ETRAP

International Conference on Education and Training in Radiation Protection

BOOK OF ABSTRACTS

8th International Conference on Education and Training in Radiation Protection ETRAP 2023

June 27-30, 2023
Groningen, The Netherlands

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Scientific programme committee

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In collaboration with Congress by Design, Groningen, The Netherlands

Introduction

Since 1999 the ETRAP conferences intend to bring together training providers, academics, policy makers, radiation protection experts, regulators and authorities, and end-users. It offers the opportunity for learning, discussing and networking about the latest findings and developments in education and training in radiation protection.

This conference is organized by the Belgian Nuclear Research Centre SCK CEN and the University of Groningen in cooperation with IAEA, EUTERP and IRPA, and with support of EFOMP, HERCA, IRPA-YG, BVS-ABR, NVS, FANR, Technical University Madrid and Leibniz University Hannover.

Organized by

sck cen
Belgian Nuclear Research Centre

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In cooperation with

IAEA
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EUTERP
Training & Education in Radiation Protection

IRPA

Programme

The timeslots indicated in the programme are in Central European Time (CET)
All presentations are given in the Geertsema room unless otherwise stated.

Tuesday June 27, 2023	
17.00 – 18.00	Pre-registration | main entrance Academy building
17.15 – 20.00	Welcome reception | Academia restaurant

Wednesday June 28, 2023		
08.00 – 10.00	Registration	
10.00 – 10.25	Welcoming words from the Programme Committee members of main organizing parties	Hielke Freerk Boersma, University of Groningen Michèle Coeck, SCK CEN Hildegarde Vandenhove, IAEA Marie Claire Cantone, IRPA Joanne Stewart, EUTERP
10.25 – 10.45	**Keynote** | Worldwide overview on the Member States' education, training and competence requirements for QE and RPO	Andrea Luciani, IAEA
10.45 – 11.00	Opening University of Groningen	Prof. Cisca Wijmenga, Rector Magnificus University of Groningen
Session 1 | Competence based systems versus qualification based systems **Chairperson: Michèle Coeck, SCK CEN, Belgium**		
11.00 – 11.15	**Keynote** | Comparison of legal requirements for education and training of RPE and RPO in Europe. The HERCA workgroup on education and training experience	Barbara Godthelp HERCA & ANVS, The Netherlands
11.15 – 11.30	UK RPA certificate changes	Mary Allan RPA 2000, United Kingdom
11.30 – 11.45	Radiation protection education and training in Belgium: challenges and opportunities	Tom Clarijs SCK CEN, Belgium
11.45 – 12.00	Q&A	
12.00 – 13.30	***Lunch & poster session***	

Wednesday June 28, 2023		
Session 2 | Attracting and preserving a competent workforce in radiation protection **Chairperson: Andrea Luciani, IAEA, Austria**		
13.30 – 13.45	Development of the radiation protection workforce knowledge base through sharing of ideas and practices	Marie Claire Cantone IRPA & University of Milan, Italy
13.45 – 14.00	Developments in radiation protection education, training and qualifications in the UAE	Meera Alshoukari FANR, United Arab Emirates
14.00 – 14.15	Ghana's experience with radiation protection training for professionals exposed to radiation	Francis Otoo Atomic Energy Commission, Ghana
14.15 – 14.30	The role of education and training in the development of a regulatory infrastructure in radiation protection in Suriname and beyond	Hielke Freerk Boersma University of Groningen, The Netherlands
14.30 – 14.45	EURADOS webinars on radiation dosimetry: a new action within EURADOS Education and Training vision and strategy	João Garcia Alves EURADOS & Instituto Superior Técnico, Portugal
14.45 – 15.10	Q&A	
15.10 – 15.45	***Break & poster session***	
Session 3 | Online and hybrid learning: innovation and experience gained **Chairperson: Eduardo Gallego, Polytechnical University Madrid & IRPA**		
15.45 – 16.00	Radiochemical experiments in a new virtual radionuclide laboratory: interim results from the European HORIZION 2020 project A-CINCH	Jan-Willem Vahlbruch Leibniz University Hannover, Germany
16.00 – 16.15	Early stage experiences with using virtual reality to enhance learning experiences with ionizing radiation in radiation protection courses	Louise Berghuijs NRG, The Netherlands
16.15 – 16.30	Radiation safety e-learning training for non-radiology doctors and other staff: Experiences in a major academic teaching hospital in Ireland	Thomas Heary Beaumont Hospital, Ireland
16.30 – 16.45	Radiation protection update training for dental professionals and university staff/students: experiences with online vs face-to-face options	Graham Hart YourRPA, United Kingdom
16.45 – 17.00	Continuing online radiological protection education for professionals	Paula Garcia Castañon University Hospital La Princesa, Madrid, Spain
17.00 – 17.25	Q&A	
17.25	***Closing words of the day by the chairperson***	

Thursday June 29, 2023		
Session 4 | Attracting and preserving a competent workforce in radiation protection (continued) **Chairperson: Adriaan Lammertsma, EFOMP**		
09.00 – 09.15	Realistic training and practice for radiological emergency preparedness and response in The Netherlands	Teetske Van Gorcum National Institute for Public Health and the Environment (RIVM), The Netherlands
09.15 – 09.30	How can we attract and preserve a competent workforce in medical radiation protection?	John Damilakis University of Crete, Greece
09.30 – 09.45	Building a new graduate-level health physics program: challenges and successes	Emily Caffrey University of Alabama, Birmingham, USA
09.45 – 10.00	The Bsc physics, medical physics and radiation protection at the university of Malta: a success story in attracting young people to the radiation protection professions	Carmel J. Caruana University of Malta
10.00 – 10.15	Protection and safety of patient and staff during external beam	Calvince Odeny Nuclear Regulatory Authority, Kenya
10.15 – 10.30	From student participation to infinity: implementing digital innovation for success in education of radiation protection	Hendrik Erenstein Hanze University of Applied Sciences, The Netherlands
10.30 – 11.00	Q&A	
11.00 – 11.30	***Break, poster session & demo A-CINCH (Room A7)***	***Jan-Willem Vahlbruch*** ***Leibniz University Hannover, Germany***
Session 5 | Online and hybrid learning: innovation and experience gained (continued) | AI **Chairperson: Ben Bewersdorf, University of Groningen**		
11.30 – 11.45	**Keynote** | Artificial Intelligence in education and training	Erik Hemberg MIT Computer Science and Artificial Intelligence Lab, Anyscale Learning For All (ALFA) Group, USA
11.45 – 12.00	Debate on AI and new developments	
12.00 – 13.30 12.30 – 13.20	***Lunch, poster session*** ***Demo VR in RP at NRG (Room A3)***	***Robert Beekveldt*** ***NRG, The Netherlands***

Session 6 | Online and hybrid learning: innovation and experience gained (continued) Chairperson: Jan-Willem Vahlbruch, Leibnitz University Hannover, Germany		
13.30 – 13.45	How BRAVER challenges students in radiation protection training	Sonja Schreurs University of Hasselt, Belgium
13.45 – 14.00	How can we use digital learning tools in hybrid learning?	Wout Moerman RadboudUMC, The Netherlands
14.00 – 14.15	Post Covid andragogic improvements of radiation safety training	Charles Wilson University of Alabama, Birmingham, USA
14.15 – 14.30	AWE radiation protection access training	Catherine Nortey AWE, United Kingdom
14.30 – 14.45	Risk minimisation in online radiation protection training	Stephen Jackson UKHSA, United Kingdom
14.45 – 15.10	Q&A	
15.10 – 16.00	***Break, poster session and 2 demonstrations:*** ▪ ***BRAVER (Room A3)*** ▪ ***Demo on 'the decontamination strategy' picture game, 'Escapelab' and a 360 degrees VR video for medical specialist training (Room A7)***	***Wim Eerdekens*** ***University of Hasselt, Belgium*** ***Wout Moerman*** ***RadboudUMC, The Netherlands***
16.00 – 16.15	National training courses on radiation protection organized at Instituto Superior Técnico in Portugal: a pandemic experience	João Garcia Alves Instituto Superior Técnico, Portugal
16.15 – 16.30	Effectiveness of the post-pandemic hybrid education in radiation protection: first results	Davit Nadareishvili Ivane Beritashvili Center of Experimental Biomedicine, Georgia
16.30 – 16.45	Hybrid training of first responders for nuclear and radiological emergency preparedness and response in Lithuania	Odeta Drungelaite Radiation Protection Centre, Lithuania
16.45 – 17.00	Q&A	
17.00	***Closing words of the day by the chairperson***	

Transport bus at 17.55

19.30 – 23.30	**Conference dinner |** De Rietschans, Haren

Friday June 30, 2023		
Session 7 | Integration of social sciences and humanities and public engagement **Chairperson: Marie Claire Cantone, IRPA & University of Milan, Italy**		
09.00 – 09.15	**Keynote** | An ethical capability-possibility framework for education and training in radiological protection	Gaston Meskens SCK CEN, Belgium
09.15 – 09.30	Co-creative Radiation Education Program (CREPE) in Osaka University	Michio Okada Osaka University, Japan
09.30 – 10.00	Debate session	
Session 8 | Competence standards for trainers **Chairperson: Hielke Freerk Boersma, University of Groningen, The Netherlands**		
10.00 – 10.15	**Keynote** | How to include AI in trainer competencies	Alicia Streppel University of Groningen, The Netherlands
10.15 – 10.30	Selection and evaluation of lecturers for EEAE 's training activities	Sotirios Economides Greek Atomic Energy Commission, Greece
10.30 – 10.45	A Portuguese experience in Education & Training in Radiation Protection	Louis Branco ISQ, Portugal
10.45 – 11.15	***Break & poster session***	
11.15 – 11.30	Implementation of quality assurance in education and training in radiation protection	Heleen Van Elsacker-Degenaar Stichting KOS & NVS, The Netherlands
11.30 – 11.45	Outcome & results of the 9th EUTERP workshop	Joanne Stewart EUTERP, The Netherlands
11.45 – 12.00	Q&A	
12.00 – 12.15	**Keynote** | The ICRP Vancouver Call for Action	Ulrike Kulka Federal Office for Radiation Protection, Germany
12.15 – 12.30	***Wrap-up of the scientific programme & closing words of the conference***	***Michèle Coeck, SCK CEN, Belgium*** ***Hielke Freerk Boersma*** ***University of Groningen, The Netherlands***
12.30	***Farewell lunch***	

Poster presentations

Systematic approach to training occupationally exposed workers for strengthening national capacity and minimize exposure to ionizing radiation in nuclear facilities in Iraq	Salwa Al-Salhy Radiation Protection Centre, Iraq
Roleplay Medical Imaging: a high school teaching module to playfully discover what expertise is necessary to suffice 20 patients a SPECT-scan in the hospital.	Robert Beekveldt NRG, The Netherlands
Attracting the future workforce in radiation protection: outreach activities by the SCK CEN Academy	Tom Clarijs SCK CEN, Belgium
Status of cross-checked database of resources, online demos and virtual labs for radiation protection training	Francesco D'Ericco University of Pisa, Italy
Development of a hybrid training plan in operational radiation protection for the staff of new proton therapy systems	Gonzalo Garcia Fernandez Universidad Politecnica de Madrid, Spain
C-arm in the OR: training of medical specialists	Kitty Hoornstra Umc Utrecht Hospital, The Netherlands
Capacity building training program for NRRC inspectors in Saudi Arabia	A. Alghamdi Nuclear and Radiological Regulatory Commission, Saudi Arabia
Applying infographics for an effective radioactive waste management in a nuclear medicine department	Rodrigo Rosado del Castillo La Princesa University Hospital, Madrid, Spain

Worldwide overview of the Member States' education, training and competence requirements for QE and RPO

A. Luciani

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Abstract

IAEA Safety Standards Series No. GSR Part 3, "Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards" (2014), introduces requirements for the Radiation Protection Officer and Qualified Expert, two of the parties with specified responsibilities in relation to protection and safety. The Radiation Protection Officer (RPO) is a person technically competent in radiation protection matters relevant to a specific practice who is designated to oversee the application of the regulatory requirements, whereas the Qualified Expert is an individual duly recognized as having expertise in a relevant field of specialization (e.g., radiation protection, as the Qualified Expert in Radiation Protection - QERP) who is consulted as necessary on the observance of the requirements (advisory role).

QERPs and RPOs play a key role to support the employers, registrants and licensees to safely operate a facility or carry out an activity with use of ionizing radiation and radiation sources. Requirements on education, training, competence and qualification should be established to enable QERPs and RPOs to carry out their duties in an effective and appropriate manner.

The IAEA has a statutory function to establish safety standards for the protection of health, life and property against ionizing radiation and to provide for the application of these standards. In line with such statutory functions, IAEA provides Member States with support to strengthen their legal and regulatory framework on education, training, competence and qualification of QERPs and RPOs, and to monitor the alignment of such framework with the IAEA safety standards. For that purpose, IAEA has developed a web-based platform, the Radiation Safety Information Management System (RASIMS), that gives Member States an instrument for collecting and collating the information on the national radiation safety infrastructure, including the legal and regulatory framework on education, training, competence and qualification of QERPs and RPOs (within the Thematic Safety Area 6: TSA6).

The information in TSA6 of RASIMS is regularly reviewed by IAEA. Currently 148 Member States are included in RASIMS, and, for about 2/3 of them, information related to QERPs and RPOs is available. This provides a unique opportunity to have a worldwide overview on the status of Member States' provisions on education, training, competence and qualification of QERPs and RPOs. The lecture will illustrate the range of approaches adopted by Member States when defining the role and functions of QERPs and RPOs, the progress made to establish requirements for QERPs and RPOs in line with IAEA safety standards, the areas where further efforts are needed. IAEA's future plans to support Member States to strengthen their framework for the education, training, competence and qualification of QERPs and RPOs will also be outlined.

Oral presentations

Competence based systems versus qualification based systems

Comparison of legal requirements for education and training of RPE and RPO in Europe. The HERCA workgroup on education and training experience

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Abstract

In the European basic safety standards, a clear distinction has been made between the different roles and responsibilities of the radiation protection expert (RPE) and the radiation protection officer (RPO). To be able to compare the legal requirements for education and training of RPE and RPO in the different Heads of the European Radiological protection Competent Authorities (HERCA) member states, the HERCA workgroup on education and training in radiation protection collected country fact sheets and/or questionnaires on the topic. So far, we collected information on RPE and RPO implementation of 27 out of the 32 HERCA member states. Analysis of the results revealed that the concepts of RPE and RPO, as defined in the BSS, are taken up in their national legislative framework in 26 and 25 MSs respectively.

RPE and RPO training is application-specific in the majority of MSs, but the number of associated categories/specialties varies to a great extent. A RPE recognition is granted by the component authorities in the majority of the MS. In some MS the RPE/RPO legal requirements are based on the previously established system concerning the expertise in radiation protection (RP). In 4 MSs the roles/functions of RPE and RPO are combined. Regarding the educational background of the RPEs, a B.Sc. or higher educational degree is required in 13 MSs, while an initial RPE specific training and/or training in radiation protection is obligatory in 18 HERCA MSs. Additionally, specific RPE training and retraining requirements have been set in 9 MS. Regarding the required RPO training and/or qualifications, there is a certification scheme in place in 16 out of 27 MS.

Although, there are many similarities among MSs in the way the concepts are implemented, however there are also areas where different approaches are followed (e.g., qualification, training requirements). In this respect the MSs may focus to the competences which are considered necessary for the effective and efficient performance of the RPEs and RPOs. This step is considered necessary regarding the mutual recognition of the RPEs in accordance with the Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications.

UK RPA certificate changes

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Abstract

In 2021, the Health and Safety Executive (HSE) – the government agency in the UK responsible for workplace health, safety and welfare in Great Britain, updated its radiation protection adviser (RPA) statement. The RPA statement covers any individual or body that may be consulted or appointed by an employer as an RPA to give advice on compliance with the Ionising Radiations Regulations 2017 (IRR17) and/or the Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPIR19). RPA 2000, the company set up for certifying competence in radiation protection practice in the UK, was required to amend its RPA certification and re-certification schemes to accommodate the revised HSE statement. This presentation will highlight the major changes that were required to the scheme, including the option for exemptions from demonstrating General Awareness and Basic Understanding underpinning knowledge. In addition, a summary will be given on the modified arrangements, the engagement required to inform stakeholders and an early review of the outcomes now that the revised scheme has been in place for a year.

Radiation protection education and training in Belgium: challenges and opportunities

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Abstract

As a scientific society with the aim of spreading knowledge and supporting the scientific, ethical and organisational framework in radiation protection, the Belgian Society for Radiation Protection BVS-ABR organises various activities for professionals in radiological and nuclear domains. It offers a networking platform for different key-profiles such as the radiation protection expert, the radiation protection officer and occupational health physicians and strives to liaise with professionals working with numerous applications of ionising radiation, such as the nuclear industry, medical sector, research and development, emergency preparedness, non-destructive testing, space industry, etc.
Since education and training (E&T) is at the foundation of competence building in radiation protection, BVS-ABR devoted two of its meetings (October 21, 2022 and May 5, 2023) to discuss the status of education and training in radiation protection in Belgium. Current and near-future regulatory requirements were featured, and specific educational paths to meet the demand of qualifications in radiation protection by the applications in today's society. Particular emphasis was put on initiatives in continuous professional development, including issues such as sustainability in the organisation of E&T, quality assurance, diffusion, efficiency and efficacy of training.
This presentation will provide an overview of the current status of radiation protection E&T in Belgium, including the discussions of the latest meetings by BVS-ABR. It will highlight challenges and opportunities in the scattered landscape of radiation protection education and training in Belgium and a way forward to strengthen competence building in the future.

Oral presentations

Attracting and preserving a competent workforce in radiation protection

Development of the radiation protection workforce knowledge base through sharing of ideas and practices

M.C. Cantone[1], M. Ginjaume[2], C.J. Martin[3], B. Le Guen[4]

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Abstract

Education and Training in Radiation Protection (RP) is essential for all the related professionals and researchers, for developing their competences within knowledge, skills and related technologies. Support is required to allow the professionals to focus on current and future aspects of RP inherent in their fields of application. They need to look ahead and be ready to provide training and support for young generation future experts with an adequate competence and to be open to future needs in Education and Training[1]).

Therefore, the preparation of educational material with up-to-date information is essential when there are significant changes in RP practice. It is important to ensure the participation and awareness of the professionals within the workforce in the steps taken, and in the progress and adaptation to scientific and technological advances, while also considering the societal and ethical aspects. In this way a competent workforce can be maintained and involve members in active participation in the development of ideas on the evolution of RP implementation[2]).

The opening of surveys, within Task Groups (TGs) involving professionals on issues that create challenges in the field of RP, allows individual professionals to consider the trends in RP, to look towards the issues that are evolving, and to open a broad communication that will lead to the sharing of points of view creating a wider spectrum of ideas.

Participating in surveys on new or evolving issues, opens the professionals towards a greater focus on the topic, and analysis of the responses to the survey shows a picture of the broad and varied viewpoints and values, which create added value for the Education and Training environment.
In the context of IRPA, which represents 68 Associations, including 86 countries, a broad program of activities is developed, including TGs with international participation, to support good practices, improve professional expertise, create networks and encourage application of the highest standards of professionalism and also tackle the challenges facing the community in development of the RP System.

IRPA, promotes excellence in RP by providing benchmarks of good practice, as well as enhancing professional competences and networking, recognizing the ethical and societal dimension of RP.

[1] IRPA YGN Strategic Agenda for 2018-2020. https://www.irpa.net/page.asp?id=54777
[2] IRPA Guiding Principles for establishing a Radiation Protection Culture (2014) https://www.irpa.net/docs/IRPA%20Guiding%20Principles%20on%20RP%20Culture%20(2014).pdf

By embedding RP at a cultural level, IRPA promotes radiation risk awareness regarding different exposure situations, maintains the RP heritage and contributes to ensure the professionals are prepared for future needs, thanks to the use of education, but also through their involvement in IRPA TGs and the discussions generated in preparing responses to survey questions.
For example, within IRPA three TGs (2013-2020) were launched[3,4]) with the aim of promoting a wide exchange of experience at the international level, on the impact of the change in the dose limit for the lens of the eye and its implementation with regard to occupational exposure and with attention to the proposed or chosen approaches. The answers received, in the latest survey, report the point of view of 44 countries from Africa, North and South America, Asia/Australia and Europe. A new IRPA TG is now open to contribute in creating awareness about effects of radiation in other tissues and organs, with particular emphasis on the circulatory system.

The current set of active IRPA TGs, apart from the TG on Tissue reactions are: Higher Education and Research; Non-Ionising Radiation; Naturally Occurring Radioactive Materials (NORM); Public Understanding; Radiation Safety in Healthcare; Review of the System of Radiological Protection and Women in Radiation.

These TGs contribute to the sharing of ideas on implementation and practice in RP. Through their work knowledge and experience are disseminated within the RP workforce and communities.

[3] M.C. Cantone, M. Ginjaume, S. Miljanic, C. J Martin, K. Akahane, L. Mpete, S. C. Michelin, C. M. Flannery, L. T. Dauer, S. Balter. *Report of IRPA task group on the impact of the eye lens dose limits*. J. Radiol. Prot. 2017, 37, p. 527-550
[4] M.C. Cantone, M. Ginjaume, C.J. Martin, N. Hamada, S. Yokoyama, J.-M. Bordy, L. Dauer, A. Duràn, C. Jeffries, W. Harris, O. Kashirina, A.O. Koteng, S. Michelin, W. Sudchai. *Report of IRPA task group on issues and actions taken in response to the change in eye lens dose limit.* J. Radiol. Prot. 2020. 40, p.1508-1533

Developments in radiation protection education, training and qualifications in the UAE

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Abstract

Since the establishment of the Working Group on the "National Strategy on Education, Training and Qualification in Radiation Protection in the UAE", as a follow-up to the 2017 IAEA EduTA to the UAE, various developments took place in the United Arab Emirates to enhance and further develop the infrastructure for the competency of Radiation Protection Professionals.

First and foremost, the UAE established in 2019 the "National Strategy on Education, Training and Qualification in Radiation Protection in the UAE", according to the IAEA guidance, as a reference framework for the coordinated developments of all subsequent actions. The Strategy has been a joint effort, coordinated by FANR and shared by more than 20 National Stakeholders, representing various sectors and stakes in the large UAE Radiation Protection scene. The Strategy has been approved by the "Radiation Protection Committee in the State", an advisory body created by the UAE Nuclear Law, and is bound to be presented to the UAE Prime Minister Office for formal Government endorsement and support.

In close collaboration with the "National Qualifications Center" (formerly known as "National Qualifications Authority") of the UAE Ministry of Education, a Committee was also established in 2018 between FANR and various UAE governmental and commercial Stakeholders, to develop detailed and comprehensive national vocational Qualifications for five categories of Radiation Protection Professionals: the Qualified Expert (QE), the Radiation Protection Officer (RPO), the Medical Physicist (MP), the Exposed Worker (EW) and the Emergency Worker (EmW).
Nationally-recognized Qualifications are a key element in ensuring a high, measurable and harmonized quality in vocational training, and are linked to the licensing/authorization process for Recognized Training Providers, ensuring the involvement of the UAE Nuclear Regulator.
Three National Workshops have been organized in 2015, 2017 and 2019, to publicly discuss of the roles, responsibilities, mutual interaction and formal qualifications of QEs, RPOs and MPs: a fourth Workshop,

initially planned in 2020 -and rescheduled due to the global pandemic-, will conclude the current development phase of the Qualifications, presenting the overall framework to Professionals and Training Institutes.
Once the Qualifications will be formally adopted and made available to Training Providers, it is expected that new Training Courses and Training Programmes will be developed and offered to the UAE market, to satisfy an important need for Training and Re-Training of Radiation Protection Professionals at various levels and sectors.

To cope with the absence of formal recognition for Qualified Experts in the UAE, and to respond to a specific EduTA Recommendation, the Working Group also established criteria for interim qualification, and set up, in 2019, a first Temporary List of Qualified Experts in the UAE, to be used in Licensing and Occupational Radiation Protection practices in the Country.
The Temporary List is public and is managed by FANR, and is continuously updated upon recommendation of the Working Group's analysis of Candidates files; it currently lists 18 names, and, according to the assessment performed in the development of the National Strategy, it is expected that a number of the order of 100 QEs will be needed, in the medium term, in the UAE.
The Temporary List will cease to be valid once the full Qualifications Framework will be available.

The Working Group also fostered the creation of two Academic Master Degrees, able to cater for the growing needs of young graduates with an interest towards the field of Radiation Protection and Medical Physics.
Khalifa University, in Abu Dhabi, received in 2019 the formal approval from the Commission for Academic Accreditation of the Ministry of Education to offer a new concentration in "Radiation Protection" within the Master of Engineering in "Health, Safety and the Environment".
In 2022, the Commission also granted approval for the creation of a new Master of Science in "Medical Physics", a specialty previously available only at the BSc level in the UAE, and the new Programme - developed with Medical Authorities and renowned clinical Counterparts- will feature a Clinical Residency Programme, enabling MSc graduates to complete the three-fold specialties' approach (diagnostics, nuclear medicine, radiotherapy) as “Clinically-Qualified Medical Physicists”, as foreseen in the UAE National Strategy.

The Federal Authority for Nuclear Regulation, FANR, is considering to propose new Regulation and Guidance for Education, Training and Qualifications in Radiation Protection, in the near future, given the importance of these topics, and their complexity.
Thanks to the initial guidance of the IAEA EduTA Mission and the coordinated efforts that FANR and its Stakeholders have deployed in these years, the quality, level and harmonization of Education, Training and Qualification for Radiation Protection Professional have been greatly improved, and represent a cornerstone of the modern and comprehensive Radiation Safety regime that FANR is fostering in the UAE.

A future follow-up review of the IAEA EduTA Mission is already planned, to acknowledge the significance of the efforts undertaken by the UAE, and to indicate final improvements to the System, also based on the experience gained by other Member States in the cyclic implementation of the National Strategy.

Ghana's experience with radiation protection training for professionals exposed to radiation

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Abstract

The Radiation Protection Institute (RPI) is one of the seven (7) technical institutes of the Ghana Atomic Energy Commission (GAEC). Act 204 of 1963 established the GAEC as the exclusive entity in Ghana responsible for all things pertaining to the non-military use of atomic energy. Act 204 has been superseded by Act 588 of 2000. Effective radiation protection for occupationally exposed workers in Ghana began in 1993 with the promulgation of Legislative Instrument (LI) 1559 under the Atomic Energy Act 204, which established the Radiation Protection Board (RPB). The RPI was established at the beginning of 2000 to provide RPB with technical support for the implementation of LI 1559. Act 895 of 2015 established the independent Nuclear Regulatory Authority (NRA), separating the operational and regulatory functions of the RPI of the GAEC. The Act, Act 895, requires that all occupationally exposed workers be provided with adequate radiation protection and safety training and certification in line with national and international best practices in occupational radiation protection. In view of this, Ghana has a National Policy for Education and Training in Radiation Protection, Transport, and Waste Safety Training Modules for Various Practices, published in 2017, and has also adopted the provisions of the International Atomic Energy Agency (IAEA) General Safety Requirements Part 3, 2014, and other appropriate documents and safety standards published by the IAEA, which require employers, registrants, and licensees to provide adequate instruction and training and periodic re-training in radiation protection and safety to ensure compliance with safety standards for protecting people and the environment. The NRA has authorized the RPI of the GAEC as a Technical Support Services Organization to provide several services, including radiation protection training. The training programs are divided into awareness and standard courses, with training methodologies that include participatory lectures, practical demonstrations, focused group discussion, and take home assignments from 3-5 day period. The technical content of the training program included: basic knowledge of ionizing radiation, radiation detection, measurements, and radiation quantities; biological effects of ionizing radiation; radiation protection and safety principles; types of radiation exposure; quality assurance in radiation protection; safety and security of radiation sources; emergency procedures; transport of radioactive materials; radioactive waste management; the national regulatory and legislative framework for the use and control of radiation sources; organizational responsibilities; the duties of a radiation protection officer; and a demonstration on the use of radiation detection equipment, among others. The target audience of the trainees includes qualified experts (QEs), radiation protection officers (RPOs), and qualified operators who work with the application of ionizing radiation in authorized practices in industrial, medical, research, etc. institutions for practitioners like radiographers, X-ray technicians, biomedical engineers, operators of density nuclear gauges, well loggers, mining engineers, transporters of nuclear and radioactive materials etc.

The role of education and training in the development of a regulatory infrastructure in radiation protection in Suriname and beyond

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Abstract

In 2020, the Dutch Society for Radiation Protection (NVS) established a chapter 'Radiation Protection in Suriname and the Dutch Caribbean' as a follow up of a mission of the NVS to Suriname in November 2019 (Adhikari et al., 2021)1. With the new chapter, the NVS intends to promote organised radiation protection in Suriname and the Caribbean area. In the mission report, the NVS provided recommendations on a regulatory infrastructure in radiation protection to the government of Suriname. In its first meetings the members of the chapter decided to focus on raising awareness on radiation and radiation protection. This contribution will focus on the activities in Education and Training in Radiation Protection.

We will first report on the recommendations to the Suriname government regarding a possible system of Education and Training in radiation protection in Suriname and provide an update on recent developments.

Simultaneously, we started Education & Training activities in Suriname, in line with the recommended system of E&T. Recent developments in facilities for online lecturing and e-learning due to the COVID-19 pandemic have contributed significantly to the possibilities for distance learning, especially in developing countries. In our contribution we will give an overview of E&T activities in Suriname realized so far, most of which have been conducted through distance learning. Finally, we will present our next steps in the development of E&T in Suriname.

EURADOS webinars on radiation dosimetry: new action within EURADOS Education and Training vision and strategy

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Abstract

The European Radiation Dosimetry Group, EURADOS, Strategic Research Agenda[5] includes education and training activities for the maintenance of expertise in the radiation protection field. EURADOS has for decades been active in education and dissemination activities and in supporting early career scientists. A review of EURADOS activities and aims on education and training are reported on a recent paper[6].

EURADOS education and training actions are focused on one hand on organising training courses and one-day schools and, on the other hand, on supporting early career scientists in their research activities in radiation dosimetry by attending conferences *(EURADOS Young Scientist Conference Support*), recognizing the scientific value of their research work *(EURADOS Award)* and on funding

[5] J-F. Bottollier-Depois, I. Clairand, E. Fantuzzi, P. Fattibene, R. Harrison, O. Hupe, P. Olko, V. Olšovcová, W. Rühm, M. Silari, R. Tanner, F. Vanhavere, *Two Decades - Strategic Research Agenda of the European Radiation Dosimetry Group: Version 2020*, EURADOS Report 2020-04 (2020)

[6] Alves, J. G., Fantuzzi, E., Rühm, W., Gilvin, P., Vargas, A., Tanner, R., Rabus, H., Lopez, M. A., Breustedt, B., Harrison, R., Stolarczyk, L., Fattibene, P., Woda, C., Caresana, M., Knežević, Ž., Bottollier-Depois, J. F., Clairand, I., Mayer, S., Miljanić, S., Olko, P., Schuhmacher, H., Stadtmann, H., Vanhavere, F., *EURADOS education and training activities*. J Radiol Prot. 39 (2019), R37-R50 (14pp).

research stays (*EURADOS Grant).* EURADOS training courses are generally mainly intended for training junior staff or early career scientists (typically less than 35 years old).

The so called *EURADOS School,* regularly combined with the EURADOS Annual Meeting (AM) since 2007, provides "refresher lessons" on selected topics relevant to radiation dosimetry for the entire community. Most EURADOS activities take place within the EURADOS Working Groups, which carry out research work, organize intercomparisons and surveys, perform simulations and measurement campaigns and, last but not least, publish reports and guidelines on best practices in radiation dosimetry. EURADOS contributed, for example, to the development of the EC Technical Recommendations for individual monitoring of external and internal exposure to ionizing radiation[7] [8].

Then specific training courses of several days are organized on a regular basis by the working groups to disseminate at best these recommendations and best practice in individual monitoring.
The COVID pandemic has substantially reduced the number of conferences but has boosted all kinds of on-line events. In education and training, virtual, on-line or e-learning initiatives were started by many, if not all organizations.

In December 2020, EURADOS started a series of Webinars with the aim of better and wider dissemination of the scientific results of its working groups. Since then, the EURADOS Webinars have been held on-line approximately once a month. Registration is invited through EURADOS newsletter and can be made directly on the EURADOS Website.

The Webinars are usually announced one month in advance, they generally last one hour, with short lectures given by three or four speakers followed by a Questions and Answers session. For a better interaction with the audience, polls with questions related to the contents of the webinar are launched and evaluated during the presentations. Indeed, the results of the polls associated with the Webinars have been found useful and, in some cases, even directly led to the definition of the topics for new tasks for EURADOS Working Groups. This Webinar Series is considered as an excellent, timely and concise way to disseminate EURADOS scientific results and to inform on recent and relevant publications produced by EURADOS Working groups, including the issued EURADOS Reports.

Since December 2020, eighteen Webinars took place with contributions from all EURADOS Working Groups, in some cases in collaboration with other international organizations (e.g., NERIS, EFOMP) or on behalf of the MEENAS consortium: one in 2020, nine in 2021, seven in 2022 and one (so far) in 2023. The average attendance is 165 persons, which is about 2/3 of the number of people who registered. A significant number of participants are not affiliated with EURADOS and some even come from outside Europe.
The list of all webinars and the presentations of each webinar can be downloaded from the EURADOS website (www.eurados.org/webinars). With single exceptions, all webinars have been recorded and are available on the EURADOS YouTube channel (www.youtube.com/eurados).
The topics covered tries to reflect the main needs or recent achievements of the dosimetry community. Recently, early career scientists attending the EURADOS AM have called for educational Webinars on basic topics of radiation dosimetry. Such kind of educational webinar (e.g. on the practical aspects of TLD measurements) are planned in the near future.

[7] European Commission 2009 - *Technical Recommendations for Monitoring Individuals Occupationally Exposed to External Radiation* - Radiation Protection 160 (Luxembourg)

[8] . European Commission 2018 - *Technical Recommendations for Monitoring Individuals for Occupational Intakes of Radionuclides* - Radiation Protection 188 (Luxembourg)

On-line events have clearly brought a new approach to educational and training activities and, in some cases, have made them more efficient, allowing to easily reach a wide audience. For this reason, even after the COVID pandemic, EURADOS webinars are continuously offered and have become a regular appointment for both early career researchers and senior scientists from all over the world.

Realistic training and practice for radiological emergency preparedness and response in The Netherlands

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Abstract

Introduction
Because radiation emergencies do not happen very often, education, training and exercise is an important part of preparedness and response. This also applies to the experts on dispersion modelling and radiation measurements of the back office of the Crisis Expert Team CETsn. This back office (RGEN) consists of experts from multiple organizations in the field of nuclear safety, radiation measurements, dispersion and dose modelling, and health. CETsn formulates an advice to mitigate the consequences of radiation accidents for health and the environment based on information and assessment of the situation by RGEN. To obtain and preserve a competent workforce of RGEN, training and exercises are drafted as realistic as possible. The coordinating institute of RGEN, the National Institute for Public Health and the Environment (RIVM), provides a realistic setting by development of specific tools and composition of an adequate setting, such as the scenario. We present the setting, tools and challenges of the participation of RGEN to the exercises of the Dutch nuclear power plant in Borssele.

Enhanced realism
Annually, the Dutch NPP practices an unplanned release of radioactive material. Both CETsn and RGEN as well as regional and national decision makers join these exercises so that a realistic environment is created. The participation of all those involved allows the response processes like information exchange, assessment, advise and decision making to be included. The approach "train as you fight" is pursued for all these processes to enhance realism.
In preparation, officers of the participating institutes ensure that the scenario outplayed during an exercise, matches the exercise goals, that comprises realistic actions under realistic circumstances. For example, if a goal is to instruct drinking water laboratories to take measurements, the expected or diagnosed release and dispersion of radioactive materials must trigger this action.

When unrealistic gaps remain in the exercise setting, prepared injects can be distributed by the exercise leaders. For instance, injects can be messages from various media about social unrest and/or spontaneous evacuation.

An important task of RIVM is the coordination of the national measurement plan, in which is stated which team will take measurements in which location. Various institutes have measuring equipment for the execution of this plan, including advanced measurement vehicles of RIVM and the Ministry of Defence. The experts of RGEN use the measurements to assess the situation and advise about protective actions, like sheltering, evacuation and intake of stable iodine tablets.
Of course, during training and exercise only background radiation can be measured in reality. However, for a realistic exercise it is important that measurements are in line with the scenario, i.e. the expected source term and the resulting dispersion of the released radioactive material. To achieve this RIVM has developed RODIN, a tool that simulates real-time the required measurement data based on the exercise scenario, location, time and weather data .

This means that changes in the release scenario and changes in the meteorological forecast directly affect the measurement data. The real-time requested measurements are made available and subsequently are submitted in the same way and format as during a real incident. This makes it possible to practice in a realistic way with the execution, submission and processing of measurements. In 2023, RODIN will be made available for the institutes of RGEN as well as for the Safety regions.

Challenges
Organising a multi-agency exercise is challenging, for instance because of different exercise goals: if the NPP puts the focus on a threat of a release instead of an actual release during preparation, RGEN cannot exercise the process of mapping deposition but should focus on prognosis. Moreover, if the operators of the NPP get the situation under control, the course of the scenario may turn out differently than expected, and vice versa. There is even the risk that if the release of radioactive material is prevented by the operators, the participants of CETsn and RGEN will become redundant. So when designing the exercise, goals need to be aligned and all possibilities of the course of events must be taken into account without limiting the exercise. As a last resort the exercise leaders can intervene during the exercise to ensure that all exercise goals can be achieved. And again, it is important that the exercise remains as realistic as possible for the participants.

How can we attract and preserve a competent workforce in medical radiation protection?

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Abstract

The European Alliance for Medical Radiation Protection Research (EURAMED) promotes research and teaching and publishes scientific and professional information, especially a strategic research agenda in the field of medical radiation protection research, thereby increasing the science base in medical radiation protection. EURAMED pursues its purpose by co-operating with relevant national, European and international scientific organisations active in this field of interest and in particular with national and international bodies that promote the interests related to medical radiation protection and medical radiation protection research as well as with radiation protection platforms and patient organisations and the public at large.

The EURAMED rocc-n-roll Horizon project aims to propose an integrated and coordinated European approach to research and innovation in medical applications of ionising radiation and related radiation protection based on stakeholder consensus and existing activities in the field. This project is divided into 7 work packages. The objective of work package 2 (WP2) is to elaborate the ideas of 5 European radiation protection research platforms (MELODI, EURADOS, SHARE, ALLIANCE, NERIS) dealing with radiobiology, radiation dosimetry, social sciences and humanities, radioecology and preparedness for nuclear accidents, in the context of medical applications of ionising radiation and the corresponding radiation protection. Moreover, WP2 analyses the ideas and concepts of the SAMIRA project and MEDICIS project and those of regulators as regards the application of ionising radiation in medicine. WP7 will develop a methodological framework and guidance document on how to organise, implement and disseminate education and training in medical applications of ionising radiation and corresponding radiation protection amongst health professionals and researchers
as a strategy to establish a harmonised and sustainable safety culture in radiation protection and related fields amongst health professionals and researchers.
Education and training is essential for the community of scientists engaged in medical radiation protection research to acquire and maintain their expertise and competence. This work will present the topics that are currently discussed within the rocc-n-roll European Union Horizon project framework aiming to attract and preserve a competent workforce in medical radiation protection.

There is a continuing need for high-quality education and training courses for the development and maintenance of the expertise and competence of early career scientists working in medical radiation protection research. Radiation protection platforms and especially the platforms dealing with medical radiation protection research can provide support by organizing education and training events for early career scientists or supporting them financially to join training courses and conferences. These platforms have already created or can create education and training working groups for early career scientists and also disseminate research results to raise the profile of medical radiation research.

A ‘strengths, weaknesses, opportunities and threats’ (SWOT) analysis was performed under the rocc-n-roll WP7. A ‘strength’ related to the education and training of early career scientists is that training initiatives support and encourage European mobility among students and trainees in the field of medical radiation protection. A ‘weakness’ identified by this study is the lack of effective implementation of radiation protection principles in everyday clinical practice. This issue can be addressed by organizing hands-on training courses for early career and experienced scientists. ‘Opportunities’ include the importance of well-trained future generations of medical radiation protection experts. The lack of time or interest by universities to include education and training in radiation protection in the curricula of health professions was included in the ‘threats’ evidenced during rock-n-roll WP7 SWOT analysis.

There is a growing need for education and training in the field of medical radiation protection for all healthcare professionals and especially early career scientists. The EURAMED rocc-n-roll strategic research agenda and the medical community should take into consideration relevant findings and study results to ensure the development of the expertise and competence of early career scientists working in medical radiation protection.

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Building a new graduate-level health physics program: challenges and successes

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Abstract

The University of Alabama at Birmingham (UAB) in Alabama, USA, began a master's-only health physics program in Fall 2016. The program is housed in the School of Health Professions, Department of Clinical and Diagnostic Sciences, alongside other more clinically focused programs such as Nuclear Medicine Technology and Genetic Counselling. The program was started while several other health physics programs in the USA were shutting down due to lack of students and interest in the programs. The UAB Health Physics program is now the only one of its kind in the South.

The program faced a number of challenges immediately after its inception. The acting program director and developer of the curriculum was a nuclear medicine technologist. Despite accepting the first cohort of students in Fall 2016, the program had no full-time health physics faculty until mid-2017. The lab equipment was severely outdated, there was no cohesive recruitment strategy, no ability to fund students, and no connection to the relevant professional societies. Most concerning, the program lacked direction.

Despite these difficulties, the program has proven successful to date, primarily because of passionate faculty willing to work hard to make the program unique amongst the declining competition. The program's key component, a practicum requirement, has given it direction and a focus on applied health physics. After retirement of the original program director, health physics faculty were promoted and given administrative support that led to new equipment, grants supporting students, and additional faculty. The result was an enrolment increase from four students to 12 from the fall 2021 cohort to the fall 2022 cohort. The program currently has over 20 applicants for the fall 2023 cohort to date.

This paper will cover the rebuilding process, including a discussion of lessons learned and mistakes made along the way, in hopes that future programs may benefit from the UAB experience.

The BSc physics, medical physics and radiation protection at the university of Malta: a success story in attracting young people to the radiation protection professions

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Abstract

In many countries the Radiation Protection professions (Radiation Protection Expert and Medical Physics Expert) face an acute shortage of entrants owing to the low popularity of two-year master's programmes and the irregular number of physics/engineering graduates. Under such conditions of uncertainty, the two professions would not only fail to grow but inevitably decline leaving patients, workers and the general public without Radiation Protection services. Solutions need to be found to: (a) address the paradox of having to reduce master's programmes to one year at a time when the knowledge-skills-competences required are expanding rapidly (b) ensure that the potential stock of entrants to the professions would be independent of erratic student numbers in physics/engineering. *We present our own solution to the issue and hope it can help other countries develop their own*.
A literature review and survey of Radiation Protection and/or Medical Physics undergraduate and postgraduate programmes was carried out. Best practices were identified and adopted. Given our limited resources, the best way forward was to opt for an undergraduate inter-faculty programme that combined physics and mathematics, radiation protection and medical physics. In this way we could use the resources from different faculties (reducing the cost) and ensure that the resulting degree would satisfy the undergraduate requirements for these professions whilst providing a robust preparation for a subsequent one-year master's in Radiation Protection and/or Medical Physics. The resulting four-year programme consists of 5 parallel strands namely physics/mathematics/statistics/programming, radiation-protection/medical-physics, basic-medical-sciences, research and hospital placements. Those opting for a Medical Physics career can then follow with a one-year Masters in Medical Physics. Since we do not have a wide industrial/nuclear base and given the size of the country, a second Masters in Radiation Protection is in our case not practicable. On the other hand, this would be highly recommended for larger countries. We have, however, included a 5 ECTS study unit in Industrial and Environmental Radiation Protection in the Bachelor's programme (in which we have included also lectures on the nuclear energy industry) and hope that this would encourage some students to follow further studies in these areas elsewhere in Europe. We also plan to include placements in industrial/environmental Radiation Protection in the future.
This innovative curricular experiment has been a great success. The inter-faculty nature of the programme (where students share lectures with both physics students from the Faculty of Science and healthcare students of the Faculty of Health Sciences), the intrinsic multi-disciplinarity of the programme together with the practical placements have been found to be the most appealing features.

We are pleased to report that the first cohort of students will graduate in July 2023 and we will report on the results of our ongoing programme review in the hope of helping others achieve similar successes. One lesson definitely comes out loud and clear, if we want to be successful in attracting (and eventually working to preserve) a competent workforce in radiation protection, the earlier in their career we target students the higher the probability of success.

Protection and safety of patient and staff during external beam

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Abstract

There is a current action to increase radiotherapy services in Kenya. The National government of Kenya, in collaboration with the county governments, has embarked on building radiotherapy centers in all the 47 regions of the country. As these new centers are established in Kenya, it has to be ensured that minimum radiation safety standards are in place prior to operation. For full implementation of this, it is imperative that more research and training to regulators are done on radiation protection and safety and national regulatory infrastructure is geared towards ensuring radiation protection and safety in all aspects of the use of external radiotherapy practices. The present work aims at reviewing the level of protection and safety for patient and staff during external beam radiotherapy using Linac in Kenya and provide relevant guidance to improve protection and safety. A retrospective evaluation was done to verify whether those occupationally exposed workers and patients are adequately protected from the harmful effect of radiation exposure during the treatment procedures using Linac. The project was experimental Research also including analysis of resource documents obtained from the literature and International Organizations. The critical findings of the work revealed that the key elements of protection of occupationally exposed workers and patients include a comprehensive quality management system governing all planned activities from siting, safety and design of the facility, construction, acceptance testing, commissioning, operation and decommissioning of the facility; Government empowering the Regulatory Authority to license Medical Linear facilities and to enforce the applicable regulations to ensure adequate protection; A comprehensive Radiation Protection and Safety programme must be established to ensure adequate safety and protection of workers and patients during treatment planning and treatment delivery of patients and categories of staff associated with the Facility must be well educated and trained to perform professionally with a commitment to sound safety culture. Relevant recommendations from the findings are shared with the Medical Linear Accelerator facilities and the regulatory authority to provide guidance and continuous improvement of protection and safety to improve regulatory oversight.

From student participation to infinity: implementing digital innovation for success in education of radiation protection

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Abstract

A key observation we made during our years as Radiation Protection (RP) educators at the Hanze UAS is the insecurity which students struggle with during their education program. This is amplified by their tendency to work on their own and highlighted by the repeated demand for additional practice material. In an attempt to combat this insecurity we decided to take several steps in order to increase student participation and supply additional, nigh infinite, practice material.

In order to stimulate student participation we introduced a digital forum in which students are steered towards for asking RP questions. This resulted in an increased student interaction and reduction in emails send. This novel forum introduction was supported with strengthening of several projects, experiments, student cooperation and tutoring by more experienced students.
Another novel introduction was the design, building and introduction of a website which generates nigh infinite RP related questions for students. This website is positively received as an educational support tool by our students. Further expansion of this website has been made possible with the support of commercial partners and is freely available at www.radquesgen.com and www.stralingsvragen.nl.

The introduction of both the forum and question generator had a positive effect on student participation, RP understanding and their confidence in the material.

Oral presentations

Online and hybrid learning: innovation and experience gained

Radiochemical experiments in a new virtual radionuclide laboratory: interim results from the European HORIZION 2020 project A-CINCH

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Abstract

A-CINCH, an EU HORIZION 2020 project, is dedicated to the education and training of radiochemists and aims amongst others to develop new digital and freely accessible learning opportunities. This includes a virtual reality (VR) laboratory in which users can approach radiochemistry including RP in a playful way. Users can move freely around the VR lab, try out detectors or carry out guided experiments. These virtual hands-on trainings (vHoT) have different levels of difficulty and are not only aiming at students, but can also be used, for example, to train members of the competent authorities who are responsible for approving radionuclide-laboratories. A preliminary version of the laboratory has already been tested for this purpose and was evaluated very positively by the users.

The VR lab was developed in an iterative process between experts in radiochemistry and programmers. For this purpose, test versions of the VR Lab were shared and extensively tested at an early stage so that possible inconsistencies were identified and resolved. The application was programmed in the 3D development environment "Unity " and is browser-based, i.e. it does not have to be downloaded and installed, but can be opened via a browser (optimized for Firefox). The VR lab was also programmed to be accessible using VR glasses, so that users can dive even deeper into the virtual world.

The VR lab includes several labs, a measuring room, changing rooms and an entry area. People who have never entered a controlled area can practice the entry and exit procedures in a short vHoT. Additionally a vHoT for determining the half-life of K-40 was implemented, which has a rather low requirement level and can be carried out in schools, for example. The determination of Pb-210 and Po-210 in water is a more comprehensive vHoT for advanced users. As in the other vHoTs, the experiment is divided into several quests, which in turn are divided into tasks. These smaller tasks support the users in carrying out the virtual experiments.

At the moment, not all vHoTs have been finalized, but by the time of the conference, the programming should be completed and initial feedback from different user groups, such as students or authorities, might be available. During the first use of the lab, the users will be asked for a comprehensive evaluation in order evaluate the learning success, user-friendliness, strengths and possible weaknesses of the program. Results of this evaluation will be published and can be used to optimize the applicability of the VR-Lab.

Early stage experiences with using virtual reality to enhance learning experiences with ionizing radiation in radiation protection courses

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Abstract

Rapid technology advancement provides the world with opportunities to improve our every life. Virtual Reality (VR) is one of those technologies which can be used to benefit the learning experience of students by providing a visual, interactive and safe learning environment. These three characteristics are especially useful in teaching students the fundamentals and behaviour of ionizing radiation, which cannot be seen by the human eye but does nonetheless affect the human body and its surroundings.

NRG Academy embraced the development of Virtual Reality in radiation protection courses as one of its main strategies for the coming years. To realize our strategy we use a phased approach where we, together with our partners first developed three different environments for themed training scenarios which are to be considered early stage pilots:

- scrap metal scenario – locating and securing contaminated objects,
- production platform scenario – this is an environment of a production platform with some small features where you can locate a source.
- medical scenario – this is an environment of an operating room with a C-arm of which you can turn a primary beam on and off and move the C-arm in all directions. Scattered radiation is not yet included.

Because VR is an expensive investment we wanted to receive early feedback, which we achieved by demonstrating our pilot scenarios at different symposia. The most important feedback we received was:

- it is 100% ALARA, the student is not exposed to ionizing radiation
- it enhances the learning experience of students: it feels real and is fun!
- VR modules offer the ability to tailor scenarios to specific needs of the user
- the student has to get accustomed with VR. Some people experience dizziness, especially older people.
- users are sceptical if VR can be a one for one replacement of lab training.

We received similar feedback from our customers since we use VR as an addition in some of our courses. With the feedback received in mind we are working on the following topics:

- a sandbox mode where one can place walls and object, add shielding properties to them, add a radioactive source, a dosimeter and more so that scenario's for specific purposes can be made.
- a simplified model of dispersing radioactive material so we can use that in a laboratory environment and on the production platform.
- a simplified model of a primary x-ray beam and scattered radiation.

With the end goal of creating well-established radiation protection VR courses in the near future.

Radiation safety e-learning training for non-radiology doctors and other staff: experiences in a major academic teaching hospital in Ireland

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Abstract

Beaumont Hospital is a major academic teaching hospital in Ireland with over 400 staff involved in work with ionising radiation, including a biennial intake of over 100 junior doctors every January and July. The requirements for radiation protection education, training and information are specified in Chapter IV of COUNCIL DIRECTIVE 2013/59/EURATOM. These requirements are articulated in Irish law under two separate regulations:

- Regulation 35 of SI 30 (2019), regulated by the Environmental Protection Agency (EPA), relating to worker and public radiation safety
- Regulation 22 of SI 256 (2018), regulated by the Health Information & Quality Authority (HIQA), relating to patient radiation safety.

The regulations require the undertaking (for example, a hospital) to ensure that workers have relevant radiation safety knowledge, competence and skills to carry out work with ionising radiation. The experience of using an in-house e-learning program to provide radiation safety knowledge training to all relevant staff is described in this synopsis.

Material and methods

Online training programs for hand hygiene, fire safety, manual handling and other topics are widely available in Beaumont Hospital. Such training is mandatory for relevant staff and is recorded on the hospital's learning management system. The online radiation safety training programs were designed and implemented in consultation with the radiation protection adviser, medical physics expert, and radiation protection officer, using the available tools (i.e. Adapt builder® on www.learningpool.com). The content of the programs is based on regulatory requirements, having regard to the knowledge components of in RP 175 (Guidelines on radiation protection education and training of medical professionals in the European Union). The radiation safety training programs for non-radiology doctors and other workers were implemented, with a three-year refresher. To simplify the training process, incoming non-radiology doctors were given a link to the relevant online radiation safety program weeks before they started working at the hospital.

Furthermore, the completion of the e-learning program is required prior to working in a controlled area and before access to the local radiology referral system.

Results

The online training program was formally implemented and provided to 360 staff, across nine clinical directorates including non-radiology doctors. The completion rates for different directorates within the hospital were captured in 2020, 2021 and 2022. The overall completion rates for all relevant staff are 63% for 2020, 69% for 2021 and 73% for 2022. Completion rates for some clinical directorates were lower on average but increased for all but one directorate year on year.

Conclusions

Future work will focus on increasing the completion rates of radiation safety training through consistent communication with directorate heads and other stakeholders. The completion rates of training for all groups and individuals are available for regulatory review. The content of the knowledge-based training modules can be updated and tailored to any future requirements prescribed by the relevant professional bodies and/or regulators. The experience of using this system has also helped to inform the current development of a national online radiation safety training program in the Irish public health service.

Radiation protection update training for dental professionals and university staff/students: experiences with online vs face-to-face options

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Abstract

Background
Dental practitioners and other registered dental care professionals in the UK undergo regular update training on radiation protection matters as part of their CPD requirement. Experience gained from delivering these courses has shown that if assessments are not made as part of the update training session, it is difficult to demonstrate that real learning has taken place. It is also difficult to know whether there are any areas within the lectures that prove difficult for participants to understand. The author examined whether this situation can be improved by the use of both pre-and post- training session testing, and what, if any, differences occur when delivering courses face-to-face or online.

Methods
Each dental CPD training session was delivered by the author as a series of 5, consecutive 1-hour lectures designed to cover the topics in the defined syllabus.
Participants in both face-to-face and online courses were encouraged to actively participate by asking for clarification on any issue. Participants in the online sessions were required to keep video on throughout the lectures, to try and ensure continued participation.

Prior to the start of the training session, participants completed a short 10-question largely multiple-choice questionnaire (MCQ). At the end of the session, participants then completed a longer 30-question MCQ. The questions on the pre-session test were a sub-set of the post-session test. Many questions on both tests were designed to have more than one correct answer, and participants were informed of this beforehand, both on the test sheets and by verbal reminder. No fixed time limit was given for the completion of the questionnaires and participants were allowed to use any notes they had taken for the post course test. The pre- and post-training session MCQs have been used at eight face-to-face training sessions with a total of approximately two hundred participants and three online sessions with a total of 32 participants.

Results
88% of participants in the face-to-face sessions, all participants in a small sub-set of subsequent courses with amended lecture ordering and content, and all participants
in the online sessions demonstrated an increase in their percentage test scores. Face-to-face sessions had a mean increase in percentage score of 18%, against 35% for the amended face-to-face lectures and 28% for the online sessions. Differences between pre- and post- course test scores were significant at $p<0.01$, assessed using the Wilcoxon Rank-sum test.
Individual question scores were also analysed and demonstrated that certain questions generated more incorrect answers than others, and these will be discussed. Anonymised feedback sheets showed satisfactory results throughout.

University radiation protection training courses
In line with the institution's health & safety policy, the author delivers short (two-hour) basic radiation safety training courses to all staff and students who are intending to use x-ray sources at a university. These are usually delivered face-to-face, although they were delivered online during the Covid pandemic. Anonymised feedback sheets are used for all the face-to-face courses, and have consistently showed satisfactory results. Difficulties in giving these courses online for this type of audience will be discussed, principally due to difficulties in ensuring active engagement.

Conclusions
The use of both pre- and post-course testing for dental radiation training courses can demonstrate that learning has been effective. The analysis of individual question scores can shine a light on those areas where learning has not been as effective and thus help with the delivery of future courses. Online courses showed no detriment in learning outcomes when compared to face-to-face courses. Online courses were not felt to be satisfactory for the university radiation safety courses.

Continuing online radiological protection education for professionals

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Abstract

Introduction
In order to fulfil Spanish legislation, health professionals that work with ionizing radiations must receive continuous education in radiation protection. This education task ought to be imparted by medical physics and radiation protection departments. During COVID-19 pandemic it was difficult to maintain training quality so online courses were developed for the units that work with ionizing radiation, both in their diagnostic or therapeutic activities. The aims of this study are to present a simple way to virtualize the continuing radiological protection lessons and to assess their satisfaction.

Materials and methods
Four courses were developed about radiation protection in nuclear medicine, radiation oncology, radiology (including all the other units that use X-rays in their clinical activity, like urology, traumatology, etc.) and physical security of high activity sources. The courses were designed with Moodle 3.4 and integrated in an established online training platform accessible by all employees. These courses consist of different units, between six and eleven, each one followed by a self-evaluation test. The contents of these courses include occupational and patient radiation protection, practical situations and frequent mistakes. Furthermore, to pass each course the trainee must complete a final virtual exam and an anonymous satisfaction survey. This online training is available for one month and its duration goes from eleven to fifteen hours for the different courses. The courses are accredited by the Regional Health Council.

Results
Thanks to the prior attendance rates in the face to face modality, we have an indicator of the scope of digitizing the education in radiation protection. The analysis shows that attendance rates grow by 30% for nuclear medicine when compared to face-to-face courses, 27% for radiation oncology and 12% for radiology. After surveying all the participants, we can ensure that the level of satisfaction is good (over 8/10). Moreover, we collect suggestions and complaints that will help to improve the next versions.

Artificial Intelligence in education and training

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Abstract

Problem-solving approaches are an essential part of learning. Knowing how students approach solving problems can help instructors improve their instructional designs and effectively guide the learning process of students. We propose a natural language processing (NLP) driven method to capture online learners' problem-solving approaches at scale while using Massive Open Online Courses (MOOCs) as a learning platform. We employ an online survey to gather data, NLP techniques, and existing educational theories to investigate this. The proposed method discovered problem-solving approaches from the text data, such as using pen and paper, peer learning, trial and error, etc. We also observed topics that appear over the years, such as clarifying code logic, watching videos, etc. We observed that students heavily rely on "tools" for solving programming problems.

How BRAVER challenges students in radiation protection training

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Abstract

International staff and students of the Cherne network collaborate in developing blended learning activities in environmental radioactivity monitoring and radiation protection within the framework of an Erasmus+ strategic partnership 'BRAVER'. Within this 2 year program virtual reality tools and virtual escape rooms are explored and developed in online and on-site training activities for and by different groups of international master students of nuclear technology in collaboration with master students from software computing. Co-creation triggers their technical and social skills. Generic skills, such as sustainable development and soft skills, are becoming very important for the future nuclear engineers. In addition, lessons learned from previous Erasmus projects and from the corona challenges are further optimized by the professors team in order to have a sound program of pre and post training activities online like e-learning, COIL, train the future trainers,… in tune of the 3 face2face training schools. The blended activities have a value of 4 ECTS per training module.
In the final stage a dissemination event for (pre-service) teachers STEM of high schools will be organised in the fall of 2023 at UHasselt in Belgium. The gamification tools dedicated to nuclear and radiation protection topics are disseminated to a larger public and this can attract more interest to these topics for future professionals which is really a necessity for the labour market.

How can we use digital learning tools in hybrid learning?

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Abstract

A few years ago the world was confronted with the need to develop online learning methods. A lot of creativity and effort was put into building online courses and digital learning tools. Nowadays we can go back to the old ways of teaching, but isn't it a waste to discard the developed learning tools? But how can we integrate the online tools in hybrid courses? And how can the teachers cope with the extra strain and difficulties of simultaneously online and in-person?

Hybrid learning is an educational model where some course members attend class in-person, while others join the class online. In radiation safety training it is often undesirable to have a pure hybrid system, as we usually want to have in-person attendance of practical classes. But we can also use online learning tools for the course members who attend the classes in-person.
How can we design radiation safety courses in which we can combine the best of both worlds?

In this presentation we will look at how we use our previously developed online learning tools in our hybrid learning programs. We specifically look at four online learning tools:

- *The decontamination strategy* is the simplest tool, a picture game in which the steps to remove a contamination are randomised. You can drag and drop the pictures in the correct order, which is a good primer for performing this task in real life.
- *The Escapelab* is much more complicated, especially for the developer! In this adventure game an alarm urges you to leave an isotope laboratory fast and safely. A menu with options is shown and selecting an option starts a short video. An actor illustrates your choice and a voice over provides feedback. A bad choice gives you a retry, a good choice gives you new options. This results in a large amount of possible scenarios, but only in a few scenarios you will leave the lab safely.
- *A 360 degrees virtual reality video* is used for training medical specialists who use fluoroscopy. Using your smartphone in a special viewer you stand at the table as member of the team. A fluoroscopy procedure starts, but around you strange things are happening … You have to spot the good, the bad and the ugly, which then is discussed with other participants and a trainer. This trains ALARA-awareness, but also shows the different roles in the team and organization.
- *The online fluoroscopy practical teaches* you how to interact with the X-ray operator. For this a video-stream of the fluoroscopy room with the X-ray operator and the generated X-ray images are merged in one single livestream. The operator can see and hear you and together you adjust the C-arm to get the right images, without unnecessary radiation for the patient and operator.

Post-Covid andragogic improvements of radiation safety training

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Abstract

At the University of Alabama at Birmingham (UAB) in Alabama, USA, hundreds of diagnostic and therapeutic procedures involving radioactive materials or radiation-producing machines are performed daily. A growing number of minor but preventable incidents related to radiation safety have brought up concerns related to the effectiveness of the training program. Historically, training of authorized users and personnel centred around a week of lectures delivered by members of the UAB Radiation Safety Program (RSP), culminating in a 100-question exam to determine competency and understanding of principles related to health physics. Technological advances and a desire to make the training more accessible resulted in this training being moved to an online medium, where concepts are taught over one to three text-based files, less than ten pages each, with five multiple-choice questions to test competency. The authors were interested to find out if this training could be the cause of the minor issues observed and how the training could be improved. A comprehensive literature review was performed to summarize post-Covid insights into andragogic online training practices, statistical analyses, and overall retention competencies in radiation safety. The review found that personnel in other institutions often suffered from a lack of understanding of foundational radiation safety concepts before interventions. While studies show that lectures can increase an employee's understanding, andragogic research shows that the best method of training adult learners is controlled simulations that test one's critical thinking and problem-solving capabilities, drawing upon previous knowledge or experiences. The authors propose a radiation safety training curriculum that will be tested within a subgroup at UAB. The curriculum will use pre- and post-testing as well as efficient use of limited university resources to attempt to maximize retention of radiation safety concepts. The curriculum will be evaluated by the tests indicated above, and an analysis of the number of radiation safety incidents over time.

AWE radiation protection access training

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Abstract

The Radiation Protection and Dosimetry Group of AWE deliver mandatory training to personnel to enable them safely carry out work in the radiological facilities in AWE. The courses are Radiological Safety, and Barrier Procedures and Basic Monitoring, which form part of the company's commitment to providing information, instruction and training to all personnel working in radiological facilities in compliance with Ionising Radiations Regulations 2017 (IRR17). Radiological Safety training has two main delivery modes: face-to-face and online, whereas the Barrier Procedures and Basic Monitoring incorporates both online and face-to-face practical sessions. Over the COVID period, due to difficulties of meeting face-to-face, we gained an opportunity to embrace modern technology and deliver a practical online course whilst still maintaining the course's hands-on elements. These access courses present the opportunity for personnel to engage with the course content at their own pace and for any learning gaps to be addressed by the trainer. During the presentation, I will explain how these two access courses were structured and delivered, and some of the challenges and benefits this mode of delivery presented.

Risk minimisation in online radiation protection training

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Abstract

The increase in the use of online and video conference technology to aid teaching and learning has resulted in a rapid growth of online tutorials. There are now university courses specifically designed to be delivered online to a global audience and even virtual schools complete with headmasters. The recent pandemic also drove training for radiation protection services onto online platforms.

My project explored how and if sufficient learning could be achieved that would satisfy the philosophy of risk minimalisation (ALARP) through online learning platforms. To do this I examined the different styles of learning people have, the training needs of a person working with ionising radiation, the depth of information and instruction that was needed, and what type of learning would be required to meet their training needs.

The different types of learning activities that a trainer may use were characterised to determine the level and depth of information they could embed in the learner. When researching online learning platforms, I compared these activities to those available on the platform. This would allow me to evaluate the level of suitable and sufficient information that can be taught and suggest if an online platform would be suitable in order to achieve the desired outcomes of the training.

This is continuing evolve and allows us to identify and work with UK businesses to provide knowledge and information to more people who require it.

National training courses on radiation protection organized at Instituto Superior Técnico in Portugal: a pandemic experience

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Abstract

In Portugal, the training programmes for the education and training (E&T) of Radiation Protection Experts (RPE), Radiation Protection Officers (RPO) and radiation technicians or operators (RT) are established by the law and recognised each 3 years by Agência Portuguesa do Ambiente (APA), as the regulatory for radiation protection. The legislation determines the structure of each E&T programme, the topics dealt with time allocated to each topic, duration of theoretical and practical sessions, as well as the eventual time length of on-the-job training.
Instituto Superior Técnico (IST), the school of engineering of the University of Lisboa, through its Laboratório de Proteção e Segurança Radiológica (LPSR) and its Departamento de Engenharia e Ciênicas Nucleares (DECN) submitted three programmes for the education and training of RPE, RPO and RT which were been approved in June 2020 for the period 2020-2023.

With the collaboration of Tecnico+ for the announcement, registration and logistics, several courses have been organized since then. Due to the SARS Covid-19 pandemic, the training courses that were initially planned to be held on an in-person basis were transformed into completely online for RT and partially (50/50) online for RPO. The Zoom and Moodle electronic platforms were used to impart classes and to disseminate the necessary information, including the transparencies presented at each training session and the evaluation process for both RT and RPO.
In the period from October 2020 to the Spring 2023, nine RT and five RPO trainings were offered, attended by 288 and 166 people, respectively.

The evaluation process for the RT consisted of a test with 30 multiple-choice questions. In the case of RPO and in addition to the multiple-choice questions, the attendants underwent a further written exam uploaded in the Moodle platform.
This work aims to understand how the training actions were performed during the pandemic time, analyse the lessons learned from that period and formulating a critical overview for the next 3 years programme, taking also in consideration the assessment made by the participants.

Effectiveness of the post-pandemic hybrid education in radiation protection: first results

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Abstract

After the Covid-19 pandemic restrictions were lifted and educational institutions were able to conduct face-to-face lectures, returning to the old model of education was not easy. The experience gained in conducting distance learning during the pandemic was analysed and used. As a result, after the pandemic, instead of returning to the old face-to-face form of education, we developed and implemented hybrid learning, which includes many elements of face-to-face and distance learning, and at the same time new approaches that we have not used before. Despite, the fact that distance and hybrid forms of education were known and used before, COVID-19 pandemic became a certain trigger that led to the development of a hybrid system of education and training on radiation safety. After the pandemic, radiation protection trainings are already being conducted by us in a hybrid form. A system that allowed us to evaluate and compare the effectiveness of training both in full-time and distance learning was used by us to compare them with a hybrid form of training and evaluate its effectiveness. For hybrid learning, a number of such indicators exceed similar indicators of face-to-face and distance learning. Despite the fact that education and training in radiation safety in a hybrid form has recently begun, and the number of students who have completed a retraining course, including radiographers, doctors and RPO, is still relatively small compared to students who have completed a course of study in person or remotely, even the first obtained results allow us to be very optimistic towards a hybrid form of education and training.

Hybrid training of first responders for nuclear and radiological emergency preparedness and response in Lithuania

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Abstract

In Lithuania there are no operating nuclear power plants or research nuclear reactors, but neighbouring country operates a nuclear power plant just 20 kilometres from Lithuania national border, which is classified as Emergency Preparedness Category (EPC) V (according International Atomic Energy Agency safety standards). Possible emergency in this nuclear power plant could have impact to Lithuania also, that's why it is very important to ensure adequate preparedness and response to potential nuclear or radiological emergencies. One of the most important aspects of ensuring Lithuania's adequate preparedness and response to potential nuclear or radiological emergencies is radiation protection training for first responders (firefighters, police officers and emergency medical personnel). First responders are the first to react to any types of emergencies including nuclear or radiological emergency, so it is essential that they would be trained in radiation protection and have the necessary knowledge and skills. It is important that all responders would be trained in radiation protection, but it is very difficult to achieve because of the lack of the human resources (competent trainers), different working hours of first responders, geographical locations, etc. For these types of challenges hybrid training becomes very convenient.

According to Lithuanian legislation, all firefighters and police officers are required to undergo compulsory radiation protection training and to repeat it every five years. Radiation protection training focuses on preparing for and responding to nuclear or radiological emergencies and on detecting orphan radioactive sources or objects contaminated with radioactive material. They receive distance learning based on pre-prepared methodological material. This training is followed by an assessment of the radiation protection knowledge of first responders. Given the large number of first responders and the insufficient human resources (competent trainers) to provide contact training, mandatory radiation protection training is organized remotely.

In addition to compulsory radiation protection training, first responders and personal health care workers receive practical and theoretical radiation protection training organised and delivered by radiation protection specialists from the Radiation Protection Centre. Such training is conducted on a contract basis to the first responders and personal health care workers working in municipalities within the extended planning distance (100 km) of a nuclear power plant in neighbouring country (Emergency Preparedness Category V). These trainings covers the following topics: biological effects of ionising radiation, methods of protection against exposure to ionising radiation, the use of personal protective equipment, the use of dosimetric devices, methods of decontamination, etc.

Exercises are essential part of preparedness and response to nuclear or radiological emergency, and allows to put to the test received theoretical and practical skills acquired during hybrid (remote and contact) training. Various types of exercises (institutional, municipal, national) are organised annually in Lithuania and involve first responders, personnel from responsible institutions, healthcare facilities, and other governmental or municipal institutions and agencies that have assigned functions in the case of a nuclear or radiological emergency.

Following the exercises, good practices and gaps in preparedness and response to nuclear or radiological emergencies are identified. These gaps are addressed in the training programs and the lessons learned are reinforced in the next exercise.

The hybrid radiation protection training has many advantages and is the most suitable for Lithuanian. The advantages of this type of training over contact-only or remote-only training are: fewer human resources (competent trainers) are required, larger number of first responders can be trained in a short period of time, flexible learning time, etc. As past events showed, one of the biggest advantage of hybrid training is that it can be carried out even during pandemic.

Oral presentations

Integration of social sciences and humanities and public engagement

An ethical capability-possibility framework for education and training in radiological protection

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Abstract

Today, any evaluation of the development and possible use of technology in society has to consider its broader impact on that society, taking into account not only technical and economic factors but also social, political and ethical aspects. And it is known that, in a future-oriented perspective, these evaluations are by default complicated by knowledge-related uncertainties and influenced by value-based informed opinions. Given the inherent presence of the radiological risk, this is especially true for nuclear technology, regardless of the application context (energy, medical, industrial).

Therefore, whether in a research and development process, in the formulation of policy advice or in a concrete political decision making setting, responsible evaluations are those that also take into account the social, political and ethical aspects and the related uncertainties and opinions as formulated above. Meanwhile, multiple theoretical and practical approaches have been proposed and developed as a response to this challenge. The 'integration' of social sciences and humanities in research, 'transdisciplinarity', 'participatory technology assessment', 'post-normal science' and 'responsible research and innovation' all have in common that they start from the recognition that 'traditional science' relying on techno-scientific rationales, models and numbers alone cannot longer do the job, and that R&D, policy advice and political decision making should also be inspired by ethical reflection that integrates the recognition of uncertainties, value-based arguments and interests of various stakeholders and the future generations.

Taking into account the meaningful similarities and differences of these 'advanced methods of knowledge generation', the presentation will initially reflect on the overall ethical motivation to consider and implement them, and propose *holism*, *transdisciplinarity* and *inclusion* as the general 'qualities' of these methods.

New visions on evaluating technology development and use is one thing. The success of these advanced methods, however, is another one, as it essentially depends on the preparedness to implement them (and take the outcome serious) but also on the way all concerned can be sensitized to recognise their value and to engage in them. Although these advanced methods can be seen as inspirational and stimulating learning processes in themselves, sensitization essentially roots in education and training. Whether researcher, technology developer, practitioner or policy maker, we all benefit from education and training programmes that integrate ethical reflection taking into account the wider context of technology assessment.

Elaborating further on this reasoning, and drawing from the capability approach of Amartya Sen and Martha Nussbaum, the presentation will consider a-priori capability requirements and propose an ethical 'capability-possibility' framework that could inspire education and training in the interest of a responsible generation and use of knowledge in radiation protection policy in the broadest sense.

Co-creative Radiation Education Program (CREPE) in Osaka University

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Abstract

Socially important issues in Japan, such as “Reconstruction of Fukushima” and “Nuclear-Power Problem”, have complex causes and backgrounds, so that no single academic discipline can approach problem solving and thus, multidisciplinary approach is necessary.

Co-creative Radiation Education Programme (CREPE) in Osaka University is an educational program to develop human resources who can play an active role in approaching the complex contemporary social issues related to the radiation sciences.

In this program, the "Fukushima Hamadohri Environmental Radiation Workshop" is the entrance of the course. Learning from the negative legacy of disasters and accidents, we should make secure society in the future. The most important thing for the future is to pass on the wisdom of reconstruction based on scientific perspectives to future leaders. In the hands-on course of the Environmental Radiation Workshop, students visited Fukushima Hamadohri area, which was strongly damaged by the power-plant accident, and conducted environmental radiation measurements, interacted with local residents, and toured the damaged areas, the under-construction areas, and also the nuclear power plant. This is a unique program that makes one think about LIFE through your five senses.

This workshop is followed by cross-departmental education subjects on the theme of radiation. Students takes subjects from two groups, “Co-creation subject group: Radiation science and Social science” and “Radiation science training”. “Co-creation subject group” has both Natural Science subjects and Social Science subjects. Students can learn the practical knowledge, such as risk communications. “Radiation science training” is an advanced program of "Fukushima Hamadohri Environmental Radiation Workshop".

By providing advanced education through practical training and lectures to students in a wide range of academic fields, we aim to develop human resources who can bring together people from many different backgrounds to consider problems and find solutions.

Oral presentations

Competence standards for trainers

How to include AI in trainer competencies

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Abstract

The recent surge of AI affects many aspects of life, including education. This has implications for students, but also for teachers and trainers.
During this keynote we will first set the scene by discussing what has changed during this recent emphasis on (new) AI tools. Next, ways in which AI can influence teaching and assessment will be addressed.
As the developments in the field of AI can happen at an overwhelming rate, we will lastly discuss some tips on how to include AI into your trainer's practice.

Selection and evaluation of lecturers for EEAE ‘s training activities

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Abstract

The Greek Atomic Energy Commission (EEAE) is the national competent authority for radiological and nuclear safety and radiation protection. Within this framework, and among other activities, it provides and ensures the training on radiation protection of occupationally exposed workers in the fields where practices with radiation sources are implemented (e.g., medicine, industry, research, etc.) Moreover, it draws up the national strategy for education and training in radiological and nuclear safety and radiation protection.

To fulfil its role and cover all the identified training needs at national level, EEAE develops and provides training courses on radiation protection, addressed to the needs of the different categories of occupationally exposed workers and professionals involved in radiation safety arrangements. In addition, it is a participant and major contributor to the Interuniversity Programme for Postgraduate Studies in Medical Physics – Radiation Physics in Greece.
At regional and international level, EEAE fulfils its role as IAEA's Regional Training Centre (RTC) in Europe in the English language by organizing the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC).

In this respect, and for ensuring the continuous improvement in the quality of the training services provided and the optimization of the available resources, EEAE has developed and implements an integrated management system for the design, development and provision of services of non-formal education and training based upon and certified according to the ISO 29993:2017 standard.

This work presents the processes, procedures and the related criteria that EEAE applies within its implemented management system as well as the associated challenges regarding the creation of a pool of competent lecturers to support its national and international training activities.

A Portuguese experience in Education & Training in radiation protection

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Abstract

The Portuguese transposition of the Council Directive 2013/59/EURATOM came into force in April 2019 and redesigned the radiation protection landscape forever introducing a new regulatory authority as well as a new inspection authority. Education and training in radiation protection has since been equally enforced.
A year later, in the midst of the COVID-19 pandemic, ISQ became the first authorised training provider for the qualification in radiation protection for general workers (minimum 18h) in both medical and industrial practices, and online learning was implemented.
After 3 years we can now look back and assess our experience over >120 courses and >1200 professionals trained. To achieve this goal, this study we will present a statistical review of all training provided taking into account different parameters such as:

- Training course scope: medical, dental and industrial (x-ray generators and sealed sources)
- Distribution between:
    - Trainee educational level
    - online vs. classroom learning
    - working hours vs. post-working hours
    - evaluation results
- Trainee satisfaction surveys: Evaluation of:
    - Trainer
    - Organization
    - Overall
    - Survey response rate

We have learnt that the immediate transition to online learning, due to COVID-19 restrictions, was relatively well implemented and well received by both trainers and trainees. The most frequent criticism of the training courses is both the extension and complexity of the program proposed by the regulatory authority, given the time available (minimum 18h) in contrast with the learning skills for the minimum trainee education level to attend (12th grade); the minimum trainee education level (12th grade) to be eligible for Level 3 (General Exposed Worker) radiation protection qualification is also seen as obstructive and a limitation to access further education and professional development, especially regarding older generations; as well as the limited practical activities.

In order to address these issues, a revision of the current radiation protection qualifications regulation has taken place, for which ISQ's participation, feedback and inputs were invited by the regulatory authority.

A draft proposal has already been concluded which includes the following main changes:

- Greater stratification for Level 2 (RPO/RPS) training
- Significant reduction of Level 2 (RPO/RPS) training duration from 100h to a range of 18h-48h according to practice

- Reduction of the minimum educational level to be eligible for Level 3 (General Exposed Worker) radiation protection qualification from 12th grade to 9th grade
- Significant reduction of Level 3 (General Exposed Worker) training duration from 18h to 9h for industrial practices, and 12h for medical practices
- Online and hybrid learning: innovation and experiences gained
- Integration of social sciences and humanities and public engagement

Regarding trainers, this has also been a struggle to access available qualified radiation protection training professionals, and essentially is due to 3 cumulative requirements:

- General initial trainer certification required for any professional education and training topic (minimum 90h) – not required for educational entities such as universities
- Specific radiation protection qualification:
    - Level 1 (Radiation Protection Expert, RPE – 300h), OR
    - Level 2 (Radiation Protection Officer, RPO – 100h)
- Individual availability (personal interest/vocation for training, time constraints and/or contract exclusivity issues)

As such, the current training team is comprised of only 3 individuals, one internal and 2 external individual service providers, which results in a reduced/limited offer to those who seek training. (There is 1 professional acquiring general initial trainer certification to integrate training team).
This difficulty in attracting and preserving a competent workforce in radiation protection is not only specific to education and training activities, but also other general radiation protection services provided such as consulting, safety assessments, radiometric surveys and other related measurements, quality control/assurance and radiation protection audits, and given the sudden spike in demand for these services, which has led to the emergence of a greater supply, naturally also results in greater movement of radiation protection professionals between entities which in turn aggravates the trouble of preserving a competent and coherent radiation protection team.

Implementation of quality assurance in education and training in radiation protection

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Abstract

The knowledge (K), skills (S) and competences (C) of radiation protection experts (RPE) and radiation protection officers (RPO) in different fields are laid down in Dutch legislation. Furthermore it is laid down these KSC are reached by the learning outcomes of training and education of training providers that are recognised by the Authorities.

The training providers created a list of quality criteria of training and training providers upon request of the authorities, already in 2008. For now, this list of quality criteria is used as a checklist of amongst others available facilities, procedures and regulations. Another item is a checklist of learning outcomes and how they are achieved.

The authorities have an unfilled wish for a long time to have an impression whether the learning outcomes are reached in practice and whether the level is suitable. Therefore they performed research how this could be implemented. Finally there was a preference to start a foundation, with the name 'Quality assurance education radiation protection', shortened to foundation KOS in Dutch.
In 2020 the foundation started with the development of procedures and a web-portal for self-assessment of the training provider. In 2022 the first pilot was performed with a training provider that host about seven different education and training types for both RPE, RPO and workers in the medical field. These seven can also be ordened by type of radiation: open sources, closed sources and equipment.

In the presentation attention will be paid to the history in relation to Dutch legislation and the development process and pilot of the system for quality assurance of training providers.

The ICRP Vancouver Call for Action

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Abstract

Recently, the International Commission on Radiological Protection (ICRP) has expressed concerns that a shortage of training, education, research, and infrastructure will compromise society's ability to manage radiation risks. This could lead to unjustified exposure to or unwarranted fear of radiation, impacting physical, mental, and social well-being. It could also unduly limit the potential for research and development in new radiation technologies (for example, in healthcare, energy, and the environment) for beneficial purposes.

Consequently, in November 2022 ICRP announced a Call for Action at ICRP 2021+1, the 6th International Symposium on the System of Radiological Protection held in Vancouver, Canada. The Call addressed national governments and funding agencies, national research laboratories and similar institutions, and universities. Furthermore, use of plain language when interacting with the public and decision makers, and fostering general awareness of proper uses of radiation and radiological protection through education and training of information multipliers was encouraged.

The present paper summarizes the major elements of the Vancouver Call for Action. Furthermore, recent activities in Germany initiated by the Federal Office for Radiation Protection (BfS), the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), and by the German Radiation Protection Commission (SSK) are described, which also deal with the concerns expressed by ICRP.

Poster presentations

Systematic approach to training occupationally exposed workers for strengthening national capacity and minimize exposure to ionizing radiation in nuclear facilities in Iraq

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Abstract

Operators are routinely exposed to high doses during work them in ionization radiation procedures, this increased exposure to ionizing radiation is partially due to a lack of awareness to the effects of it. In 2022 the total number of workers in the field of radiation in Iraq was 6196 for all sectors,. All statistics available indicate the categories of exposed workers who are working in nuclear facilities, International safety standards require that all personnel who rely on the protection and safety of persons are trained and qualified. And A personal dosimetry service that evaluates the occupational doses for external and internal radiation of the radiation workers is one of the main components of radiation protection program in Iraq . The education and training (E&T) activities in this field are basic aspects of the optimization of all exposures to radiation. The E&T activities in the field of occupational radiation protection at the national and international level are of main interest and implemented by the Training Center at the Radiation Protection Center of the Ministry of Health and Environment in Iraq has adopted a systematic approach to training those who are sometimes exposed to ionizing radiation during their work. The RPC usually provides training according to the following roles: Initial Training Course: Level 1, Periodic Training Course: Advanced Radiation Protection and Supervisors Course: Radiation Safety Officers Course , All statistics available for the last five years indicate that 1,200 workers are trained according to their functional titles (in all sectors of health, industry, research and nuclear). The Radiation Protection Center (RPC) is a regulatory body in Iraq and is responsible for the training of trainers for all radiation protection officers (RPOs) in Iraq in accordance with radiation Iraqi Law No. 99 of 1980 on Radiation Protection and in accordance with requirements 4: Protection and Safety Responsibilities / GSR Part 3. In 2018 where available statistics indicate training about 500 workers on (role and duties of Radiation Protection Officers in all sectors in Iraq). All training activities carried out by the Training Center in Iraq contributed to the promotion of a culture of safety within the institutions that participated. And the awareness and safety culture programs include advance planning and good management in dealing with radiation sources and to learn about and how to lower it.

Roleplay Medical Imaging: a high school teaching module to playfully discover what expertise is necessary to suffice 20 patients a SPECT-scan in the hospital

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Abstract

NRG's Junior Academy, founded by Nuclear Technology trainees, has developed a playful teaching module that can be taught in high schools (HAVO/VWO). The activities of the Junior Academy NRG are part of the PIONIER research program that NRG|PALLAS has realised on behalf of the Dutch Ministry of Economic Affairs and Climate. The first module is called '*Roleplay Medical Imaging*' and teaches students about medical imaging and what type of expertise is necessary to suffice 20 patients a Single Photon Emission Computed Tomography (SPECT)-scan in the hospital. While working with this module, students learn about medical imaging which is a subject of the Dutch nationwide exam in physics. The module consists of a workbook for the students, a teacher's manual and booklet with answers to the questions. The module is created in collaboration with physics teachers and a didactician from Delft University of Technology.

To tackle the main question "*How many gram of uranium needs to be irradiated in a nuclear reactor to suffice 20 patients a SPECT-scan in the hospital?*", four expert roles are defined:

- Physicist: to determine whether the desired radioactive material can be produced
- Chemist: to separate the radioactive substance from harmful and unnecessary particles
- Expert Transport & Safety: to ensure that logistic processes run smoothly and safely
- Physician: to weigh the advantages and disadvantages to justify the use of a radioactive substance on a patient

If the student know his/her role, the lesson structure of the next five lessons will look like:

1. Theoretical introduction about radioactive decay, SPECT and the production of Technetium-99(m) and generally introducing the roles as mentioned above
2. Learning about one of the four roles through an "expert briefing", making assignments and preparing a small presentation
3. Presentation to team members about own expertise + team members answer quiz questions
4. Start *Challenge*: find an answer to the main question
5. Finish *Challenge*: find an answer to the main question

Along the way, the students will learn how the theory is applied in practise and which experts are involved in this multi-disciplinary application.

Feedback that came in from teachers and students is that working with the module *Roleplay Medical Imaging* has been experienced as very positive. Some quotes from teachers that helped develop the module are: "*Problem-based learning makes it tangible*", "*Challenging but equally difficult experienced by all students*" and "*Expert roles are effective for the process of learning*". From student's perspective, they said that learning about medical isotope production, separating residual material, safely transporting the medical isotopes to the hospital and how the radiopharmaceutical is administered to the patient, was more interesting that they originally thought it was. They were surprised how many roles are necessary to have the right amount of expertise.

As a consequence, the Junior Academy NRG is proud of the achieved result which contributes to the goal of disseminating nuclear knowledge to society.
After the success of the first module, the Junior Academy NRG is currently working on developing a second module: *Roleplay Nuclear Energy*. The module Roleplay Medical Imaging can be downloaded from https://www.ensuringnuclearperformance.com/rollenspel-medische-beeldvorming.

Attracting the future workforce in radiation protection: outreach activities by the SCK CEN Academy

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Abstract

One of the main challenges in nuclear today is to preserve an adequate workforce, in terms of quality as well as quantity. To meet this challenge, the SCK CEN Academy aims to maintain and expand the nuclear competences in general and specifically for radiation protection that are necessary, now and in the future, to safely manipulate radioactive sources and to realise new findings that benefit our society's common welfare. It does so by providing guidance for students and junior researchers, contributing to academic courses and organising customized training for professionals. In addition, the SCK CEN Academy organises various outreach activities towards pupils, teachers and the public.

These outreach activities aim to improve general scientific literacy and support the target groups (i.e. pupils, teachers and the public) for example when teaching or when participating in the public debate on nuclear-related issues including radiation protection. They benefit from an open and critical approach and insight in multi-aspect issues such as the risks and benefits of radioactivity, and its applications in the medical and industrial sector. With these actions the SCK CEN Academy also aims to inspire pupils to choose for an academic STEM related study.
Located near the technical domain of SCK CEN, the visitor centre TABLOO offers a scientific exhibition on the origin and characteristics of radioactivity, the challenges related to waste and disposal management, and the purpose and latest findings of nuclear research activities. Complementary to the interactive exhibit, SCK CEN experts explain pupils, their teachers and the public state-of-the-art solutions which require the integration of multiple disciplines in STEM (science, technology, engineering and math). Additionally, at the laboratories of the Belgian Nuclear Research Centre, we offer technical visits to scientific oriented schools and universities to experience the work floor.

Complementary to providing information and guided visits, the SCK CEN Academy supports small-scale STEM projects that are organised by schools or groups of pupils, and provides guest lecturers (as 'STEMfluencer') for classes of high school pupils. This way, they inspire pupils with their personal stories.

Additionally, a dedicated website supports pupils and their teachers with educational materials such as lesson plans and suggested classroom experiments, as well as multi-media and games on topics related to radioactivity and the research of SCK CEN. The aim is to inform and fascinate a wide range of people, including students, educators, and the public.

To further encourage pupils and students to explore STEM in general and nuclear science and technology in particular, the SCK CEN Academy contributes to various science communication events such as science battles, science festivals and science Olympiads. Nuclear science and thesis contests are organized in collaboration with industrial and scientific partners and professional societies, such as the Belgian Society for Radiation Protection and the Belgian Nuclear Society. To inform about potential advanced studies and careers paths, the SCK CEN Academy initiated in 2015 the Belgian Nuclear Career Days.

Status of cross-checked database of resources, online demos and virtual labs for radiation protection training

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Abstract

This report provides an update on the progress of a working group of collaborating educators and trainers who are developing a database of cross-checked resources, online demos, and virtual labs for radiation protection training. To identify publicly available resources that are free of charge to end-users, including their students and trainees, the authors utilize both "surface" and "deep" web search engines. They conducted initial screening and cross-checking of the identified resources before "road-testing" them with more than one hundred students and trainees. The aim is to collect feedback on user-friendliness, learning curve, and educational value from the students, which will guide further identification and development of similar tools. Initially, the group aimed to address the need for online resources to replace laboratory sessions and practical exercises during the pandemic. However, these resources are now also used to supplement their courses with these teaching methods in a post-pandemic world. The authors stress that they do not claim to have a comprehensive set of resources or rank the resources presented. They welcome feedback and contributions from the community. Additionally, the authors highlight the importance of developing tools that are both didactically sound and appealing to media-savvy students.

Development of the hybrid training plan in operational radiation protection for the staff of new proton therapy systems

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Abstract

Proton therapy is a radiotherapy modality especially indicated for the treatment of paediatric cases, adolescents, and tumours that are difficult to access, being the most precise and advanced technology available to fight against cancer. Despite its more than sixty years of existence, in Spain its incorporation has been very recent, with a first centre in operation since December 2019, and the second one since April 2020. A third centre, of the Public Health System in this case, is under construction in the north of the country, in the province of Santander.

Finally, in August 2022, the Ministry of Health has announced the contract for the acquisition of equipment for ten new proton therapy rooms for the Public Health System, thanks to a donation of 280 million euros by a private foundation.
https://www.sanidad.gob.es/gabinete/notasPrensa.do?metodo=detalle&id=5689

With the incorporation of these new proton therapy facilities, the situation of the Spanish healthcare system will be remarkable around the world. Spanish healthcare will be at the forefront of technology, and each year thousands of patients will be able to be treated near their place of residence.

Considering the training that supervisors and operators of this kind of facility must receive, as well as the staff and work teams that will carry out their activity in these centres, the main objective of this work has been to develop a proposal on training in operational radiation protection focused on proton therapy centres.

Likewise, considering these professionals must carry out their training simultaneously with their work for the health system, the training plan will be developed in a hybrid way, with activities that can be followed remotely, and others that must be carried out in person as is the management of ambient surveillance equipment and personal and area dose control.

Finally, the training plan will be based on evaluating the radiation protection competences and capabilities of the personnel assigned to the centres, rather than on the qualifications.

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C-arm in the OR: training of medical specialists

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Abstract

In the University Medical Centre (UMC) Utrecht, procedures with X-ray imaging in operating theatres are performed by the surgeon supported by operating assistants. The UMC Utrecht has 35 OR's in three different locations, where 23 OR's are in use to operate on adults and there are 12 paediatric OR's at the Wilhelmina Children's Hospital. At these sites, 10 different mobile C-arms are in use from 4 different manufacturers.

It is a challenge to get and keep all staff involved, adequately skilled in working with the different C-arms and scanning protocols. Medical specialists obtain their basic diploma in medical radiation protection during their education, sometimes many years before they start using a C-arm themselves. Operating assistants receive radiation protection training as part of their professional preparatory education. Only limited attention is given to practical skills. In practice, this means that theoretical knowledge of radiation protection is often outdated, and practical skills are limited. In recent years, a theoretical and practical training program has been initiated by the radiation protection department.

The aim of the training program is to ensure that staff using the C-arms obtain up-to-date knowledge and skills in the use of the device, thereby optimising radiation exposure in OR. A radiation protection training for operating assistants was started more than 10 years ago. As of 2019 this program was expanded with theory classes for general surgeons and orthopaedists. The basic principles of radiation protection, justification, ALARA and the dose limits applicable in the Netherlands, are discussed, as are protective measures and dose constraints. Besides these radiation lessons, medical specialists and operating assistants learn the skills to operate the C-arm during practical (application) training sessions. In an OR setting C-arm settings, like diaphragm, are practised on a dummy doll fitted with a human skeleton. For many employees, radiation protection is only a small part of their work, it is therefore difficult to get enough participants to attend the training progam.

In 2021, with the introduction of a new application to the OR, a different approach was taken. The training program was initiated and organised by the radiation protection expert together with some specialists involved in the working group, who supervised the purchase of this 3D C-arm. This way, the needs of the target group could be better met. The following arrangements, focused on the use of this 3D C-arm were made:

- All surgeons attend or have recently attended the theoretical radiation lessons of the radiation expert. This way, everyone in OR has the same basic information with the introduction of the 3D C-arm.
- All surgeons follow specialty-oriented e-learning modules from the manufacturer in preparation for the application training.
- Operating assistants may follow these e-learning modules.
- The application training is scheduled on three consecutive days in 2-hour blocks, where each speciality will have its own time block. This way the practical training is speciality specific.

- All potential users are to be personally invited by their specialty specific contact, they register in advance via this contact person.
- After demonstrably completing the e-learning, theoretical education and application training, the specialist is competent and will be allowed to work with the new 3D C-arm.

These arrangements were documented in the internal permit for the new C-arm, which regulates the use of ionising radiation sources within academic hospitals. Together with the trauma surgery contact person, an online (due to the COVID pandemic) radiation training was scheduled the week before the application training. They hadn't attended this theoretical lesson before. All 14 trauma surgeons were present. The joint preparation of the training programme proved to be a great success. Some participants found the manufacturer's e-learning modules taken beforehand added value to the application training. Other specialists these e-learning modules unnecessarily laborious. Based on this feedback, it was decided that in future these manufacturer's e-learning modules may be followed voluntarily.

The first skills training sessions were held in February 2021. In three days, a total of 40 medical specialists and operating assistants were trained. Additional training sessions took place in March and May 2021 and were attended by another 17 colleagues. Practising in a dummy setting provided insight into the operating and 3D possibilities of the C-arm, new imaging possibilities were explored, and the training explicitly addressed the effect of diaphragm on image quality. The specialists were able to learn how to optimise imaging (and radiation exposure). The training was very positively received.

A new 2D C-arm was introduced in early 2023. Together with the OR staff and specialists involved, 2 application training afternoons were scheduled. No speciality-specific training was provided this time. This led to a wonderful dynamic in which different imaging settings and positions of the dummy doll were tested. Due to the success of the earlier application training, the specialists were motivated to attend the training. In total 18 specialists and 13 operating assistants attended the sessions. Despite this being a 2D C-arm without all kinds of additional features, the attendance and commitment of all staff was great. By guiding the specialists and providing support in radiation protection on the work floor, this great result was achieved.

Training medical specialists is an ongoing process; with our set-up, a successful, workable foundation was laid.

Capacity building training program for NRRC inspectors in Saudi Arabia

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Abstract

Nuclear and Radiological Regulatory Commission (NRRC) has established a competency building training program. IAEA publications (IAEA 2007)1 composed the basics for the training.

Method
Participants from related sectors attended an entry exam. The exam was mainly used for gap analysis to carefully assess the training needs and design the learning objectives in order to find out the required competencies that should be measured.

Result
Analysis shows a difference between the entry exam (mean is 78.15) and the final exam (mean is 87.36), and with mean difference (9.21). The *t*-value is 3.27. and the *p*-value is 0.0043 (the significance value is $p < 0.05$).

Conclusion
The competency of the participants has been significantly improved in terms of their skills, knowledge and hands-on experience compared to the entry exam.

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Applying infographics for an effective radioactive waste management in a nuclear medicine department

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Abstract

Introduction
Defining the procedure for an adequate management of radioactive wastes generated in a nuclear medicine department is responsibility of a radiation protection unit. A practical and self-explanatory management system has been designed to avoid non-compliance with procedures. It is designed to be understood by the nursery staff who administers radiopharmaceuticals and handles the produced waste.
The objective is to present a simple training method, based on infographics, to optimize radioactive waste management in a Nuclear Medicine Department.

Materials and methods
The system shows the path of waste from the three physical forms in which radiopharmaceuticals are served: pills, vials and single-dose syringes. Therefore, waste originated in daily clinical practice is sorted by both kind of waste and half-life of the radioisotopes. Different types of waste include syringes, vials, mixed waste (gloves, paper, packaging….), unused pills or lead containers.
Taking into account the half-life and emission type of radionuclides, some of them are managed separately, and others like Ga-67, In-111 or I-123 are clustered in the same box or bag due to the similarity of physical characteristics, as long as they belong to the same type (vial, syringe or mixed waste).
This waste management scheme has been put into a process flow diagram made with open graphic editor yEd (see Figure 1). There is a colour code to make it simpler, applied to the available wells in order to reduce mistakes (see Figure 2).
The infographics has been placed nearby the hot chamber, where the waste is produced, and also by the containers in the waste storage room. Radiation Protection physicists have delivered personalized training lessons in situ, to both nurses and nuclear medicine specialists.

Results
Thanks to these infographics, the nursery personnel states that they now understand more instinctively how to manage every contaminated item or radioactive material, rather than with the traditional written procedure used prior to this scheme. Some annotations about how to label a recipient are included: radionuclide incorporated and their opening and closing dates. These comments help the staff in charge of the waste management and evacuation to fulfil the Spanish legislation on this matter.

Discussion
This infographics has allowed, minimizing doubts and mistakes, assuring a more strict accomplishment of correct waste management, no matter which professional carries it out. It also gives them more confidence avoiding mishaps like: not to replace radioactive symbols before the evacuation, mixing different radionuclides or not specifying dates or radionuclide in the containers.

Conclusion

A more uniform method, easy to consult and straightforward to interpret, has led to a more robust radioactive waste management. It optimizes the radiation protection for people and the environment. As is the case with procedures, the associated infographics must be reviewed and adapted to changes periodically.

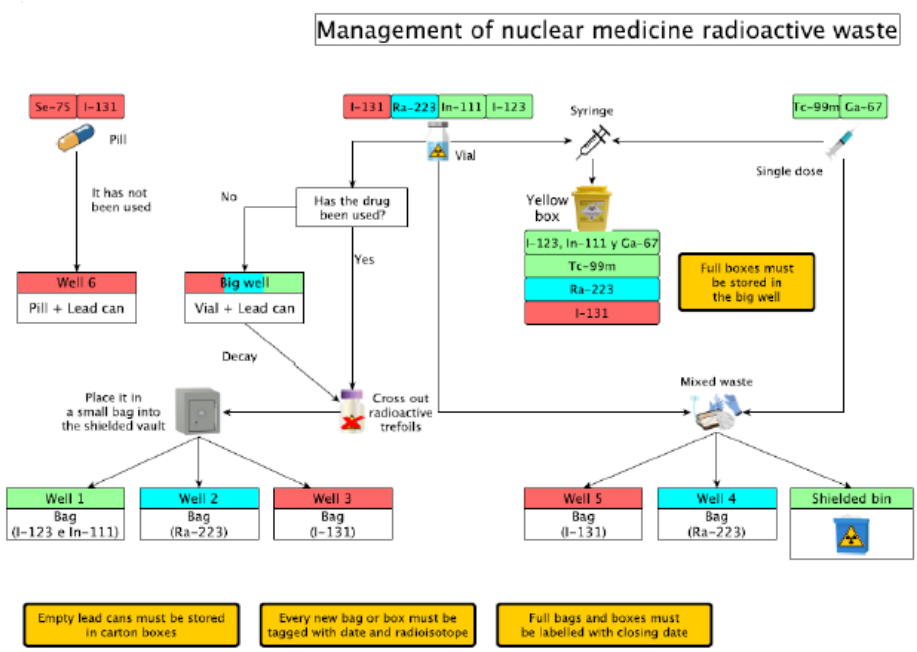

Figure 1: Process flow diagram about radioactive waste management in a Nuclear Medicine department

Figure 2: View of the wells where the radioactive waste is placed in along the color-coded tags described in Figure 1, which specify the kind of waste and radioisotope

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