-14:30	Coffee break/check-in
14:30-15:00	J1: Joint Sessions Moderator: Naeem UI Syed
	J1-2 Invited talk: Nordic cooperation and clinical trials in proton therapy (Einar Dale)
15:00-15:30	J1-3 Invited talk: Exposure from wireless transmitters – is there cause for concern? (Lars Klæboe, DSA)
15:30-16:00	J1-4 Invited talk: Nucleosynthesis - The formation and origin of elements (Svein Nøvik)
16:00-16:30	J1-5 Participation in and Nordic influences on ICRP (Jack Valentin)
17:30	Transport to Skibladner departs from hotel
18:00-21:00	Skibladner cruise
21:30	Return to hotel

Thursday 28. August	
	Location: Weidemann
	Location: Birkebeiner
L1: Decommissioning Moderator: Rune Oldeide	M1: Emergency preparedness, Accidental exposure & Waste management Moderator: Christian Bernhardsson
08:30- 09:00	L1-1 Sharing the Learnings: International Cooperation in Decommissioning (Jonas Nikolaisen og Ingeborg Mork-Knutsen)
09:00-09:15	L1-2 Enhancing radiological impact assessments to better support reaching a consensus on their sufficiency among stakeholders (Ari Ikonen)
09:15-09:30	L1-3 Removal of the Co-60 sources from the gamma irradiation facility at IFE NUK Kjeller: A pre-decommissioning activity (Maria Due-Hansen)
09:30- 09:45	L1-4 Downblending of Norways Highly Enriched Uranium (Tore Ramsøy)
09:45- 10:00	L1-5 Decommissioning of a RADON-type radioactive waste storage facility in Tammiku, Estonia (Siiri Salupere)
10:00- 10:30	Poster walk and Coffee break
L2: Decommissioning Moderator: Sidse Lærke Lolk	M2: Emergency preparedness & Accidental exposure Moderator: Henrik Öberg
10:30-10:45	L2-1 Depletion and activation analysis of the JEEP-I reactor using SCALE (Tony Skovli)
10:45-11:00	L2-2 A plan for decommissioning of a medical cyclotron vault (Ingunn Løvik)
11:00-11:15	L2-3 Localization and depth determination of radioactive contamination inside a decommissioning NPPs (Viktor Lehmann)
11:15-11:40	L2-4 A Decommissioning plan for a proton therapy facility (Kristin Ramberg)
11:40-12:30	Lunch
L3: NORM including Radon Moderator: Audun Sanderud	M3: Pregnant worker and radiation protection Moderator: Evabeth R. Bruvoll
12:30-13:00	L3-1 Radon Management in the Nordic countries (Ingvild Finne, DSA)
13:00-13:15	L3-2 Enhancing radon testing and mitigation levels in Norway: Insights from social science studies (Yevgeniya Tomkiv)
13:15-13:30	L3-3 Mobility of uranium at an alum shale legacy site in Norway (Mila Pelkonen)
13:30-13:45	L3-4 Estonian nation-wide survey on indoor air radon in dwellings (Siiri Salupere)
13:45-14:00	L3-5 Evaluation of the efficiency of thoron adsorption by three zeolites using alpha and gamma spectrometry (Misbah Javed)
14:00-14:15	Coffee break
L4: Environmental radiology and monitoring Moderator: Marte V. Holmstrand	M4: Radiation Protection in Medicine, Research and Industry Moderator: Ingunn Løvik
14:15-14:30	L4-1 The fate of I-131 when released to the environment through authorized medical discharges in the North of Norway (Justin Gwynn, DSA)
14:30-14:45	L4-2 A quantitative comparison of two software packages used for the analysis of gamma spectroscopy applied to environmental monitoring (Henrik Öberg)
14:45-15:00	L4-3 Investigating the metal distribution in algae used as bioindicators for the environmental monitoring of Swedish nuclear power plants (Guillaume Pedehontaa-Hiaa)
15:00-16:30	NSFS General Assembly
16:30-17:00	Meeting of new nordic board
18:30-19:30	Young Scientist: Mingling
19:30 - 24:00	Conference dinner and social gathering, Scandic Lillehammer Hotel

	Friday 29. August Location: Weidemann
	Education, competence and certification of professionals working in radiation protection Moderator: Ingeborg A. Mork-Knutzen (DSA)
08:30-10:00	<p style="text-align: center;">Panel debate: Competence and challenges in radiation protection</p> <p>Key points for the debate:</p> <ul style="list-style-type: none"> • Certification of radiation protection officer/expert • When is the certification good enough? • What kind of training is good enough? • Recruitment of employees with radiation protection expertise can be a challenge <p>Representatives from regulators, educational institutions and industry are invited to give an introduction and participate in the debate.</p> <p>Participants in the panel:</p> <ul style="list-style-type: none"> • Audun Sanderud, Technical Lead Characterization and Radiation Protection, Norsk nukleær dekommisjonering (NND) • Jukka Liukkonen, Senior physicist PhD, Radiation and Nuclear Safety Authority (STUK) • Paula Nuñez, Group Lead Radiation Protection, Institute for Energy Technology (IFE) • Naeem Ul Syed, Senior Advisor, R&D Section, Norwegian Radiation and Nuclear Safety Authority (DSA) • Klara I. Björk, Senior scientific Secretary, Swedish Radiation Protection Authority (SSM)
10:00-10:30	Coffee break and poster walk
	J2: Joint Sessions Moderator: Eva Forssell-Aronsson
10:30-11:00	J2-1 Norway's involvement in the 'PREDICT' project (Justin Brown, DSA)
	Young Scientist and future of radiation protection
11:00-11:15	J2-3 Review of worker contamination at IFE 1998-2024 (Kevin Cappa)
11:15-11:30	J2-4 Thyroid Response to low-to-intermediate-dose ¹³¹ I exposure. Impact of age at exposure on gene expression (Anja Schroff)
11:30-11:45	Young scientist award
11:45-12:00	Closing ceremony and Presentation of next conference
12:00-13:00	Lunch

Preferred presentation: ORAL

Evaluation of the efficiency of thoron adsorption by three zeolites using alpha and gamma spectrometry

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ABSTRACT

Thoron (^{220}Rn) is a naturally occurring radioactive gas that contributes to indoor radiation exposure. Its mitigation is critical for radiological safety, especially in confined spaces where accumulation may pose health risks. This study evaluates the adsorption efficiency of three zeolites (Chabazite, 4A, 13X) for the removal of thoron from air. The experiments were carried out under controlled conditions, comparing thermally activated zeolites treated in an oven at 350°C for 24 hours with untreated zeolites. Two spectrometric techniques were employed to quantify thoron adsorption. Alpha spectrometry was performed with a silicon detector within an electrostatic collection chamber to detect ^{216}Po decay in the air where zeolites are posed. Gamma spectrometry was used to measure ^{212}Pb activity in the zeolite samples using a High Purity Germanium (HPGe) detector. The results show that Zeolite 13X exhibited the highest adsorption capacity (>70%), especially after thermal activation (>90%), which significantly improved pore accessibility and adsorption efficiency. Zeolite 4A displayed moderate performance (around 45%), while Chabazite had the lowest adsorption capacity (40%). Thermal activation significantly improves the adsorption efficiency in each zeolite. These results of this research, that supports the potential application of zeolites for reducing thoron levels in indoor environments, highlight (i) the importance of thermal pre-treatment in optimizing zeolite performance for thoron adsorption, (ii) the major adsorption efficiency of the oven-treated 13X and (iii) the effective use of alpha and gamma spectrometry for a comprehensive analysis.

Keywords: Zeolites, Thermal Activation, Alpha Spectrometry, Gamma Spectrometry

Preferred presentation: ORAL

Category: Decommissioning

Sharing the Learnings: International Cooperation in Decommissioning

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ABSTRACT

After extensive research in the field of nuclear energy and technology with four research reactors since 1951, the Institute for Energy Technology (IFE) shut down the last two reactors in 2018 and 2019. Norway is transitioning from operation to decommissioning, with the recent transfer of license for the Halden research reactor to Norwegian Nuclear Decommissioning (NND). This transition presents new challenges related to radiation protection and nuclear safety. As the regulatory body, the Norwegian Radiation and Nuclear Safety Authority (DSA) needs to adapt to an ever-developing field of emerging technologies and best available techniques in decommissioning and management of radioactive waste, as well as a rapidly changing international landscape. Norway faces an increased need for competence building both on the operator and the regulatory side. Other countries are facing similar challenges, and sharing experiences and building competence together as part of the international community is key to success. Facing these challenges, and in times of uncertainty in Europe, multilateral cooperation is more important than ever. There is an increased need to engage in partnerships both bilaterally and through international organizations to ensure radiation protection and nuclear safety, by sharing experiences in the field of decommissioning and management of radioactive waste. Recently, the DSA has engaged in several EEA and Norway Grants projects to build capacity to ensure safety, security and enabling sustainability by sharing experiences and involving experts from different countries. One of these projects has been a joint effort on safety enhancement of Ignalina NPP Radioactive Waste Management in Lithuania. With examples from the DSA's work, this presentation aims to showcase "learning by sharing" in decommissioning and waste management, by sharing experiences and showing how international cooperation can build competence for radiation protection and sustainable nuclear decommissioning.

Keywords: Nuclear decommissioning, international cooperation, nuclear safety, radioactive waste management, competence building

Preferred presentation: ORAL

Category: Emergency preparedness

Empowering Radiological Triage with Pocket-Sized Gamma Spectrometry: A Low-Cost Approach Using Untrained Staff

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ABSTRACT

In the critical first moments of a suspected radiological incident—or even amid rumours intentionally spread to cause disruption—rapid situational assessment is essential. Yet deploying trained experts with traditional mobile gamma spectrometers remains logistically difficult and cost-prohibitive. This paper presents a new approach by using next-generation, compact gamma spectrometric detectors based on a GAGG:Ce (Gadolinium Aluminium Gallium Garnet doped with Cerium) crystal. A radiation meter of this type can be bought, costing around €500, that pairs with a smartphone via Bluetooth. The meter fits in a shirt pocket and enables on-site data collection by minimally trained personnel. An integrated app supports real-time visualizations including breadcrumb maps, waterfall plots, dose and count rates, and radiation hardness over time. Users can select data from specific time intervals or GPS-tagged locations to generate spectra, overlaid with time-adjusted background levels. Instant radionuclide identification is enabled by scanning by finger on-screen peaks, which reveal additional expected gamma lines for verification. Raw data as well as assessment results can easily be shared with faraway experts or transferred to the advanced *Interspec* gamma spectrometric software on the phone for further analysis. Field tests demonstrate that this low-cost system can outperform conventional devices in emergency scenarios, supporting discreet and scalable radiation mapping—on foot, by car, or via drone. The paper also details practical sampling methods, including improvised inverted Marinelli setups for food and environmental measurements, significantly easing the burden on central laboratories in the initial mapping phase of an emergency. We present a pilot project validating this approach across diverse scenarios and discuss the next steps in refining field procedures and expanding operational use. By presenting at the NSFS conference, we seek to engage Nordic authorities in collaboration on this innovative and accessible radiological triage framework.

Keywords: Radiological triage, gamma spectrometry, low cost

Title: Lead the Way: Challenges with Implementing New Lead Shielding Recommendations

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Abstract: The implementation of new lead shielding recommendations by the American Association of Physicists in Medicine (AAPM) has presented significant challenges in clinical practice. This implementation review aims to describe our experiences and challenges in implementing AAPM's updated recommendations for lead shielding use. While similar challenges have been reported in other countries, there is a lack of documentation from Norway. Initially, our department extensively used lead shielding for patients and staff. The COVID-19 pandemic highlighted the need to revise this practice due to infection control concerns. In 2020, we discovered AAPM's new guidelines and began the process of changing lead shielding practices, starting with pediatric radiology and expanding to the entire radiology department. We developed new internal guidelines, which have evolved to address various situations and modalities. We translated patient brochures and updated our website to inform patients about these changes. As a result, we have eliminated lead shielding for patients and implemented new internal guidelines based on AAPM's 2019 recommendations. Despite these efforts, discrepancies in practice remain, such as differing advice on lead use in emergency procedures. Furthermore, studies confirm the difficulties in changing ingrained practices despite evidence supporting the discontinuation of patient shielding. After five years, the process is still ongoing in some areas, with certain procedures needing updates and some staff still expressing uncertainty. Research on the challenges of implementing significant new recommendations in radiation protection in Norway would be valuable for comparison. Our five-year implementation period raises questions about the typical duration for such changes and the time required for attitude shifts. This experience highlights the importance of patience, persistence and inter-professional collaborations in navigating the complexities of clinical practice changes.

Keywords: *Lead, shielding, implementation, review, radiology*

Preferred presentation: ORAL

Category: Radioactive waste management

Three Decades of Biosphere Assessments of Final Disposal of Radioactive Waste in Sweden

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ABSTRACT

The Swedish Nuclear Fuel and Waste Management Co. (SKB) has now obtained most of the permits to start building a repository for spent nuclear fuel. This was the result of several safety assessments reviewed by authorities. One important part in the safety assessment is the biosphere where the potential dose to humans and the environment is estimated. The challenge is to make reasonable estimates thousands of years in the future. This presentation will provide an overview of the challenges, achievements, and mistakes over the last three decades of research at SKB regarding the biosphere and surface ecosystem.

Keywords: biosphere, repository, radioecology, dose-assessment

Preferred presentation: Oral

Category: Decommissioning; Radioactive waste management

Localization and depth determination of radioactive contamination inside a decommissioning NPPs

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ABSTRACT

The decommissioning and dismantling of nuclear power plants (NPPs) require extensive radiation measurements to map contamination in concrete structures. Accurate determination of the depth distribution of radionuclides, particularly cobalt-60 (Co-60) and cesium-137 (Cs-137), is essential in the clearance work. The aim of this study was to evaluate methods for this purpose using gamma spectrometry. Calibration measurements were carried out in an external lab using point sources of Co-60 and Cs-137 positioned at varying depths within concrete. The detectors used were a 3"×3" NaI(Tl) scintillation detector and a DetectiveX HpGe detector, both surrounded by 5 cm of lead shielding, with the detectors positioned 60 cm from the concrete surface. The point source measurements were converted to surface sources and subsequently into depth-distributed sources based on possible distributions (uniform- and exponentially decreasing depth distributions, etc.). To determine the contamination depth an exponential calibration curve was fit to the count rate ratio between the high energy Compton photons and full energy photons as a function of mass thickness. Although this approach can determine the point source depth, it does not resolve contamination distributions. A least-squares method was utilized to combine calibration spectra, by minimizing the difference between the combined and measured spectra resulting in a contamination depth distribution. The residuals between the reconstructed and measured spectra provide an estimate of the uncertainty of the calculated distribution. Accurate determination of the depth distribution of radioactive contamination in concrete at NPPs remains a challenging task requiring complex calculations. This work is an important contribution to this process and creates potential for continued studies.

Keywords: decommissioning, gamma spectrometry, contamination depth distribution, radionuclides, concrete contamination, radiation measurements

Preferred presentation: ORAL

Category: Decommissioning

Depletion and activation analysis of the JEEP-I reactor using SCALE

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ABSTRACT

The isotopic contents of structural materials and fuel rods of the JEEP-I reactor have been analysed using simulations in SCALE for radioactive activation products, actinides and fission products which are relevant today, 57 years after reactor shutdown. Actinides have been found as expected, and include $^{232-239}\text{U}$, $^{239-241}\text{Pu}$, ^{241}Am , and ^{234}Th . The most radioactive fission products, found in the fuel rods, are ^{137}Cs , ^{90}Sr and their daughter products $^{137\text{m}}\text{Ba}$ and ^{90}Y , respectively, in addition to ^{147}Pm . The moderator water was found to contain tritium as well as some ^{14}C . Samples have been added in the structural materials. In the concrete ^{41}Ca and ^{14}C were found to be the only long-lived radioisotopes of significance. Europium was expected, as trace amounts exist in regular concrete, but has not been proven. ^{14}C was, as expected, found in the graphite reflector, as was ^{10}Be . In the cadmium shield, $^{113\text{m}}\text{Cd}$ was the only significant long-lived radioisotope found. In the aluminium alloy of the reactor tank and guide tube structure, amounts of ^{55}Fe and ^{60}Co were found. The activity of the proven isotopes at discharge and at present day have been tabulated for the actinide and fission product contents.

Keywords: Decommissioning, Reactor simulations, Neutron physics

Preferred presentation: ORAL**Category: Decommissioning;**

A plan for decommissioning of a medical cyclotron vault
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Hospital, Norway*

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ABSTRACT

The medical cyclotron for PET-isotopes at St. Olavs hospital accelerates protons with energies up until 16.5 MeV to create positron-emitting isotopes. As a biproduct neutrons of high enough energies to activate the materials of the cyclotron vault are produced. Some of the isotopes created by activation in the cyclotron and the cyclotron vault will have very long half-lives and care must be taken with a dismantling of the radiopharmaceutical facility or a change in cyclotron. A special condition in the hospitals radioactive waste licence requires a plan for the decommissioning of the medical cyclotron vault which must be updated every 5 years. The cyclotron vault at St. Olavs hospital is made of heavy concrete and has an inner dimension of 5 x 4.1 x 3 m³. The vault is below ground, with 2.1m thick roof and walls. The floor is 1.3m thick. Four 15 x 15 x 15 cm³ concrete bricks, of the same concrete as the walls, are placed at strategic places inside the vault for analysis of the activation of the concrete during the cyclotron's lifetime. At time of dismantling of the vault analysis of the walls will be necessary. A medical cyclotron has a lifetime of 20-25 years. The cyclotron vault is created such that a replacement of the cyclotron can be performed through the roof without the need of destroying the vault and create radioactive waste. The decommissioning plan of the cyclotron vault lays out the compromise between choice of decay time and amount of radioactive waste taken into consideration the economic consequences and radiation protection aspects of the personnel involved and the public.

Keywords: decommissioning medical cyclotron vault radiopharmaceutical

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Preferred presentation: ORAL

**Category: Environmental radiology and monitoring; or possibly also
Radiation protection in medicine, research and industry**

The fate of I-131 when released to the environment through authorized medical discharges in the North of Norway

Justin P. Gwynn^{1*} and Bredo Møller¹

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ABSTRACT

The University Hospital of Northern Norway (UNN) in Tromsø, Norway has permission for the use and discharge of a range of different radioisotopes for the purposes of radiotherapy and diagnostic radiography. Patients at UNN undergoing thyroid ablation therapy typically receive 3.7 GBq of I-131, but have received higher activities up to 13.2 GBq in the period between 2018 and 2024. UNN does not have any decay tanks for sewage from patients who are isolated when undergoing thyroid ablation therapy, and so all excreted I-131 is processed at a nearby primary wastewater treatment plant (WTP). Sewage arriving at this WTP is only mechanically filtered before being released directly into the marine environment.

Over the course of two studies, we have investigated the fate of the authorized discharges of I-131 in sewage, in the marine environment as well as in the air over Tromsø. I-131 and other medical radioisotopes could be detected in inflowing wastewater as well as filtered solid material and treated wastewater. I-131 has been detected in the brown seaweed *Fucus vesiculosus* up to 10 km from the discharge point, with seaweed closest to the discharge point showing rapid uptake of I-131. I-131 has also been detected on filters from the high-volume air sampling station in Tromsø, when patients underwent I-131 thyroid ablation therapy at UNN. Air sampling at the WTP showed that measurable levels of I-131 can be produced in indoor air in the filtration room. This is likely the source of I-131 detected in the air over Tromsø on these occasions, although other pathways from I-131 discharged to the marine environment cannot be ruled out. This work includes an

assessment of the impact on sewage workers from the authorized discharges of I-131 and discusses the controls on the further atmospheric transport of I-131.

Keywords: medical radioisotopes; I-131; authorized discharges; marine environment; atmospheric transport, dose assessment

Preferred presentation: ORAL

Other topic; (History of NSFS and RP)

Participation in, and Nordic influences on, ICRP

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ABSTRACT

The International Commission on Radiological Protection, ICRP, has since its inception in 1928 been an internationally active and influential body. It is not however in United Nations parlance an ‘international organisation’ (i.e., members are not selected by their governments, do not formally act on behalf of their own countries, and are not necessarily selected to represent fairly the global population). In earlier years, ICRP was sometimes criticised for an excess of Anglo-Saxon participation, and in the Nordic context for an excess of Swedes. Based on his experience as a member and later on employee of ICRP, and extensive contacts with IRPA (the International Radiation Protection Association), IAEA (the International Atomic Energy Agency), WHO (the World Health Organization), OECD/NEA (the Nuclear Energy Agency), CEC (the European Commission), NKS (Nordic Nuclear Safety Research), and NSFS (the Nordic Society for Radiation Protection), the author feels that not only have processes and decision-making changed considerably for the better in recent decades, but also expert judgements and advice from all of the Nordic countries have always influenced ICRP. Due to the small size of the secretariat, random events and fluctuations have affected the hiring of paid staff even more than the selection of volunteer members. Examples of fascinating oddities concerning the author’s, and earlier employees’, participation and appointments will be presented.

Keywords: History, ExeC, RASSC, REMPAN, CRPPH

Preferred presentation: ORAL

Category: Emergency preparedness

Adapted approaches for the control of radioactive contamination in medical emergency situations occurring in a radiologically controlled area at a Nuclear Power Plant

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ABSTRACT

In case of an accident or a severe health issue occurring in a radiologically controlled area in a Nuclear Power Plant (NPP), an adapted approach for the control of radioactive contamination must be conducted. The purpose of this presentation is to compile experiences and present lessons learned from various incidents at Forsmark NPP. Worker safety in a NPP has many similarities with any other industrial working environment. However, the radiological aspect forces certain aspects to be handled in suitable manners, where an adapted approach is necessary in several situations. General risks, such as heart issues, fall accidents, unconsciousness, injuries with heavy bleeding, severe burns, electric shock or inhalation of suffocating gasses may occur and the need for prompt emergency care must not be delayed by the regular contamination control. This investigation includes CAP-reports, interviews with radiation protection (RP) workers, Forsmark NPP local first responders/firefighters, paramedics, the regional hospital ER and Nuclear Medicine Department. In conclusion the collected lessons learned show that RP workers tend to rely on well-known work methodology in stressed situations and, in relation to the medical situation, overwork the RP aspects. The RP worker assisting the paramedics experiences greater psychological safety when prepared with proper training and prior experience. Therefore both co-training with other involved professions as well as the use of appropriate post job debriefing for collection of gained experiences are invaluable.

Keywords: Emergency; Contamination Control; Nuclear Power Plant; Accident; Radiation Protection; Worker Safety

Preferred presentation: ORAL

**Category: Radiation protection in medicine, research and industry;
Decommissioning; Radioactive waste management; Emergency preparedness;**

An AI, and Digital Twin-Inspired Approach to Modern Radiation Protection

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ABSTRACT

Advancements in Building Information Modelling (BIM), robotics, and artificial intelligence (AI) offer transformative opportunities for radiation protection, particularly in the face of increasing expectations for digitalization, automation, and safety optimization. Addressing this challenge, we present a novel integration of these technologies through IFE Nuclear's HADRON concept (Hazard Aware Digitalization and Robotics in Nuclear), with the VRdose software platform as a core component. VRdose is a 3D tool for real-time simulation and decision-support for use in ALARA planning, which enables the users to visualize radiation fields, optimize shielding and task sequences, and generate scenario-specific dose estimates using the point-kernel method. The system can integrate efficiently with BIM systems to access and manage up-to-date facility information and layouts, ensuring context-aware planning. Simultaneously, mobile robots equipped with gamma cameras, other sensors and 3D scanners can autonomously map radiological environments, feeding spatial and radiometric data into VRdose scenarios. Additionally, AI-based tools are being developed to augment VRdose's physics-based modelling, enabling intelligent dose modelling, automated scenario generation, and enhanced input processing through natural language interfaces and data-driven analytics. The combined system supports immersive planning, collaborative briefings and training, real-time response evaluation, and continuous learning across the facility lifecycle from design and operation to decommissioning and emergency preparedness. Our approach demonstrates how radiation protection workflows can evolve beyond conventional planning tools toward integrated, intelligent ecosystems that improve safety, efficiency, and

regulatory compliance. Preliminary applications and demonstrations, including collaborations with national decommissioning and research organizations, show promising results in scenario optimization, stakeholder communication, and adaptive planning capabilities. This work underlines the critical role of multidisciplinary innovation in shaping the future of radiation protection and sets the stage for further development, including integration into digital twin architectures and wider deployment in safety-critical environments.

Keywords: Radiation protection, Building Information Modelling, Robotics, Artificial Intelligence, ALARA planning, digitalization

Keywords: maximum 6 words

Preferred presentation: ORAL

Legal Framework and Practice: Clearance of remediation materials in Austria

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ABSTRACT

On 1 August 2020, Austria introduced a new radiation protection law to align national regulations with European Council Directive 2013/59/Euratom, which modernises and harmonises rules for artificial and naturally occurring sources of radiation. As a result, the regulations for handling naturally occurring radioactive materials (NORM) are now contained in the General Radiation Protection Ordinance 2020. Workplace radon exposure is now regulated under the Radon Protection Ordinance. Austria produces only low- and intermediate-level radioactive waste, mainly from medicine, industry and research. As there are no nuclear power plants in Austria, the country does not produce high-level radioactive waste or spent fuel. A significant part of the radioactive waste comes from the remediation of historically contaminated sites, including decommissioned research facilities with artificial radioactive waste. These remediation projects are closely monitored by the authorities. The Radiation Protection Act 2020 defines the clearance process, while the General Radiation Protection Ordinance 2020 specifies the corresponding clearance levels: unconditional clearance, where materials are released without restrictions; conditional clearance, which requires disposal in incinerators or special landfills; and radioactive waste, which is placed in interim storage, as Austria does not have dedicated disposal facilities for very low-level radioactive waste or NORM. The dose criterion is 0.3 mSv/a for NORM and 10 µSv/a for artificial radionuclides. The presentation outlines the Austrian clearance procedure with case studies. Prior to remediation, the authorities review a site model, a radiological characterisation and an operational plan to ensure compliance with clearance levels. A permit is issued for case-by-case assessment, while a licence provides a broader regulatory framework. During and after remediation, regulators and external experts monitor compliance. If criteria are not met, remediation continues. Effective planning minimises radioactive waste, a key principle monitored by the authorities.

Keywords: Austria, clearance, remediation, decommissioning

Preferred presentation: ORAL

Category: Other topic [cross-cutting several]

Enhancing radiological impact assessments to better support reaching a consensus on their sufficiency among stakeholders

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ABSTRACT

Safety of nuclear facilities is a common concern among the public, which is a challenge particularly for new developments including small modular reactors and radioactive waste disposal. Such concerns may challenge the continued operation, or decommissioning, of existing facilities as well. However, the communication on evidence for safety tends to remain at highly technical levels, which may unduly reduce the general acceptability. Also, some debates seen also at the expert level could had been avoided by framing those issues clearer in their context of safety relevance or societal considerations. This contribution gives an outline how the process of assessing the safety of a nuclear facility to the public and to the environment could be enhanced to more effectively satisfying the information needs of regulators, academia, local inhabitants and other interest groups, in a focused, resource-effective and risk/hazard-proportionate manner. The approach is to identify ways and practical tools to systematically enhance the coherence in presenting the safety arguments towards various audiences while duly acknowledging the unavoidably remaining uncertainties and their significance. This involves I) formulation of an assessment strategy and selection of methods fit for purpose; II) numerical sensitivity and uncertainty analyses; III) qualification of the assessment process itself; and IV) supported statement of reaching sufficient maturity in the assessment context. To keep the extent of the assessment manageable and understandable, a graded approach and multiple iterations often become essential.

Keywords: assessment; risk communication; social licence; acceptability

Preferred presentation: ORAL

Category: Emergency preparedness

Norway's involvement in the 'PREDICT' project

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ABSTRACT

A summary of activities from the Norwegian partners in the project PREDICT (Improvements in atmospheric dispersion modelling and protective action strategies in case of nuclear detonations) will be presented. PREDICT is a collaboration between 13 northern European institutes from 7 countries and is coordinated by Federal Office for Radiation Protection (BfS), Germany. The main focus of the initial part of the project has been on ranking radionuclides that are radiologically important, in terms of their dose contribution from different pathways (ground-shine, inhalation and ingestion), and in determining the characteristics of the radioactive cloud following a nuclear detonation. Norwegian partners have been particularly involved in work related to the latter theme providing input, *inter alia*, on aspects of the cloud dimensions and geometry given a particular detonation yield and upon information concerning the physical-chemical forms and solubility of particles that are deposited in nuclear fallout. A substantial focus has been placed upon the georeferencing and digitising of exposure rate contours published in earlier reports from selected detonations at the Nevada test site, USA. This has allowed preliminary comparisons to be made with the output from the Norwegian atmospheric transport and dispersion model SNAP (Severe Nuclear Accident Programme) adapted for nuclear explosions and drawing upon historical weather information (i.e., ERA5 is the fifth generation ECMWF atmospheric reanalysis of the global climate).

Keywords: nuclear detonations, emergency preparedness, radionuclide transfer

Preferred presentation: ORAL

Recommendations for Medical Follow-up for Thyroid Effects after a Radionuclear Event

Joachim N Nilsson^{1*}, Daniel Thor¹, Karin Lindberg¹, Marita Lagerström Lindberg¹, Leif Stenke¹, Jack Valentin¹ and Christel Hedman¹

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ABSTRACT

Following an emission of large amounts of radioactive iodines, most likely after a major nuclear power plant accident, individuals may receive high thyroid absorbed doses. This can cause acute thyroid effects, predominantly hypothyroidism, but also thyroiditis and hyperthyroidism. An increase in the risk of subsequent thyroid cancer in substantially exposed younger individuals is expected. This work aimed at giving actionable recommendations on medical follow-up, specifically for which individuals, which methods, which part of the health care system and for how long follow-up should be advised. The work draws upon international guidelines, such as the International Atomic Energy Agency General Safety Requirements Part 7 (from 2015) and the International Agency for Research on Cancer (from 2018). A review of more recent literature was performed. The work furthermore included a cost-benefit analysis of follow-up for thyroid cancer. The recommendations were adapted for Swedish conditions, with consideration for thyroid cancer prognosis, clinical management of hypothyroidism, structure of the health care system and general trust in the health care system and government agencies. The recommendations include an age and dose differentiated scheme for acute effects, from 4 Gy in foetuses and children and 10 Gy in adults. After weighing the costs, risks of overdiagnosis and associated negative effects, the recommendations discourage any follow-up for thyroid cancer. Follow-up for thyroid cancer is discouraged regardless of absorbed dose to the thyroid. In this regard, the recommendations contrast with actions conducted in Japan after the major release of radioiodines during the Fukushima nuclear power plant accident in 2011.

Keywords: radionuclear event, radioiodine, thyroid cancer, hypothyroidism, medical follow-up

The abstract should be written in a single paragraph, without subheadings, tables, figures or references. It should be a summary of your presentation that states the problem, the objectives, the methods used, and the major results and conclusions. It should be single-spaced in 12-point Times New Roman. Use only the SI units (e.g. Bq, Gy, Sv, kg m⁻³). Use a zero before decimal points such as “0.45” not “.45” The first part of your abstract should state the problem or issue you set out to solve and explain your motivation for pursuing the research. Your abstract should also describe the research methods, the results or outcomes of the work you have done so far. The abstracts will be peer-reviewed by the scientific committee of the conference. Authors will be informed about acceptance for oral or poster presentation via email.

The word limitation for the abstract (300 words) must fit into one page. The abstract should be submitted in the format of MS Word (.doc or .docx) document by e-mailing secretary@nsfs.org .

Preferred presentation: ORAL

Category: Dosimetry/ Worker contamination

Review of worker contamination at IFE 1998-2024

Kevin Cappa^{1*} and Paula Nunez¹

¹*Radiation Protection and Physics Department, Institute for Energy Technology, Norway*

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ABSTRACT

The main objective of this work is to create a cohesive database of all the workers' contamination events at the Institute for Energy Technology from 1998 to 2024, that have been significant and registered as standalone reports. This has been done in order to compile a guideline on worker's safety when handling radioactive material, learn from past contamination mistakes and provide a best practice rule of thumb for decontamination. This work also illustrates the difference between dry and wet contamination to show that the latter form of contamination persists longer on the skin surface after decontamination and will in most cases not result in further contamination of objects in contact with the contaminated skin region. This project resulted in a review paper of the aforementioned contamination events with proper decontamination techniques and an excel file database of all the registered contamination events comprising contamination causes and received doses. This document is mainly for use by the Department of Radiation Protection at IFE NUKK and as a pedagogical resource for educational purposes.

Keywords: Contamination, Decontamination, Radiation Protection, Dosimetry.

Preferred presentation: ORAL

A national model for thyroid measurements in Sweden, following a nuclear power plant accident

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ABSTRACT

In case of a release of radionuclides from an accident at a nuclear power plant, there will be a need to perform thyroid measurements on individuals possibly internally contaminated through inhalation of radioactive iodine. In Sweden, the health care providing regions are assumed to perform these measurements, although no formal decision about this can be found. The Västra Götaland region (health care region) therefore initiated a project to determine, on a national level: 1) if the regions are responsible for making the measurements, 2) the estimated absorbed dose to the thyroid that can justify measurements and follow-up, 3) the number of affected individuals that might be subject to measurements, 4) method to be applied for measurements 5) methods for follow-up of individuals and 6) a strategy for long-term management of the method developed within the project. The project involves representatives from the regions with nuclear power plants; Halland, Uppsala and Kalmar regions, two neighboring regions Västra Götaland and Skåne, the National Board of Health and Welfare, the Swedish Radiation Safety Authority and the University of Gothenburg (Center for Disaster Medicine and Medical radiation sciences). The aim is to increase the ability among the regions to perform thyroid measurements and have a system of follow-up of individuals, with the goal to have a national model that can be applied in emergency preparedness.

The project is ongoing. Results at the time of conference will be presented and dialogue is wanted.

Keywords: thyroid measurements, emergency preparedness, regional responsibility

Preferred presentation: ORAL Category: Non-ionizing radiation

Assessing the Carcinogenic Risks of Extremely Low Frequency Magnetic Fields: Cohort Studies on Residential Exposure and Cancer Incidence

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ABSTRACT

Extremely low frequency (ELF) magnetic fields (MF) have garnered attention for their potential carcinogenic effects. Epidemiological studies indicate varying associations between residential ELF MF exposure and some forms of cancer, particularly childhood leukemia but also adult hematological malignancies and brain tumors. In this synthesis we review findings from cohort studies involving individuals living adjacent to indoor transformer stations, with a focus on adult hematological malignancies and brain tumors as well as skin cancers and all adult cancers. Notably, while the hazard ratios for most hematological neoplasms decreased with prolonged exposure, an elevated risk was observed specifically for acute lymphocytic leukemia (ALL) linked to childhood exposure. Comparable findings were noted in skin cancers, with an increased incidence for adult melanoma in those exposed during childhood. Further investigation revealed an increase in the risk for digestive organ cancers, including gallbladder cancer, within the ELF MF-exposed cohort. However, overall cancer risk remained unchanged. These results underscore the complexity surrounding the health implications of ELF MF exposure, suggesting that while childhood exposure may pose specific risks—particularly for ALL—overall adult cancer risk remains predominantly unaffected by general residential ELF MF levels. Future research should aim to refine exposure assessment methodologies and further elucidate the mechanisms through which ELF MFs may influence carcinogenesis, thereby addressing the existing gaps and

confounding factors that blur current understanding. This body of work is essential to accurately assess the potential health risks associated with ELF magnetic fields.

Keywords: Residential ELF MF exposure, Hematological malignancies, Brain tumors, Skin cancers, Digestive organ cancers

Preferred presentation: ORAL

Category: New challenges in radiation protection; Decommissioning; Environmental radiology and monitoring;

A Decommissioning plan for a proton therapy facility

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ABSTRACT

In 2025, two proton therapy facilities, at the Radium Hospital in Oslo and at Haukeland University Hospital in Bergen, will commence with proton therapy treatment. The facilities are equipped with identical proton therapy systems, the facility in Bergen has one room for treatment and one room for research. The proton accelerator is an isochronous, superconducting cyclotron. In order to vary the treatment depth in the patient, an energy modulation system is used that makes use of wedges of material that can rapidly be shifted into the beamline during irradiation, enabling interactions between the traversing protons and the wedge material and, thus, induce interactions that vary (reduces) the energy of the protons. In these interactions, neutrons will be produced with energies varying from the initial proton beam energy and downwards. The field of secondary neutrons primarily originating from the energy modulation system, called a degrader system, dictates the dimensions of the shielding surrounding the cyclotron and the degrader. Since the energy of the protons leaving the cyclotron and entering the degrader is around 221 MeV, the concrete shielding surrounding this area is several meters thick, in all directions. During a normal year at the facility in Bergen, the accelerator and degrader will be in operation around 1400 hours, producing high energy neutrons that, in turn, will induce interactions in the concrete, and in the rebar (steel) inside this. The bunker structure will through secondary neutron irradiation contain radioactive isotopes. A decommissioning plan has been made that will enable an orderly caretaking of the activated parts of the cyclotron bunker structure. The decommission plan has been an integral part of the planning and construction of the facilities both in Oslo and Bergen. The presentation will aim at presenting the decommissioning plan for the proton therapy facility at Haukeland University Hospital.

Keywords: Decommissioning plan, proton therapy, neutron irradiation.

Preferred presentation: ORAL
Category: Environmental radiology and monitoring

Mobility of uranium at an alum shale legacy site in Norway

Mila Kristiina **Pelkonen**^{1*}, Estela **Reinoso-Maset**¹, Gareth T.W. **Law**², Ole Christian **Lind**¹, and
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ABSTRACT

Construction and mining in areas rich in alum shale can generate large volumes of acid-forming rock debris. If not properly disposed, this waste rock can produce acidic rock drainage (ARD) when in contact with air and water, which may trigger the mobilization of potentially hazardous elements into the surrounding ecosystem. Leached-out elements can be immobilized in the receiving environment by newly formed secondary minerals (e.g., iron (Fe) oxides and oxyhydroxides), clay minerals, or organic matter. However, a change in geochemical conditions can induce desorption, oxidation, or solid phase dissolution, potentially leading to remobilization. The Taraldrud site is an alum shale legacy site located in southeast Norway, where the disposal of acid-forming alum shale waste rock has led to high enrichment of uranium (U) in the local aquatic and terrestrial environments. Our initial study showed that U is retained by amorphous Fe phases (formed after oxidation of native Fe sulphate phases in alum shale) and transiently stored under the prevailing environmental conditions. Thus, the aim of the current work was to investigate the mobility of U from impacted soils and sediments by studying the solid phase association and long-term stability of U and newly formed Fe phases. Sequential chemical extractions were applied to determine the solid phase association and exchangeability of U under both oxic and anoxic conditions, while flow-through column leaching experiments with different synthetic surface waters were carried out to assess the release and long-term fate of U under environmental and remediation scenarios. These results will help to understand the mechanisms governing U release and retention at the Taraldrud site but also at environments affected by shale-related ARD runoffs, as well as being of interest for remediation and management of sites where the transport of U into water bodies may pose environmental risks, i.e., nuclear fuel cycle operations.

Keywords: alum shale, NORM, uranium, ARD

Preferred presentation: ORAL

Category: Radiation protection in medicine, research and industry

Shaping the future for improved quality and safety in the medical use of ionizing radiation: PrISMA, a preparatory Joint Action

Trude Dahl **Jørgensen**^{1*}, Eva Godske **Friberg**¹, Tricia **Larose**², Hanne **Waltenburg**³, Anja **Almén**⁴, Anna **Sundlöf**⁵, Ritva **Bly**⁶, Hanna-Mari **Jauhonen**⁷

¹*Radiation Safety and Security Department, Norwegian Radiation and Nuclear Safety Authority, Norway*

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ABSTRACT

Medical use of ionizing radiation is crucial for modern healthcare, significantly enhancing diagnostic and therapeutic capabilities. However, the increasing utilization of ionizing radiation raises concerns about potential harmful effects. To address these issues, the European Commission has launched PrISMA, a preparatory Joint Action (JA) under the SAMIRA Action Plan. This JA is supporting EUs Beating Cancer Plan and is co-funded through the EU4Health program. The main outcome of this JA is a proposal for a future JA with the aim on improving quality and safety in medical use of ionizing radiation. There are 18 partners in the consortium, representing 12

European countries. During the project period, lasting 18 months, relevant stakeholders in the area of medical ionizing radiation application will be mapped. So far over 400 relevant stakeholders in 33 potentially eligible countries are identified. The stakeholders are among others: radiation protection authorities, health authorities, medical product agencies, hospitals and professional societies. Shaping the content of the future JA, 11 projects have been developed. These projects cover topics like justification, optimization, DRLs, clinical audits and incident learning systems, all of them focusing on facilitating better implementation of radiation protection requirements at European and national levels. The content of the future JA was further developed through a multi-stakeholder workshop in April 2025, gathering over 150 participants from 24 European countries. In the longer perspective, a successful implementation of the future SAMIRA JA will contribute to high-quality healthcare services and increased safety in use of ionizing radiation for diagnostic and therapeutic purposes.

Keywords: patient safety, quality, Joint Action, EU4Health, SAMIRA, radiation protection

Preferred presentation: ORAL

Category: NORM including Radon

Radon management in the Nordic countries

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ABSTRACT

In 2018, the Nordic radiation protection authorities established a working group, Nordic-Nat, with focus on Natural Ionizing Radiation. The aim of the group is to identify common topics of interest for further work at the Nordic level, and to develop relevant projects, documents and statements. In 2024 the group published a report giving the overview of national radon exposure and the authorities' management and regulation of radon. The report provides, among other things, an overview of national average radon activity concentrations in air and water, national reference levels and limit values, comparison of measurement protocols and preventive measures in new buildings. The report will be presented, including any changes since publication, and hopefully provide the listener with a clear picture of similarities and differences in radon management in the Nordic countries.

Keywords: Radon, exposure, reference level, management, regulations

Preferred presentation: ORAL

Estonian nation-wide survey on indoor air radon in dwellings

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ABSTRACT

Radon risk areas in Estonia are currently determined based on radon measurements in soil air. According to current estimations, 48 of Estonia's 79 municipalities are classified as elevated radon risk areas. To get a better overview of the indoor air radon levels, the Estonian Ministry of Climate initiated a nation-wide survey of indoor air radon in dwellings. The survey is carried out in 2022 and 2024-2025 by the Institute of Physics, University of Tartu. The project includes development of a survey methodology, recruitment of participants and measurement of the indoor air radon concentration using 3000 solid-state nuclear track detectors. One third of the detectors were provided to Estonia by the International Atomic Energy Agency as technical assistance. Two-month long measurements are conducted during the heating season (from November to April) with two detectors per one dwelling. The participants, covering all municipalities of Estonia, were chosen on a volunteer basis. Laboratory analysis of the detectors is performed by the Climate and Radiation Department of the Estonian Environmental Board in accordance with accredited analysis procedure based on ISO standard 11665-4. The presentation will give an overview of the survey: the methodology, the return rate of the detectors, and the measurement results, that will be revealed by summer 2025.

Keywords: Radon survey, indoor air quality, dwellings

Preferred presentation: ORAL

Decommissioning of a RADON-type radioactive waste storage facility in Tammiku, Estonia

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ABSTRACT

The Tammiku site is a soviet-era legacy site in Estonia, approx. 18 km from the capital Tallinn. The radioactive waste storage facility in Tammiku was used to store low- and intermediate-level radioactive waste from medicine, industry and research in the period 1963-1995. Since 1995, AS ALARA is responsible for the site. Decommissioning of the Tammiku facility begun in 2001. At the beginning of decommissioning works, the inventory was estimated to be 97 tons of solid radioactive waste with a total activity of $7 \cdot 10^{13}$ Bq. Decommissioning of the facility has been performed in multiple stages over more than two decades. After removal of the radioactive waste, radiological characterization of the facility was performed. The next stage involved decontamination of the facility. The final stage focuses on clearance of the facility and the site. The most problematic radionuclides turned out to be Ra-226, Cs-137, C-14, and Sr-90. By 2024, concrete of the facility has been removed from the site. In spring 2025, final measurements of the territory (0.12 hectares) will be performed by mapping the area with a dose rate meter. At locations with highest dose rate, additional measurements will be performed with surface contamination monitor and in situ gamma spectrometer. Finally, soil samples will be taken for laboratory analysis. The results will be compared with monitoring results from nearby reference areas. The presentation will give an overview of the decommissioning process, and the measurements performed on the territory in spring 2025.

Keywords: decommissioning, clearance of legacy site

Preferred presentation: ORAL

Category: Decommissioning/Radioactive waste management

Downblending of Norways HEU(Th) material

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ABSTRACT

Institute for Energy Technology (IFE) is currently storing highly enriched uranium (HEU) materials. Norway is thus a country that is in possession of HEU, a weapons-usable material. The material is mixed with natural thorium (90%) and may therefore not be downblended to low enriched uranium (LEU) to make it suitable for use in commercial nuclear fuel. A Memorandum of Understanding between the Norwegian government and the U.S. Department of Energy (USDOE) was signed in 2021 with the purpose of downblending and consolidate all of Norway's HEU material. A technological solution, Mobile Melt-Consolidate (MMC) has been developed by USDOE at the Savannah River site. Downblending is achieved by adding depleted uranium and stainless steel in the melt process. The product from the MMC is an ingot consisting of approximately 90% steel with LEU and thorium well mixed in the matrix. The ingots, 30 in total, will be suitable for long term storage and disposal in the planned repository for high level waste. The MMC shall be shipped to Norway when the necessary licenses and permits are in place. The paper will present the radiation protection issues connected to the downblending process. This includes calculation of external dose rate and doses from releases to the atmosphere in normal operation, including anticipated operational occurrences.

Keywords: HEU, downblending, MMC

Preferred presentation: ORAL

Category: Environmental radiology and monitoring

Investigating the metal distribution in algae used as bioindicators

for the environmental monitoring of Swedish nuclear power plants

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ABSTRACT

Coastal algae such as *Fucus serratus* (toothed wrack) and *F. vesiculosus* (bladderwrack) are an essential part of the environmental monitoring program of Swedish nuclear power plants (NPPs) thanks to their ability to efficiently absorb waterborne radionuclides and heavy metals. However, the mechanisms of uptake and retention of radionuclides and heavy metals by *Fucus* spp. are not fully understood and there is a lack of knowledge regarding the actual elemental distribution in the plants. Heterogeneous distributions of radionuclides and heavy metals in the algae can affect the results of radiological monitoring if not taken into account. In this work, *Fucus* spp. samples were collected at different times and at various distances from the discharge point of the cooling water of the Ringhals NPP (Sweden). Gamma spectroscopy, X-ray fluorescence (XRF) and inductively coupled plasma mass spectrometry (ICP-MS) measurements were performed on segmented algae samples to determine the differences in radionuclide and heavy-metal concentrations, between the blade (leaf equivalent) and the stipe (stem equivalent). These methods were then complemented with imaging techniques to assess the distribution of elements at the tissue-scale. Elemental maps in *Fucus* spp. were obtained by micro-XRF, laser ablation ICP-MS and micro particle-induced X-

ray emission (micro-PIXE). Results confirm the heterogeneous distribution of heavy metals in the plants and highlight the influence of the dilution of the source term on the elemental distribution.

Keywords: environmental monitoring, imaging techniques, bioindicators, nuclear power plants,

Preferred presentation: ORAL

Category: Radiation protection in medicine, research and industry

Thyroid response to low- to intermediate-dose ^{131}I exposure: Impact of age at exposure on gene expression

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ABSTRACT

After a nuclear emergency, ^{131}I is a radionuclide of concern, due to its characteristic tendency to accumulate in the thyroid. Epidemiological studies following the Chernobyl accident revealed an increase in thyroid cancer among children exposed by ^{131}I fallout, but not in adults, indicating that age at exposure strongly influences the thyroid's sensitivity to ^{131}I . Although numerous studies have tried to identify the drivers behind ^{131}I -induced carcinogenesis, our understanding of the radiobiological mechanisms behind this age-related difference remains limited. To determine how age at exposure influences gene expression after low- to intermediate-dose ^{131}I exposure, rats were intravenously injected with 0, 0.5, 5, 50 or 500 kBq of ^{131}I either during childhood or adulthood. Thyroid tissue was collected 12 months post-exposure, RNA was extracted, and RNA sequencing was performed to determine differentially expressed genes (DEGs) and enriched biological processes. Based on a previously conducted dosimetry study, the absorbed dose to the thyroid was estimated to be 0.012, 0.12, 1.2, and 12 Gy for adult rats and 0.028, 0.28, 2.8, and 28Gy for young rats. Differential expression analysis revealed a pronounced age-dependent response, with over 1000 DEGs in young rats, compared to only 31 in adults. Eight genes (*Bmp2*, *Btbd3*, *Clstn2*, *Hgf*, *Itk*, *Klhdc7a*, *Lhx3*, *Pla2g4a*) were consistently upregulated in young rats, while for adult rats, only two genes (*Herpud1*, *Hspa5*) were consistently downregulated at three of four doses. Enrichment analysis identified age-specific biological processes, including metabolic and mitochondrial stress in young rats and unfolded protein response pathways in adults. These findings highlight age at exposure as a crucial determinant of the long-term response in the thyroid following low- to intermediate-dose ^{131}I exposure, whereby young rats demonstrated a more pronounced response. Ongoing analyses, including DNA methylation, will provide further insight into the radiobiological response and regulation of the thyroid following ^{131}I exposure.

Keywords: iodine, transcriptomics, RNA sequencing, in vivo, rat, radiobiology

Preferred presentation: ORAL

Category: Emergency preparedness

Revisiting nuclear testing fall-out data strengthening today's emergency preparedness and response

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ABSTRACT

The geopolitical situation has led to an increased likelihood—whether intentional or unintentional—of the detonation of nuclear weapons, compared to what we have seen in recent times. Several countries are now preparing their emergency response capabilities for the possibility of a nuclear detonation, either over their own territory or in a nearby region.

To best tailor emergency preparedness measures, simulations must be conducted related to detonation height above ground and the yield of the weapon itself. Data and experience from previous nuclear tests, both near the ground and higher in the atmosphere, provide valuable insight into which radionuclides are likely to dominate and how the population can be best protected.

Although much information has been classified, more detailed descriptions do exist in open sources regarding local and regional fallout from nuclear tests, including inventories of radionuclides and weapon yields. This work summarizes data available in the open literature. Expected yields are discussed in the context of possible countermeasures to reduce radiation doses to exposed populations. Historical data serve as a crucial tool in assessing protective actions for the public. Our analysis shows that immediate implementation of certain measures can have a significant impact. Well-developed evacuation plans will also be of critical importance.

Keywords: nuclear weapons, near ground detonations, protecting population, short-lived radionuclides

Preferred presentation: ORAL

Category: Nuclear energy in a new area

Update on the current debate on nuclear energy in Norway

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ABSTRACT

At the same time as many countries in Europe are experiencing increasing energy consumption, efforts are being made to reduce CO₂ emissions. Across the continent, there is a large-scale expansion of renewable, green energy production, primarily through solar and wind power. Norway has traditionally had a strong energy supply through hydropower, but most of the country's waterfalls and rivers have now been utilized. Several wind farms have been built—onshore—and this has faced significant opposition from the public.

While the Norwegian population firmly rejected nuclear power throughout the 1970s, public opinion has since shifted. Many more people are now in favor of nuclear energy than before. Norsk Kjernekraft AS is a small company that promotes small modular reactors (SMRs) and has been active at the governmental level, engaging with ministries, relevant authorities and municipalities. As of today, around 60 municipalities have expressed support and are open to hosting SMRs within their local areas.

This paper examines the political processes that must be completed before Norway can become a nuclear power nation. We also discuss whether the current Norwegian regulatory framework is adapted to nuclear energy production, and whether Norwegian society is ready to begin developing nuclear power.

Keywords: SMR non-nuclear country, energy mix

ORAL**Engaging with the public through citizen science using individual
dosemeters of household salt**Christian **Bernhardsson***Medical Radiation Physics, Department of Translational Medicine, Lund University*

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ABSTRACT

During and after unintentional exposure to ionising radiation, individual dose assessments are key. Existing retrospective dosimetry methods are important but associated with large uncertainties. As previously suggested, ordinary household salt (NaCl) is a candidate for retrospective dose estimations due to its excellent dosimetric properties when read by optically stimulated luminescence. However, using salt from a households' kitchen to estimate exposure to residents is also uncertain, although helpful in the overall retrospective dose assessment. Therefore, we suggest to use a prospective approach to more accurately determine individual radiation doses in connection with unintentional exposures *e.g.* a radiological contamination in connection with a nuclear power plant accident. In a PIANOFORTE funded project "Resilience to RADiological Events in Wartime" we aim at investigate methods for informing the public to prepare individual dosimeter kits based on NaCl, a system for collecting, reading, analysing and reporting the results back to each household. This approach will offer all that are concerned and interested in their individual dose to take part in their own measurements and protection. A case study will be conducted in Ukraine during the summer 2025, where participants in selected regions of Ukraine will be interviewed about their attitude to the suggested dose assessment methodology. The participants will also test the instructions on how to prepare a NaCl dosimeter kit at home, that will be evaluated afterwards. This new approach for individualised mass-dosimetry in radiological emergencies will be presented together with reflections on citizen science related to "affordable" radiation protection instruments currently expanding on the market.

Keywords: citizen science, NaCl, OSL, PIANOFORTE, emergency preparedness

Preferred presentation: ORAL

Category: Decommissioning, Radiation protection in medicine, research and industry

Removal of the Co-60 sources from the gamma irradiation facility at IFE

NUK Kjeller: A pre-decommissioning activity

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ABSTRACT

The gamma irradiation facility located in the basement underneath the JEEP I reactor at Kjeller, associated with Norway's first research reactor (JEEP I), was operational from 1970 to 2019.

The facility played a significant role in both research and service-related tasks. Though not a nuclear installation, this bespoke, non-conventional facility presents unique challenges and valuable learning opportunities, particularly in preparation for decommissioning.

Following its shutdown in 2019, various disposal options were considered. The most feasible solutions were either returning the sources to the producer or interim on-site storage until a national repository is established. The former option was quickly deemed unfeasible, requiring us to handle the disposal at a national level. The facility is now slated for decommissioning, necessitating the removal of its sources – a task not undertaken since 1998. Moreover, a complete removal has never been performed before.

This operation requires specialized and custom-made equipment and methodologies, addressing radiation protection challenges and necessitating precise calculations and carefully planned measures.

We will outline the history of Norway's first and only gamma irradiation facility, along with the plan for source removal, including relevant radiation protection measures and evaluations.

Keywords: Gamma irradiation, Co-60, Decommissioning, Radiation protection

Preferred presentation: ORAL

Category: Environmental radiology and monitoring

**A quantitative comparison of two software packages used for the
analysis of gamma spectroscopy applied to environmental
monitoring**

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ABSTRACT

This study aims to compare the performance of two different software packages, GREINA and GammaVision, in analyzing spectra obtained from gamma spectroscopy measurements applied to environmental monitoring. While GREINA is an in-house developed package, GammaVision is a commercial software commonly used application for high- and low-resolution gamma spectrometer systems. GREINA was employed by the Icelandic Radiation Safety Authority (IRSA) for all gamma spectrum analysis applications from the beginning of its environmental monitoring program until 2020, when GammaVision became the main tool for this purpose. The reason for the change was mainly due to GammaVision's ability to better handle variations in complexity of the system subject to measurements. At present, GREINA is merely used for radionuclide concentration determination in sea water samples, and work is ongoing to switch to GammaVision also for this application.

The present study focuses on assessing the tools' performance with respect to quantification of radionuclide concentrations in a large array of environmental samples, including meat, milk and milk powder. This is done by statistical analysis of obtained result parameters from the respective software, and associated difference. The quantitative difference in Cs-137 activity in the samples, as well as computed FWHM, is assessed and presented. The results from the statistical analysis are used for benchmarking in the IRSA measurement routines and will also contribute to the authority's optimization of radionuclide activity concentration determination in environmental samples.

Keywords: Gamma spectroscopy, environmental monitoring, statistical analysis

Preferred presentation: ORAL

Category: NORM including Radon

**Enhancing radon testing and mitigation levels in Norway: insights
from social science studies**

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ABSTRACT

Radon is a known public health issue contributing to over 21,000 annual lung cancer cases in EU member states. Norway ranks among the countries with the highest indoor radon concentrations worldwide. Approximately 160,000 of Norwegian households have indoor radon levels exceeding 200 Bq/m³, a threshold recommended for remediation. Despite this, only 21% of the population in Norway have measured radon in private homes and the rates of remediation, while unknown, are likely even lower. Therefore, enhancing radon measurement and remediation rates is crucial. This presentation will share findings from two research studies conducted in Norway as part of the EU RadoNorm project, focusing on these challenges. The first study is a citizen science pilot project that explored the potential of citizen science approach to increase rates of radon measurement and remediation. Conducted in the Gjøvik municipality - one of the radon priority areas – the project involved local authorities and local intermunicipal public service company (Miljørettetthelsevern IKS). We employed ‘extreme citizen science’ approach, allowing our participants, or citizen scientists, to define the project’s focus and their level of involvement. Citizen scientists participated in the workshop addressing barriers to remediation, initiated a radon measurement campaign, co-developed a remediation guide, and co-organised an open meeting. The second study involved a public opinion survey with a representative sample of the Norwegian population (N=1263). This survey included questions and scales specifically designed to assess a broad range of theory-based socio-psychological concepts influencing individual behaviour. The results of both studies lay groundwork for improved radon mitigation interventions and more effective communication strategies.

This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 900009 as well as the Research Council of Norway, grant nr 313072.

Keywords: radon, citizen science, survey, remediation, communication

Preferred presentation: POSTER**The Goiânia accident, Brazil 1987 – Glowing dust caused a tragedy**

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Abstract

During the Goiânia accident, poverty, ignorance, fascination for pretty things and human curiosity led to half a cup of stardust causing four deaths, multiple amputations, 28 burns, 125 000 investigations and the discrediting of both residents and products of a major city. Goiânia is the provincial capital of Goiás in the central-west region of Brazil. In 1971, a cancer clinic opened near the airport. Fourteen years later, the cancer clinic moved to new premises, the same year there was a change of ownership. The newer cobalt-60 teletherapy machine was brought along, while the technologically outdated cesium-137 unit was left behind due to disputes over ownership. The building was partially demolished, and in 1987 became a target of a break-in by two scavengers who were looking for scrap metal. The source of the radiation, the luminescent blue cesium-137 powder, were admired by family and friends of a junkyard owner, and was used for play and to smear on themselves like carnival glitter. The powder eventually spread over large parts of the city and other parts of the country, and led to a major clean-up operation. Large quantities of material and waste were collected and first temporarily stored. The clean-up took 11 weeks, and in 1997 the waste was permanently stored in two specially built storage piles at a new facility. After the incident, an interest organization was set up for the victims, who have suffered injuries, illness and death in the time since. Even before the incident took place, a court case regarding the ownership of the radiation treatment device was ongoing. There were several court settlements in the years that followed. The presentation contains an updated, detailed and clear description of the incident, including a description of waste treatment and crisis management, from which useful experience can be gained.

Key words: Radioactive contamination, Prussian blue, Emergency preparedness, Brazil, Teletherapy unit, Cesium-137.

Preferred presentation: POSTER

Category: Radioactive waste management; NORM including Radon

Safety Assessment of Near-Surface Disposal of NORM Waste at Søve, Norway

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ABSTRACT

A safety assessment is being produced to evaluate the radiological safety of a proposed near-surface repository for naturally occurring radioactive material (NORM) waste at Søve, Norway. The waste consists of thorium- and uranium-containing slag, contaminated soil from historical mineral processing, and slag fragments dispersed in a former tailings area. These materials are remnants from niobium production in the 1950s–60s and are currently located on-site. The repository concept is based on a reinforced concrete sarcophagus, supported by engineered barriers such as epoxy coatings and external geomembranes. The safety assessment follows a structured methodology including definition of assessment context, system description, dose consequence evaluation, and argumentation for radiological safety. The safety assessment includes both the operational phase and the post-closure period. The assessment for the operational phase includes dose calculations for workers performing tasks such as excavation, transport, manual handling, and disposal of the waste. Both normal operations and anticipated operational occurrences, such as equipment failure, are addressed. For the post-closure period, a set of scenarios is identified based on analysing system features, events, and processes (FEP). Results will be presented for all expected radiation doses—both occupational during operations and public/environmental post-closure—and compared to regulatory constraints. The robustness of the barrier system and the conservative assumptions in dose modelling support the conclusion that the repository will provide sufficient containment and isolation of the NORM waste, ensuring long-term protection of human health and the environment.

Preferred presentation: POSTER

Category: Radiation protection in medicine, research and industry

Simulation of stable iodide-induced thyroid blocking in radioiodine biokinetics: extension of the ICRP biokinetic model

Martin Andersson^{1*}, Eva Forssell-Aronsson^{1,2}and³ Sören Mattsson³

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ABSTRACT

Radioiodine-labelled radiopharmaceuticals are frequently used in diagnostic nuclear medicine. To minimize radiation dose to the thyroid gland, it is essential to block thyroidal uptake of free radioiodine released through the catabolism of these compounds. This is typically achieved via oral administration of inorganic iodide. The biokinetic model developed by the International Commission on Radiological Protection (ICRP) describes the systemic behaviour of iodine following internal administration but does not account for the blocking effect of stable iodide on thyroid uptake. To model this effect, the ICRP framework was extended into two parallel systemic models: one for stable iodide and one for radioactive iodine. The original ICRP model includes 30 compartments and 48 transfer coefficients governing iodine kinetics in the human body. Stable iodine intake was modelled as a daily baseline dose of 160 μg , with additional doses introduced to simulate blocking. It was assumed that 8.35 mg of stable iodine in the thyroid completely blocks further iodine uptake. To incorporate dynamic blocking, the ICRP thyroid transfer rate from iodide to organic iodine (95 day^{-1} under steady-state conditions) was adjusted over time using a linear model. Under full blocking conditions (8.35 mg stable iodine in the thyroid), the transfer rate was reduced to 0 day^{-1} . The effectiveness of blocking was dependent of both the amount and timing of supplemental stable iodide relative to radioiodine administration, and both parameters were optimized within the model. The expanded models and supporting computational tools were implemented, and simulations were conducted for iodine isotopes I-124, I-125, and I-131. This approach allows for more accurate dosimetric assessment and improved radiation protection strategies in nuclear medicine applications.

Keywords: radiation protection, iodide, thyroid, ICRP, biokinetic model

Preferred presentation: POSTER**Category: Radiation protection in medicine, research and industry****Improving the estimation of radiation risks in intraoral dental x-ray**

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ABSTRACT

Introduction: X-ray examinations are an important part of the dental diagnosis and with the purpose improving the patient's dental health. Current research states that even at low radiation doses, DNA damage can arise and develop radiation-induced cancer later in life. To reduce the radiation dose to the patient the Swedish Radiation Safety Authority (SSM) requires that the patient should use thyroid protection, a lead collar with at least 0.25 mm lead. Objective: The overall aim of this project is to estimate the radiation field more accurately to an adult and a pregnant patient with intraoral radiography using bite-wing technique. The specific aim was to study the effect of the lead collar and map the radiation dose to a 15-week-old foetus. Materials and methods: The mapping of the radiation dose is done through calculations in the form of Monte Carlo simulations. Calculations were performed on modified versions of the latest ICRP virtual Mesh phantoms for adults and a pregnant woman with a 15-week-old foetus. To adjust the calculations to the dental exposure virtual lead collars were created and a bite-wing exposure model was created. The exposure was performed at 60 kV with a mAs that generates an absorbed dose corresponding to a clinical radiation dose in the Region Västra Götaland. Result and conclusion: The calculations showed that for bite-wing exposures the lead collar had no significant effect in lowering the absorbed dose to the adult patient. Bite-wing is the most common dental exposure, however the lead protection for other dental exposures has not yet been investigated. The data also shows that no additional radiation protection is needed for pregnancy.

Keywords: radiation protection, dental care, ICRP phantom, lead collar

Preferred presentation: POSTER

Category: Radiation protection in medicine, research and industry;

Implementing CT Scout Imaging for Lead Apron Quality Assurance: Efficiency and Unexpected Artifacts

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ABSTRACT

Lead aprons are essential in medical imaging environments to protect staff and patients from ionizing radiation. Routine quality assurance (QA) of these aprons is necessary to ensure their protective integrity and adherence to ALARA principles, but traditional methods—such as fluoroscopy—are time- and resource-intensive. At Helse Nord-Trøndelag HF (HNT HF), a more time-efficient method using CT scout imaging was introduced in 2024 to streamline the QA process. This technique enables rapid assessment of multiple aprons without occupying diagnostic imaging suites for extended periods. HNT HF adopted a modified version of the Matsuda and Suzuki classification system, utilizing four stages to evaluate apron damage. While CT scout imaging proved an effective and timesaving method, a technical issue occurred in April 2025, when a QA session caused ghosting artifacts on the Canon Prime SP Aquilion CT-scanner. These artifacts, not previously encountered, were linked to lead apron imaging and required detector recalibration. Normal function was restored, though one patient scan had to be repeated. This incident highlights the benefits and potential risks of alternative QA methods and underscores the importance of ongoing evaluation during a QA.

Keywords: lead apron, QA, radiation protection, CT scout

Preferred presentation: POSTER

Category: Radiation protection in medicine, research and industry

Radiation protection methods and guidelines regarding pregnant surgeons

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ABSTRACT

Technological advances and understanding of radiation protection methods among surgeons has reached a point where the surgeon receives a far lower dose now, when compared to the previous millennium. The improved working conditions opens possibilities which are not utilized due to misunderstandings or stringent rules. Pregnant surgeons are sometimes sidelined under the premise of protecting the foetus from radiation exposure. This is especially unfair to surgical residents who might postpone pregnancy because there are no replacement methods for learning surgical procedures other than surgical rotation. The lack of discussion has left room for speculation which inflates the risks of ionizing radiation disproportionately. In revision, an alternative solution for abstaining from operating was considered. According to personal dosimeter readings of Finnish orthopaedic surgeons, registering a measurable dose is uncommon and, when registered, remains well within safe limits — even before considering personal protective gear. Furthermore, studies have not yet shown a significant rise in birth defects or childhood cancer among surgeons' progeny due to occupational radiation exposure. Clinics where proper radiation hygiene practices have been established, early pregnancy should not be considered a reason to remove the pregnant surgeon from surgical duties. Updated guidelines would allow the pregnant surgeon to continue working safely and promote pregnancy-positivity.

Keywords: Radiation protection, Surgery, Pregnancy

Preferred presentation: POSTER

Category: NORM including Radon

Radon exposure in workplaces with time-controlled ventilation

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ABSTRACT

The Swedish Radiation Safety Authority's (SSM) method description for measuring radon in workplaces is based on long-term measurements for at least 2 months or continuous measurements for a whole year. These are often carried out as integrating measurements that do not provide information on how the radon level varies over time. The SSM method description points out that long-term measurements can overestimate the actual radon exposure during working hours. Time-controlled ventilation that is reduced at night often results in radon levels temporarily increasing, and integrating measurements can then give an overestimated radon level during working hours. We report an example where long-term measurements can instead underestimate radon exposure in workplaces. The case applies to workplaces with time-controlled ventilation and to employees who regularly work outside regular working hours. Previously measured long-term average values at the workplace according to a certified method have been below the applicable reference level (200 Bq/m³). In a short-term measurement using a EcoQube radon detector (Ecosense) carried out between 28 January and 13 February 2025, we have observed that the energy-saving measures implemented at a workplace a couple of years ago, with reduced ventilation at night and on weekends, have resulted in a risk of radon exposure of workers exceeding the limit values, under the assumption that the work mainly takes place with great regularity outside normal working hours. The night-time averages (from midnight to 08:00) were ~600 Bq/m³. After this short-term measurement, the ventilation in the building was increased (during nights and weekends now running at 50% of the daytime power). This mitigation measure reduced the radon activity concentration in air to low levels throughout the day on all days of the week (average value from 14 February to 18 March 2025: 18 Bq/m³, one standard deviation: 7 Bq/m³, maximum observed value: 45 Bq/m³).

Keywords: radon exposure, workplaces, time-controlled ventilation

Preferred presentation: POSTER

Category: Radiation protection in medicine, research and industry

Can administration of dimercaptosuccinic acid (DMSA) better reduce kidney uptake of ^{177}Lu -octreotate?

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Treatment with ^{177}Lu -octreotate is an effective for treatment of patients with advanced neuroendocrine tumors, but results are often limited by risk of side effects in kidneys and bone marrow. Today, co-injection of amino acids to block kidney uptake of ^{177}Lu -octreotate is routinely used, but additional kidney protection with more potent combinations of kidney blocking agents would be valuable. In this work, we investigated dimercaptosuccinic acid (DMSA) as a potential kidney blocking agent for treatment with ^{177}Lu -octreotate.

C57BL/6N female mice were i.v. injected with 5 MBq ^{177}Lu -octreotate. In addition, some mice received DMSA and L-lysine, either separately or together, in various doses and time points (-2, 0 or 2 h), compared to the ^{177}Lu -octreotate administration. One group received only ^{177}Lu -octreotate and was used as control. The mice were sacrificed after 24 hours, followed by organ excision and blood sampling. The activity concentration of ^{177}Lu in kidneys, blood and other organs was measured and compared with the control group.

DMSA reduced the renal uptake of ^{177}Lu for all dose levels, with greater reductions generally obtained as the amount of DMSA was increased. The highest administered DMSA dose (32 mg), given concomitantly with ^{177}Lu -octreotate (0 h), generated the largest mean reduction in kidney uptake of 65%. Even though the combination of DMSA and L-lysine resulted in reductions in kidney uptake up to 56 %, no statistically significant additive effects was found compared to the groups that only received DMSA or L-lysine.

DMSA gave promising results as a kidney blocking agent for treatment with ^{177}Lu -octreotate.

Keywords: kidney protection, chelate, lutetium

Preferred presentation: POSTER

Category: Environmental radiology and monitoring

From Past to Present: Investigating the Long-Term Environmental Impacts of Historical Alpha Radionuclide Discharges from the IFE JEEP Reactor

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ABSTRACT

Legacy discharges of long-lived alpha-emitting radionuclides from the JEEP research reactor in Norway, operated by the Institute for Energy Technology (IFE) since the 1950s, have resulted in contamination of nearby wetlands and river systems, particularly Sogna and Nitelva. Between 1963 and 1967, several megabecquerels of alpha emitters were released into a wetland area before discharges were redirected to the river. Although the releases ended decades ago, subsequent environmental changes, such as erosion, sedimentation, and human interventions, have complicated the understanding of radionuclide distribution and mobility.

This project aims to characterize the extent and behaviour of the contamination through a comprehensive and interdisciplinary approach. By combining historical records, new environmental sampling, and geostatistical analysis, the project seeks to deliver robust data for environmental risk assessments and support future remediation efforts. Particular focus is placed on the mobility and bioavailability of plutonium.

Sampling in rivers and wetlands presents both technical and safety challenges, including sediment coring in dynamic environments and the potential presence of unexploded World War II ordnance. The heterogeneity of the terrain and the time elapsed since the discharges require careful planning to ensure that selected sampling sites are both representative and scientifically meaningful.

The outcomes of this work will contribute to a better understanding of the environmental fate of long-lived radionuclides in complex natural systems. The methods and planning strategies employed may also serve as a template for similar legacy contamination assessments elsewhere. Ultimately, the project aims to provide decision-makers with reliable data to evaluate

environmental risks and determine appropriate management actions in accordance with Norwegian regulatory frameworks.

Keywords: IFE JEEP reactor, legacy contamination, plutonium, sediment sampling, environmental risk assessment

Preferred presentation: POSTER

Category: New challenges in radiation protection; Radioactive waste management; Environmental radiology and monitoring; NORM including Radon

Environmental and regulatory challenges in organic radioactive waste management

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ABSTRACT

Environmental and regulatory challenges in organic radioactive waste management

Norway currently is lacking solutions for environmentally sound management of radioactive waste containing > 10% total organic carbon (TOC). One of the reasons for this is that Norwegian waste regulations prohibit the disposal of waste with high organic content in compliance with the Council Directive 1999/31, mainly because it can result in significant greenhouse gas emissions and production of environmentally harmful leachate. Typical sources of radioactive waste with high TOC content may include peat and stone masses, sludge and/or sediment from treatment plants and precipitation ponds, and waste from the petroleum industry. Treatments solutions considered for management of radioactive waste containing > 10 % TOC includes amongst other things incineration and composting. From these methods there is also potential for resource extraction in the form of energy production and biogas. Incineration has in particular been considered a feasible solution, but there is still need for continuous development of technology and management solutions for this waste treatment. Since this also is a new solution in Norway, it is important that all aspects of the activity will be identified before the method is used.

There can be great potential in the development of new technologies and methods which can stabilize, remove, separate or transform radioactive waste with high organic content to safe material, and identify, extract and utilize valuable resources in the waste. A suggestion is to establish an inter-disciplinary approach to future research, with collaboration between environmental science, chemistry, industrial sciences and nuclear fields to develop innovative solutions to reduce the environmental impact and improve the safety in the management of radioactive waste with a considerable fraction of organic carbon.

Keywords: Radioactive waste management, regulation, environmental science, pollution

Preferred presentation: POSTER

Category: Environmental radiology and monitoring

Ground contamination in-situ measurements

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ABSTRACT

In connection with the future decommissioning of the nuclear facilities at IFE Kjeller, it is necessary to map contamination in areas that have been or may have been affected by previous activities. The Ground Contamination Project aims to summarize relevant information from earlier work, as well as conduct new surveys in order to give input to environmental impact assessments and provide data to assess future waste volumes after possible remediation works. As a part of this survey, there have been identified locations where further investigations are required. Additionally, the project will carry out specific investigations in areas where radionuclides are not expected to be found due to IFE's operations, to verify earlier assumptions that these regions are uncontaminated.

Within a prior environmental survey project, traces of radioactive emissions, including Cs-137, have been detected. However, it is assumed that any airborne emissions are detectable only in the immediate vicinity of the emission source.

Planned in-situ measurements in the area surrounding IFE Kjeller will serve as a control and confirmation of the assumption that there is no contamination in the vicinity.

Keywords: decommissioning, contamination, in-situ measurements, IFE Kjeller, airborne emissions, waste volumes

Preferred presentation: POSTER

Category: Radiation protection in medicine

National report: insights into recent statistics on nuclear medicine in Finland

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ABSTRACT

In Finland, the Radiation and Nuclear Safety Authority has regularly surveys the number of nuclear medicine examinations and treatments, as well as the radiation exposure caused by examinations of adults. The first survey was conducted in 1975. Since 1994, the survey has been conducted every three years. A report on the results of the surveys is published. The most recent report covers the year 2021. The report for 2024 is still in progress. Since 2021, the data collected in the survey has also been published as open data on the Radiation and Nuclear Safety Authority's website.

Data for the report was collected using an Excel form sent to the practitioners. This procedure was effective, albeit laborious. The response rate from practitioners was 100%. In the survey, the practitioners record the number of examinations or treatments performed, as well as the radionuclide and the radiopharmaceutical used for each one. For SPECT-CT and PET-CT examinations performed on adults, the $CTDI_{vol}$ and DLP_w were also recorded. The data also included information on age (adult or child) and whether the examination was part of scientific research. The survey used the research titles and codes of the Finnish Institute for Health and Welfare (THL).

Analysis of the results showed a sharp decline in the number of nuclear medicine examinations. In 2024, the rate was 6.4 nuclear medicine examinations per 1,000 inhabitants, compared to 7.8 examinations per 1,000 inhabitants in 2021. The study also revealed that while the number of PET examinations had plateaued, the number of treatments has continued to increase. Nuclear medicine is constantly evolving, with significant changes in its use occurring even within relatively short periods of time. Therefore, it is crucial for the radiation safety authority to maintain an overview of the situation and prepare for potential changes.

Keywords: nuclear medicine, imaging, treatment

Preferred presentation: POSTER

Category: Other topic – validation of measurement method

Validation of measurement method in surface contamination measurements: a case study

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ABSTRACT

New technologies are advancing rapidly and are often adopted to streamline workflows, especially when resources are limited. However, it is crucial to ensure quality assurance when implementing these new technologies. In a recent case, a commonly used surface contamination monitor was integrated with a mobile phone app from another supplier via Bluetooth. This app was designed to read and record radiation measurement results. However, measurements performed by the Radiation Metrology Laboratory (STUK) showed discrepancies between the results obtained with the mobile app and “handmade measurements”. The difference in readings was as much as factor of 600, with the app consistently showing lower values compared to the manual measurements. This discrepancy could be due to two factors: a difference in the conversion from counts per second (cps) to counts per minute (cpm), as well as a ten-fold error in the app’s calculations. The app developer has been notified of the issue, and the hospital has reverted to using their previous setup in critical areas until the app is corrected. Even though, the measurement accuracy in surface contamination measurements is not even close to same accuracy than in dosimetric measurements this issue could have been detected earlier if a simple comparison between the new and old measurement setups had been conducted in the hospital. However, it is fully understandable that commercial software was taken into use without further investigation. This incident highlights the critical importance of validation of measurement methods in all technological implementations.

Keywords: radiation measurements, surface contamination monitor, validation, quality assurance, measurement accuracy

Preferred presentation: POSTER**Category: New challenges in radiation protection****ENISS Expert Group on Radiation Protection**

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ABSTRACT

ENISS (European Nuclear Installation Safety Standards) brings together license holders from 14 European Countries. From the Nordic countries, Vattenfall, operating two nuclear powerplants in Sweden, as well as the Finnish nuclear power companies Fortum and TVO, are members. ENISS mission is to develop common views and positions on emergent issues, and to interact appropriately with the regulators and other key stakeholders such as the ICRP, to ensure that the licensees' positions are given due consideration. ENISS also serves as an efficient information exchange platform between its members, the dissemination of information and good practices is essential to ensure the safety of our facilities and to keep radiation exposure as low as reasonably achievable. The objective of the poster-presentation is to provide information about the ENISS Expert Group on Radiation Protection (EGRP), its recent and ongoing work. EGRP is one of the SLO's to ICRP and hence part of the group of organisations supporting ICRP in their revision of the system of radiological protection. EGRP has published two relevant positions papers "Implementation of Reasonable Optimisation" and "Avoid Unnecessary Complexity". The group is also addressing the issue on the validity and applicability of the Linear Non-Threshold (LNT) hypothesis in low dose and low dose rate regions. Further, the group has an ongoing dialogue with ICRP TG 114, as well as with the NEA Division on Radiological Protection and Human Aspects of Nuclear Safety (RP-HANS). Beyond sharing information about EGRP this poster is intended to foster general discussions on opportunities and challenges of radiological protection practitioners in the Nordic countries.

Keywords: ICRP, ENISS, optimization, complexity, LNT

Preferred presentation: POSTER**Radiological environmental impact assessment for non-human biota
during normal operation of NPP:s**

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Following recent revisions of radiation protection regulations in Sweden, a radiological environmental impact assessment for exposure during normal operation must be performed for nuclear power plants (NPP:s). The poster will present Vattenfall's chosen methodology, in line with IAEA GSG-10, and calculated results for Vattenfall's NPP:s in operation. Estimated realistic source terms for atmospheric and aquatic releases were used, and nuclide specific activity concentrations in media (air, soil, water) were simulated using the PREDO-model. PREDO takes into account air dispersion and deposition, terrestrial transport and aquatic transport for discharges to the sea. ERICA Tool was used to estimate dose rates to reference organisms in terrestrial, marine and freshwater ecosystems from radionuclide concentrations in media. Using the built-in database of equilibrium concentration ratios and distribution coefficients, radionuclide concentrations in non-human biota were derived, and absorbed dose rates were estimated using a library of dose conversion coefficients specific for each combination of radionuclide, organism and exposure situation. A number of local, representative organisms (RO) were selected to represent the potentially most exposed biota at each site. RO:s were mapped to relevant reference organisms in ERICA Tool, and estimated dose rates were compared to the Derived Consideration Reference Level (DCRL) for relevant RAP:s. For Vattenfall's NPP:s estimated dose rates to RO:s were below or well below DCRL. The impact on populations of non-human biota in both terrestrial, marine and freshwater ecosystems can therefore be considered as negligible and the level of protection adequate. Furthermore, the poster will address identified challenges for radiological impact assessments in licensing processes for new nuclear power, for example dealing with large uncertainties characteristic for the early planning phase.

Keywords: environment, NHB, NPP, normal operation

Preferred presentation: POSTER

Category: Other topic

Safety investigation enhances holistic understanding of radiation safety

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ABSTRACT

STUK conducts supervisory activities to ensure compliance with the Nuclear Energy Act, the Radiation Act, and associated regulations regarding nuclear energy and radiation practices. STUK may conduct investigations when a thorough examination is necessary, when there has been a dangerous situation or accident. An investigation may also be initiated without an actual event if the situation requires. In all cases, there must be a legal basis for the investigation. The purpose of an investigation is to determine the root cause of an event or situation, as well as the contributing factors, in order to prevent similar incidents and identify areas for improvement. Investigations clarify situations using procedures that differ from those employed by other supervisory measures.

This work presents investigative activities in general, as well as two investigations and their key findings: (1) The results and recommendations of the thematic investigation on radiation safety deviations in nuclear medicine that occurred in 2023, and (2) an investigation into deficiencies in quality management at the chemical laboratory of Teollisuuden Voima Oyj (TVO).

The most important themes observed in investigation (1) concerned actions to prevent radiation safety deviations, competencies, information flows, handling of incidents within organizations, management systems for radiation practices, cooperation within and between organizations, and the activities of the authorities.

The investigation (2) did not reveal any additional issues in TVO's chemical laboratory operations besides minor errors in reports submitted to the authorities. The investigation also examined

STUK's actions. Due to the errors found in the emission reports, confidence in TVO's operations had apparently declined, prompting STUK to intensively supervise them.

In general, investigations provide a deeper understanding on safety culture than other regulatory methods. Investigations are particularly well-suited to developing a safety culture and gaining a comprehensive understanding, although the legal framework for qualifications is somewhat challenging and should be developed further.

Keywords: investigation, radiation safety, nuclear safety, safety culture

Preferred presentation: POSTER

Category: Radiation protection in medicine

Supervising Safety Culture in Finnish Radiology Departments: A Nationwide Survey and Inspection Study

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ABSTRACT

The Finnish Radiation and Nuclear Safety Authority (STUK) assessed safety culture in the radiology departments of university and central hospitals. Promoting safety culture is a key legal obligation under the Finnish Radiation Act, especially where radiation safety affects both patients and staff.

A mixed-methods approach was used across 26 radiology departments within Finland's 21 wellbeing services counties. An anonymous questionnaire, based on frameworks from the International Atomic Energy Agency (IAEA) and the Technical Research Centre of Finland (VTT), was distributed to staff, receiving 811 responses. The survey evaluated perceptions of core safety culture elements. To validate the findings, follow-up inspections were conducted in each county. Statistical analysis was performed using R software with a significance threshold of $p < 0.05$.

Findings showed a generally open atmosphere and strong safety culture. Staff actively voiced concerns and made suggestions, which were addressed in all departments. Challenges included staffing shortages, high workload, and time pressure. Many respondents were critical of management's communication and role in supporting safety culture. Managers rated all key survey items 10–20% more positively than other staff. Statistically significant differences ($p < 0.05$) appeared in perceptions of organisational climate and safety concern handling based on the respondent's tenure and whether they worked in a central or university hospital.

Combining anonymous surveys with targeted inspections proved effective for monitoring safety culture in large healthcare settings. This first nationwide study provided a broader perspective and

revealed issues not easily captured through conventional inspections or interviews. The approach offers a potential model for strengthening safety oversight in other safety-critical sectors.

Keywords: safety culture, radiation safety, healthcare supervision, radiology