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# Table of Contents

## Opening session

<table>
<thead>
<tr>
<th>Topic</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education and training in radiation protection in the proposal for revised Euratom Basic Safety Standards Directive</td>
<td>Simeonov, G. (1)</td>
</tr>
<tr>
<td>An IAEA Perspective on establishing sustainable national infrastructures for education and training in radiation, transport and waste safety</td>
<td>Luciani, A. (1); Wheatley, J. (1)</td>
</tr>
</tbody>
</table>

## Harmonization of terminologies and definitions

<table>
<thead>
<tr>
<th>Topic</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enetrap II: WP5 Develop And Apply Mechanisms For The Evaluation Of Training Events, Material and Providers</td>
<td>Van Elsäcker-Degenaar, I. H. (1); Sutmuller, M. (1); Draisma, F. S. (1); Stewart, J. (2); Livolsi, P. (3); Fantuzzi, E. (4); Moebius, S. (5); De Regge, P. P. (6); Vaz, J. P. (7); Ceclan, M. (8); Buurveld, H. A. (1)</td>
</tr>
<tr>
<td>BILATERAL COMPARISON OF LOW LEVEL RP TRAINING AND EDUCATION COURSES – A STEP TOWARDS MUTUAL RECOGNITION OF RPOs AND RADIATION WORKERS</td>
<td>Boersma, H. F. (1); Vahlbruch, J.-W. (2); Greuter, M. (3); Van Dongen, O. (4); Haagen, J. (5)</td>
</tr>
<tr>
<td>Establish the RPE training standard: the ECVET approach as a tool</td>
<td>Paul, L. (1); Michèle, C. (2); Tom, C. (2); Philippe, M. (3); Joanne, S. (4); Annemarie, S.-H. (5); Pedro, V. (6); Elena, F. (7); Marisa, M.-A. (8); Mihail, C. (9)</td>
</tr>
<tr>
<td>The European Qualifications Framework (EQF) and it’s application in the design of medical radiation protection qualification and curriculum frameworks in Europe</td>
<td>Caruana, C. J. (1); Castillo, J. (2)</td>
</tr>
</tbody>
</table>

## Efficiency & Effectiveness of Training

<table>
<thead>
<tr>
<th>Topic</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSTEM OF EDUCATION AND TRAINING IN RADIATION SAFETY OF THE STAFF BELONGING TO A RADIOACTIVE FACILITY</td>
<td>Amador Balbona, Z. H. (1); Perez Pljuan, S. (1); Ayra Pardo, F. E. (1); Soria Guevara, M. A. (1)</td>
</tr>
<tr>
<td>EMERGENCE OF COMPETENCY BASED TRAINING WITHIN RADIATION SAFETY TRAINING IN AUSTRALIA AND REDEVELOPMENT OF AUSTRALIA NUCLEAR SCIENCE TECHNOLOGY ORGANISATION TRAINING COURSES INCORPORATING THESE UNITS.</td>
<td>Mccarthy, L. (1)</td>
</tr>
<tr>
<td>Title</td>
<td>Authors</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Radiation protection training for emergency services in Austria</td>
<td>Neuwirth, J. (1); Stolar, A. (1); Hefner, A. (1)</td>
</tr>
<tr>
<td><strong>(Inter)national collaborations and networks, (inter)regional approaches and collaborations</strong></td>
<td></td>
</tr>
<tr>
<td>MEDICAL PHYSICS EDUCATION AND TRAINING: REGULATORY ASPECTS IN LATIN AMERICA</td>
<td>Kodlulovich, S. (1); Sâ, L. (1)</td>
</tr>
<tr>
<td>CONTRIBUTION OF THE TRAINING CENTER OF NATIONAL CENTRE FOR NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY (CNESTEN) TO BUILDING COMPETENCIES IN RADIATION PROTECTION IN THE AFRICA REGION: POST GRADUATE EDUCATIONAL COURSE (PGE) / MOROCCAN EXPERIENCE</td>
<td>Nasri, B. (1)</td>
</tr>
<tr>
<td>SARA – An Intensive Program Course from the CHERNE Network</td>
<td>Cechak, T. (1); Gerardy, I. (2); Hoyler, F. (3); Janssens, H. (4); Lopes, I. (5); Tondeur, F. (2)</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>European Regional Workshops on Establishing a National Strategy for Education and Training in Radiation, Transport and Waste Safety</td>
<td>Dimitriou, P. (1); Timoshchenko, A. (2); Pafilis, C. (3)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>THE EUROPEAN DB ON E&amp;T IN RP</td>
<td>Marco, M. (1); Llorente, C. (1); Coeck, M. (2); Livosi, P. (3); Möbius, S. (4); Van Elisacker - Degenaar, H. (5); Massiot, P. (3)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>European Guidance for RPO Radiation Protection Training</td>
<td>Schmitt-Hannig, A. (1)</td>
</tr>
<tr>
<td><strong>Qualification, accreditation &amp; certification</strong></td>
<td></td>
</tr>
<tr>
<td>MASTER PROGRAM IN RADIATION PROTECTION IN MOROCCO</td>
<td>Hakam, O. K. (1); Choukri, A. (1)</td>
</tr>
<tr>
<td>Implementation of the UK scheme for Radioactive Waste Advisers</td>
<td>Wright, A. (1); Englefield, C. (2); Peake, L. (3)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL OF EDUCATION AND TRAINING IN RADIATION PROTECTION IN THE CURRICULUM OF HEALTH PROFESSIONALS IN NORWAY</td>
<td>Silkoset, R. D. (1); Widmark, A. (1); Friberg, E. G. (1)</td>
</tr>
<tr>
<td>The development of a recognition system for Radioactive Waste Advisers</td>
<td>Paynter, R. (1); Partington, C. (2)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ESTABLISHING A NATIONAL STRATEGY FOR E&amp;T IN RADIATION PROTECTION</td>
<td>Dimitriou, P. (1); Pafilis, C. (2); Karfopoulos, K. (2); Kamenopoulou, V. (2); Housiadas, C. (2)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Sector specific training needs

<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURRICULUM OF RADIATION PROTECTION EDUCATIONS AND TRAININGS IN HUNGARY</td>
<td>Elek, R. (1); Pesznyak, C. (2); Lumniczky, K. (1); Pellet, S. (1); Safrany, G. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - &quot;Frederic Joliot-Curie&quot; National Research Institute for Radiobiology and Radiohygiene, Hungary</td>
</tr>
<tr>
<td></td>
<td>2 - Budapest University of Technology and Economics, Institute of Nuclear Techniques, Hungary</td>
</tr>
<tr>
<td>New Swiss Regulations about the Responsibilities of Persons in Radiation Protection and their Necessary Capabilities and Skills</td>
<td>Jahn, S.-G. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - Swiss Federal Nuclear Safety Inspectorate, Switzerland</td>
</tr>
<tr>
<td>CURRICULUM OF RADIATION PROTECTION EDUCATIONS AND TRAININGS IN HUNGARY</td>
<td>Prendes Alonso, M. (1); Guillén campos, A. (2); Valdés Ramos, M. (1); Soler Basco, K. (2); Rodríguez Rodríguez, M. (2); Tomas Zerquera, J. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - Center for Radiation Protection and Hygiene, Cuba</td>
</tr>
<tr>
<td></td>
<td>2 - National Center for Nuclear Safety, Cuba</td>
</tr>
<tr>
<td>CURRICULUM OF RADIATION PROTECTION EDUCATIONS AND TRAININGS IN HUNGARY</td>
<td>Fornalski, K. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - PGE EJ1 (PGE Nuclear), Poland</td>
</tr>
<tr>
<td>New Swiss Regulations about the Responsibilities of Persons in Radiation Protection and their Necessary Capabilities and Skills</td>
<td>Fannin, R. (1); Wright, A. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - Health Protection Agency, United Kingdom</td>
</tr>
<tr>
<td>RADIO SAFETY TRAINING IN THE VETERINARY SECTOR</td>
<td>Grindrod, E. (1); Stewart, J. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - Health Protection Agency, Centre for Radiation, Chemicals and Environmental Hazards, United Kingdom</td>
</tr>
<tr>
<td>RADIO SAFETY TRAINING FOR EMERGENCY RESPONDERS</td>
<td>Timal, G. (1); Schoenhacker, S. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - Civil Protection School, Federal Security Academy, Federal Ministry of the Interior, Austria</td>
</tr>
<tr>
<td>ACCREDITED RADIATION PROTECTION TRAINING FOR THE AUSTRIAN POLICE</td>
<td>Tarutin, I. (1); Morozik, M. (2); Timoshchenko, A. (3); Kadshtskaya, M. (3)</td>
</tr>
<tr>
<td></td>
<td>1 - Department of radiotherapy, N. Alexandrov Cancer Centre of Oncology and Medical Radiology, Belarus</td>
</tr>
<tr>
<td></td>
<td>2 - Department of molecular and environmental genetics, International Sakharov Environmental University, Belarus</td>
</tr>
<tr>
<td></td>
<td>3 - Department of nuclear and radiation safety, International Sakharov environmental university, Belarus</td>
</tr>
<tr>
<td>RADIATION SAFETY TRAINING IN THE VETERINARY SECTOR</td>
<td>Landsberger, S. (1); George, G. (1)</td>
</tr>
<tr>
<td></td>
<td>1 - Environklean Product Development Inc, United States</td>
</tr>
</tbody>
</table>
Results and Lessons Learnt from 2010 and 2011 International Training Course on Management of Waste in Accordance with IAEA Safety Standards and International Best Practice

Kinker, M. (1)
1 - International Atomic Energy Agency, Austria

RADIATION PROTECTION TRAINING OF CONTRACTORS AT LOVIISA NPP

Holmberg, K. (1); Koivisto, M. (1)
1 - Fortum Power and Heat Oy, Loviisa NPP, Finland

Tools and resources, methods of delivery, introduction of modern learning tools

NEW LEARNING TOOLS DEVELOPED IN WP7 FOR ENETRAP II PROJECT: TEXTBOOK AND CYBERBOOK

Massiot, P. (1); Livolsi, P. (1); Jimonet, C. (1); Coeck, M. (2); Mobius, S. (3); Marco, M. (4); Pesnyak, C. (5)
1 - CEA-INSTN, France
2 - SCK-CEN, Belgium
3 - KIT, Germany
4 - CIEMAT, Spain
5 - BME-NTI, Hungary

A serious 3D game for education and training in Radiation Protection

Pin, A. (1); Massiot, P. (2)
1 - CEA-INSTN-Cherbourg-Octeville, France
2 - CEA-INSTN-Saclay, France

Public education/communication on radiation effects and radiation protection

INTERACTIVE WEBSITE ON RADIATION IN THE NETHERLANDS

Huitema, K. (1); Van Bourgondiën, M. (1)
1 - TUDelft, Reactor Institute Delft, Netherlands

UNDERGRADUATE EDUCATION IN RADIATION PROTECTION IN THE UK: MEETING A NATIONAL NEED

Marsh, A. (1); Englefield, C. (1)
1 - University of Cumbria, United Kingdom

An On-Line Graduate Course in Nuclear Environmental Protection for Health Physics and Radioactive Waste Management

Landsberger, S. (1); Tamalis, D. (2)
1 - University of Texas, United States
2 - Florida Memorial University, United States

How to inform the public about radiation exposure

Sabol, J. (1); Hudzietzova, J. (1)
1 - Czech Technical University in Prague, Faculty of Biomedical Engineering, Czech Republic

Introduction of ethics in education and training for radiation protection

WHERE IS THE BORDER BETWEEN PROFESSIONAL AND RADIATION PROTECTION EDUCATION AND TRAINING

Koželj, M. (1)
1 - Jožef Stefan Institute, Slovenia

Sustainable Development, Alara Culture and Ethics in the E&T Programmes of the Cherné Network

Janssens, H. (1)
1 - UHasselt/XIOS, dptm. Nuclear Technology, Belgium

The future of education and training in radiation

International high-school student meetings:“Radiation Protection Workshops”

Livolsi, P. (1); Reaud, C. (2); Ceclan, M. (3)
1 - CEA-INSTN, France
2 - CEPN, France
3 - University Politechnica of Bucharest, Romania
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support and integration of education and training on low dose radiation research in Europe</td>
<td>Ottolenghi, A. (1); Trott, K. (1); Smyth, V. (1)</td>
<td>1 - Physics Department, University of Pavia, Italy</td>
</tr>
<tr>
<td>The SRP &quot;Young Generation&quot; Initiative</td>
<td>Stewart, J. (1)</td>
<td>1 - HPA, United Kingdom</td>
</tr>
<tr>
<td>Drivers and Enablers for Changes in Education &amp; Training: all stakeholders involved under Euratom Horizon-2020</td>
<td>Van Goethem, G. (1)</td>
<td>1 - European Commission, Belgium</td>
</tr>
</tbody>
</table>
| National Strategy on Education and Training in radiation protection in CUBA | Prendes Alonso, M. (1); Guillén Campos, A. (2); Tomas Zerquera, J. (1); Santana, J. (2); Valdés Ramos, M. (1); Fernandez Rondon, M. (3) | 1 - Center for Radiation Protection and Hygiene, Cuba  
2 - National Center for Nuclear Safety, Cuba  
3 - Agency for Nuclear Energy and Advances Technologies, Cuba |
| Education and Training in Radiation Protection at the University of Groningen – past, present and future | Burskoeke msc, A. (J.). (1); Boersma, H. F. (1)                          | 1 - University of Groningen, Netherlands                                       |
| Accreditation of a radioactivity testing laboratory: challenges from a laboratory point of view | Wellens, B. (1)                                                         | 1 - Nuclear Engineering Seibersdorf, Austria                                  |
| INTERDISCIPLINARY APPROACH TO NUCLEAR EDUCATION – TOWARDS SUSTAINABILITY | Dreimantis, A. (1)                                                      | 1 - Radiation safety centre of the State Environment Service, Latvia          |
| How well do we cope with digital detectors? A Visual Grading Analysis of orthopedic radiographs. | Decoster, R. (1); Mol, H. (1); Smits, D. (1)                           | 1 - Hogeschool Universiteit Brussel, Belgium                                  |
| Towards to the sustainable system of education and training for building competence in nuclear and radiation safety in Belarus | Lugovskaya, O. (1); Astashko, G. (1); Vasilieuskaya, L. (1); Maruda, M. (2); Timoshchenko, A. (3) | 1 - Department of nuclear and radiation safety, Ministry of Emergency of the Republic of Belarus, Belarus  
2 - Ministry of education of the Republic of Belarus, Belarus  
3 - Department of nuclear and radiation safety, International Sakharov environmental university, Belarus |
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Institutions</th>
</tr>
</thead>
</table>
| IMPLEMENTATION OF ISO 29990:2010 MANAGEMENT SYSTEM FOR PROVIDERS OF LEARNING SERVICES IN NON-FORMAL E&T ON RADIATION PROTECTION | Dimitriou, P. (1); Pafilis, C. (1); Stassinopoulos, I. (2); Ntalles, A. (1); Karfopoulos, K. (1); Carinou, E. (1); Kamenopoulou, V. (1) | 1 - Greek Atomic Energy Commission, Greece  
2 - Ioannis Stassinopoulos Consultancy Services, Greece |
| DESIGN FACTORS WITH ICT TOOLS IN COURSES TO TRAIN THE TRAINERS        | Aveleyra, E. E. (1); Ferrini, A. (1); Vega, A. F. (1)                   | 1 - Universidad de Buenos Aires- Facultad de Ingeniería- Centro de Educación a Distancia, Argentina |
| The involvement of a regulatory authority in Education and Training on Radiation Protection | Kamenopoulou, V. (1); Pafilis, C. (1); Karfopoulos, K. (1); Carinou, E. (1); Economides, S. (1); Dimitriou, P. (2) | 1 - Greek Atomic Energy Commission, Greece  
2 - University of Athens, Medical School, Greece |
| Education and Training in Medical Radiation Protection provided by a Medical Physics University Department | Dimitriou, P. (1); Papagiannis, P. (1); Yakourmakis, E. (1); Karaiskos, P. (1); Georgiou, E. (1) | 1 - Medical Physics Department, Faculty of Medicine, University of Athens, Greece |
| A New Training Course for Master Craftsman in Radiation Protection     | Jahn, S.-G. (1); Terbeek, C. (1); Jentjens, L. (1)                      | 1 - Expert Group "Strahlenschutzmeister" of VGB-PowerTech (European association of power plant operators and manufacturer), Germany |
| On-line Training in Radiological Protection: Master's degree in Radiological Protection in Radioactive and Nuclear Installations | Mayo, P. (1); Miró, R. (2); Campayo, J. M. (3); Verdú, G. (2); Baeza, G. (4); Ballesteros, L. (2); Cortina, M. T. (5); Díez, S. (3); Gallardo, S. (2); Juste, B. (2); Llorca, N. (6); Mestre, V. (6); Monforto, A. (7); Ortiz, J. (2); Peiró, J. (8); Renado, D. (5); Alcaraz, D. A. (1) | 1 - Titania Servicios Tecnológicos S. L., Spain  
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7 - Hospital Universitari i Politécnic La Fe de Valencia, Spain  
8 - Secció de Seguretat Radiològica. Generalitat Valenciana, Spain |
| First Patagonian Course "Diagnosis and treatment of ionizing radiation induced injuries" | Andres, P. (1); Bellotti, M. (2); Cascón, A. (3)                       | 1 - División Protección Radiológica - Centro Atómico Bariloche, Argentina  
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<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Affiliations</th>
</tr>
</thead>
</table>
| A Survey on the Awareness of the Radiation Protection in Medical Sector in Istanbul, Turkey. | Yildiz Yarar, Y. (1); Kara, Ö. E. (2)                                    | 1 - YILDIZ TECHNICAL UNIVERSITY, PHYSICS DEPARTMENT, DAVUTPASA CAMPUS, ISTANBUL, Turkey  
  2 - YILDIZ TECHNICAL UNIVERSITY, INSTITUTE OF SCIENCE, ISTANBUL, Turkey |
| TRAINING COURSES ON RADIATION PROTECTION FOR THE EMERGING NUCLEAR STATES IN THE CENTRAL INSTITUTE FOR CONTINUING EDUCATION & TRAINING | Tairov, T. (1); Bombin, R. (1); Labyntseva, M. (1); Artisuyk, V. (1)     | 1 - Central Institute for Continuing Education and Training, Russian Federation                        |
| TURKISH EXPERIENCE IN EDUCATION AND TRAINING IN RADIATION PROTECTION FOR DIAGNOSTIC RADIOLOGY | Akbiyik, H. (1); Zeyrek, C. T. (1); Aksu, L. (1)                          | 1 - Ankara Nuclear Research and Training Center, Turkey                                              |
| THE EFFECTIVENESS OF RADIATION PROTECTION TRAINING IN LITHUANIA     | Gatelyte, I. (1)                                                         | 1 - Radiation Protection Centre, Lithuania                                                           |
| Establishment of a Regional Center of Competence for VVER Technology and Nuclear Applications (CORONA) | Cvetkow, I. (1)                                                         | 1 - Bulgarian Nuclear Society, Bulgaria                                                             |
Opening Session
EDUCATION AND TRAINING IN RADIATION PROTECTION IN THE PROPOSAL FOR REVISED EURATOM BASIC SAFETY STANDARDS DIRECTIVE

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ABSTRACT

In May 2012 the European Commission published its proposal for revised Euratom Directive laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation (‘Euratom BSS’). The proposal updates and consolidates five current Euratom Directives containing specific requirements for education and training in radiation protection. Current Directives’ provisions referring to different groups of individuals, either exposed to ionizing radiation or having responsibilities for protection of others, are grouped in Chapter IV on education, training and information. The Euratom BSS proposal puts special emphasis on the education and training of individuals having responsibilities for radiation protection of workers, patients or the general public. It introduces the concepts of ‘Radiation Protection Officer’ (RPO) and ‘Radiation Protection Experts’ (RPE) and defines their respective roles and responsibilities. The RPE and the ‘Medical Physics Expert’ (MPE) are defined as individuals having theoretical knowledge, practical training and work experience in order to provide advice on radiation protection in their respective area of competence. Provisions for recognition by the competent authorities and for retraining and continuous education form another important part of the requirements on the RPE and the MPE. The new Euratom BSS proposal creates strong requirement to the EU Member States to ensure that an adequate legislative and administrative framework is established for providing appropriate radiation protection education, training and information to all individuals whose tasks require specific competences in radiation protection. Specifically for the RPE and the MPE, Member States are obliged to establish education, training and retraining to allow their recognition. The Euratom BSS proposal is subject of modifications as it goes through the process of approval by the Council of the European Union. The European Commission is supporting several initiatives to facilitate the implementation of the Euratom BSS requirements on education and training in radiation protection. These include initiatives by the Directorate-General for Energy, most recently the launching of the EUTERP platform and the development of European guidelines on MPE, as well as support under the EU programme for Research and Innovation, for example for the European Network for Education and Training in Radiation Protection (ENETRAP I and II).

1. Introduction

1.1. European legal basis for radiation protection

In the field of nuclear energy the treaty establishing the European Atomic Energy Community (1), widely known as the "Euratom Treaty", is binding primary law for 27 member states of the European Union with almost 500 million inhabitants. Since its entry into force in 1958 the Euratom Treaty provides the foundations on which the European institutions and member states share their competencies and discharge their respective responsibilities (2). The main tasks under Euratom Treaty are defined in its Article 2, among them to protect the health of the workers and of the public against the dangers arising from ionising radiation.

Chapter III Health and Safety of Euratom Treaty offers the legal framework for the establishment of Euratom Basic Safety Standards (BSS) for the health protection of the workers and the general public. The first Euratom BSS date back to 1959 and the latest version, Council Directive 96/29/Euratom (3), was published as Euratom secondary law in 1996. According to Article 31 of the Euratom Treaty, the Euratom BSS are worked out by the Commission after it has obtained the opinion of a group of public health experts, commonly referred to as the "Article 31 Group".
The Euratom BSS has been supplemented by additional binding instruments, including in areas such as medical exposure, regulated under Council Directive 97/43/Euratom (4), and outside workers, dealt with in Council Directive 90/641/Euratom (5).

The Commission also issues documents of non-binding nature, which have different status in the hierarchy of EU-instruments and include e.g. recommendations, communications and guidance.

1.2. Revision of the Euratom BSS

The process to revise the existing Euratom BSS Directive started more than five years ago. The decision to start this revision was motivated, among others, by the (upcoming) 2007 recommendations of the International Commission on Radiological Protection (6) as well as by the need to update the European legislation for radiation protection and bring it in line with the latest scientific and technological development.

Following the general move of that time for simplification and codification of the European legislation a decision was also taken to integrate all related European legal acts in one piece of legislation covering all categories of exposure and types of exposure situations. In result, the proposed by the Commission revised BSS Directive (7), will replace five existing legal instruments issued in the past more than twenty years.

2. Education and training in current Euratom legislation

Current Euratom legal basis for radiation protection contains a number of different provisions on education and training scattered in different legal acts. The main pieces of Euratom legislation dealing with these matter include the 96/29/Euratom BSS Directive (3), Directive 90/641/Euratom on outside workers (5), Directive 2003/122/Euratom on high activity sealed sources (8) and Directive 97/43/Euratom on Medical exposure (4).

The Euratom BSS Directive defines the figure of the 'qualified expert', as a "persons having the knowledge and training needed to carry out physical, technical or radiochemical tests enabling doses to be assessed, and to give advice in order to ensure effective protection of individuals and the correct operation of protective equipment, whose capacity to act as a qualified expert is recognized by the competent authorities." It also states that a qualified expert may be assigned the technical responsibility for the tasks of radiation protection of workers and members of the public.

In addition to the qualified expert, the BSS Directive calls for recognition by the national competent authorities of the approved dosimetric services, approved occupational health services and approved medical practitioners. Member States shall ensure that the training of these experts and services is arranged.

The BSS Directive requires also information and training to be provided to the occupationally exposed individuals and defines this as a responsibility of the natural or legal person who carries out the respective practices (the 'undertaking').

The outside workers Directive 90/641/Euratom requires that information and training on radiation protection is provided to workers, who are not directly employed by the undertaking responsible for the practice but performing tasks in the undertaking's controlled area. This responsibility should be appropriately shared between the employer of the outside workers and the undertaking responsible for the practice.

Directive 2003/122/Euratom contains additional requirements with regard to workers in practices holding HASS. These include training requirements for this category of staff, which are focused on a possible loss of control over the source. An important element of the HASS Directive is the requirement that the training should be repeated at regular intervals and documented. The Directive also requires from Member States to provide encouragement for training of the management and workers in installations where orphan sources are most likely to be found or processed, such as large metal scrap yards recycling plants and significant nodal transit points.
The medical exposure Directive 97/43/Euratom requires that the medical practitioner, the medical physics expert (MPE) and all individuals involved in the practical aspects of medical radiological procedures receive adequate theoretical and practical training for the purpose of radiological practices, as well as relevant competence in radiation protection. The Directive also calls for continuing education and training after qualification and for specific training whenever a new technique is being introduced. In addition, the introduction of a course on radiation protection in the basic curriculum of medical and dental schools is encouraged.

3. Education and training in the revised Euratom BSS

The revised Euratom BSS gives further prominence to the education and training in radiation protection, including through the grouping of the majority of the related provision in a separate Chapter IV on "Radiation Protection Education, Training and Information".

3.1. National infrastructure for education and training

The proposal for a revised Euratom BSS recognises the importance of a strong and sustainable national infrastructure for education and training in radiation protection. Thus, an explicit requirements for the EU Member States to ensure the establishment of adequate legislative and administrative framework for providing appropriate radiation protection education, training and information to all individuals whose tasks require specific competences in radiation protection is now included.

Specifically, with regard to the services and experts seen as an important part of the national infrastructure for radiation protection (discussed in more detail in the next section), the BSS Directive requires an appropriate education, training and retraining to be in place to allow for their recognition by the competent authority. Member States shall also lay down provisions to ensure the continuity of expertise of these services and experts.

3.2. Services and experts for radiation protection in the revised EU BSS

The proposal for revised Euratom BSS contains some important changes in the definitions of services and experts needed to ensure radiation protection (included in Chapter II) as well as of their roles and responsibilities.

An important fact that should be noted is that the roles and responsibilities of these services and experts are defined in Chapter X "Requirements for Regulatory Control" under the section on "National Infrastructure", i.e. together with the requirements on the (national) competent authority. Chapter X puts an emphasis on the state recognition of these services and experts and on the continuity of their expertise.

The most important change in the revised Euratom BSS with regard to services and experts for radiation protection is arguably the replacement of the current 'qualified expert' by two entities, namely the 'Radiation Protection Expert' (RPE) and the 'Radiation Protection Officer' (RPO). This change follows directly from the recommendations made by the EUTERP Platform, which was originally created with funding from the European Commission and later transformed into the independent EUTERP Foundation (9). Further detail about the RPE, RPO and the Medical Physics Expert (MPE) is provided in the following sections.

3.2.1. Radiation Protection Expert (RPE)

The RPE is designed to largely replace the current 'qualified expert', as defined in Council Directive 96/29/Euratom, in his/her role as an adviser on radiation protection of individuals. This is best reflected in the RPE definition as "an individual having the knowledge, training and experience needed to give radiation protection advice in order to ensure effective protection of individuals, whose capacity to act is recognized by the competent authorities".
The role of the RPE is further specified in Chapter X on regulatory control, which limits his/her advice to occupational and public exposure issues (i.e. excluding medical exposure). Chapter X also defines the most important areas, which should be covered by the RPE's advice, including: plans for new installations and the acceptance into service of new or modified radiation sources; the categorisation of controlled and supervised areas; the classification of workers; the content of workplace and individual monitoring programmes; the appropriate radiation monitoring instrumentation to be used; the appropriate methods of personal dosimetry; the optimisation and establishment of appropriate dose constraints; quality assurance; the environmental monitoring programme; radioactive waste disposal requirements; the arrangements for prevention of accidents and incidents; and, preparedness and response in emergency exposure situations.

The proposal for revised Euratom BSS stipulates that, where appropriate, the task of the radiation protection expert may be carried out by a group of specialists who together have the necessary expertise.

3.2.2. Radiation Protection Officer

The RPO is defined in the revised BSS as "an individual technically competent in radiation protection matters relevant for a given type of practice who is designated by the undertaking to oversee the implementation of the radiation protection arrangements of the undertaking". Thus a clear separation is made between the RPE, acting as an adviser to the undertaking in establishing the local radiation protection arrangements, and the RPO, who would exercise oversight on already established rules and procedures.

The BSS proposal does not require that an RPO is appointed for all practices and facilities but leaves it to Member States to decide in which practices one should be appointed; accordingly, competent authority's recognition of the RPO's qualifications is not required. On the other hand, where the designation of RPO is deemed necessary, he/she shall be provided with the means necessary for them to carry out their duties and report directly to the undertaking.

Similarly to the RPE, the task of the RPO can be carried out by a radiation protection unit which, in this case, shall be established within the undertaking.

3.2.3. Medical physics expert (MPE)

The role of the MPE, as currently defined in Council Directive 97/43/Euratom, is a mixture of direct action (e.g. in patient dosimetry) and advise. This situation has been preserved in the revised BSS, where the MPE was defined as "an individual having the knowledge, training and experience to act or give advice on matters relating to radiation physics applied to medical exposure, whose competence to act is recognised by the competent authority".

The new BSS proposal makes the distinction between the RPE (and RPO) and the MPE much clearer, the former dealing with occupational and public exposure issues and the latter with medical exposure (i.e. patients, volunteers in biomedical research and carers and comforters). Liaison between the RPE and the MPE (in clinical environment) is defined as an explicit part of their responsibilities.

The revised BSS contains several changes related to the responsibilities and the level of involvement of the MPE. The general direction of these changes is towards increasing the involvement and widening of MPE's responsibilities, while maintaining a balanced approach
taking into account the complexity and the radiation risk posed by the practice and the roles
and responsibilities of other clinical staff (radiological practitioners, radiographers, etc.)

Similarly to the RPE (and RPO), the proposal for revised Euratom BSS stipulates that, where
appropriate, the task of the MPE may be carried out by a group of specialists who together
have the necessary expertise.

3.3. Other requirements for education and training

Chapter IV "Radiation Protection Education, Training and Information" deals with education
and training of exposed workers, apprentices and students, workers potentially exposed to
orphan sources and emergency workers. The respective requirements are kept mostly
unchanged from current legislation.

The same chapter deals also with education, information and training in the field of medical
exposure, preserving most of the current requirements. An important change is that the
introduction of radiation protection in the basic curricula of medical and dental schools is now
made mandatory.

4. Euratom BSS adoption procedures

The first published draft of the revised Euratom BSS was issued in February 2010 together
with the opinion of the Euratom Art. 31 Group (10). Following an impact assessment and
internal procedures, and after obtaining the opinion of the European Economic and Social
Committee, the European Commission issued its final proposal in May 2012 (7).

The Commission proposal is currently being discussed in the Council of the European
Union's Working Party on Atomic Questions (WPAQ) and, in parallel, by the European
Parliament. The results of the negotiations in the WPAQ materialize in revised drafts, which
are publicly available through the public register of Council documents (11, 12)

The current expectations are that the WPAQ would reach an agreement on the revised BSS
by mid-2013, allowing for adoption of the new Council Directive by the end of the year. This
should be followed by transposition into the national legislation of the EU Member States
within a deadline yet to be decided.

5. Discussion and conclusions

The European Union has a long history of developing legislation for radiation protection,
which has become quite complex and comprehensive, especially in the past couple of
decades. The need to update the legislation in the recent years provided also an opportunity
to codify the different pieces of legislation in order to build a truly integrated European legal
system for protection of the public, staff and patients.

The revised BSS maintains the existing radiation protection framework adding several
important updates and advances, including in relation to education and training in radiation
protection. The importance of education and training has been fully recognized and given
further legal prominence. Important developments have taken place with regard to the
definition, and the respective roles and responsibilities, of the services and experts identified
as part of the national infrastructure for radiation protection.

The amendments of the European legal basis will require some changes in the established
national arrangements for radiation protection, in general, and for education and training, and
services and experts, in particular. At the same time, the revised Directive provides enough flexibility allowing Member States to achieve the defined objective in a manner best suiting the national circumstances.

The key to successfully implementing the revised legislation and to fully benefiting from the advance

s it provides for should be sought through co-operation and exchange of experience between Member States and different organizations and professions concerned. Learning from other regions and international experiences is no less important. In this respect, the current conference represents welcome and timely contribution in the area of education and training.

The European Commission is prepared to play an active role going beyond the adoption of the revised BSS Directive. In line with previous experiences, Commission support to Member States through fostering co-operation and providing guidelines will facilitate the implementation in practice of the new requirements.

6. References


AN IAEA PERSPECTIVE ON ESTABLISHING SUSTAINABLE
NATIONAL INFRASTRUCTURES FOR EDUCATION AND TRAINING
IN RADIATION, TRANSPORT AND WASTE SAFETY

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ABSTRACT

The statute of the International Atomic Energy Agency includes the establishment of, and provision for, the application of safety standards for protection of health, life and property against ionizing radiation. IAEA assigns high priority to education and training in nuclear, radiation, transport and waste safety as one of the main mechanisms to facilitate the application of safety standards in IAEA Member States and to globally strengthen radiation protection. The ‘Strategic Approach to Education and Training in Radiation, Transport and Waste Safety, 2011-2020’, submitted to the IAEA Policy Making Organs in 2010, where it was endorsed by the General Conference, provides the inspiring principles for IAEA’s education and training activities in the field of radiation, transport and waste safety. Its ultimate vision is for Member States to have established a sustainable education and training infrastructure that addresses national needs for building and maintaining competence in radiation, transport and waste safety, consistently with the Agency’s safety standards. For that purpose it emphasizes the importance of Member States developing a national strategy for education and training, considered to consist of four interlinked phases, where the outcome of one phase is the starting point for the next phase: analysis of the needs; design of; development and implementation of; and evaluation of the national education and training programme. The strategic approach also outlines the role played by IAEA and the training centres in the regions to help Member States to establish their national strategies. For that purpose IAEA have developed a range of mechanisms, including appraisal missions, regional workshops, educational and training events (delivered in cooperation with the training centres at regional level), and standardized syllabi. A methodology to guide States in establishing a national strategy for education and training in radiation, transport and waste safety has recently been developed and this has been disseminated to many Member States via IAEA regional workshops. The paper gives an overview of the efforts by which IAEA is helping Member States to establish sustainable infrastructures for education and training in radiation, transport and waste safety around the world. In addition to describing what has worked well, the paper will indicate what can be improved and what challenges lie ahead.

1. Introduction

1.1 IAEA’s objective and safety functions

The International Atomic Energy Agency was set up in 1957 within the United Nations family to promote safe and peaceful nuclear technologies by working together with its Member States and multiple partners worldwide. According to the IAEA Statute, the objective of the Agency is to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world, assuring that any assistance provided for that purpose is not used in such a way as to further any military purpose. In exercising its safety functions, the Agency is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards. The IAEA’s safety standards are not legally binding on
Member States but may be adopted for use in the concerned national regulations and legislation. However, these standards are binding on the IAEA in regard to its own operations and on Member States whenever receiving assistance by the IAEA. The IAEA’s safety standards are based on a hierarchic system of publications, structured on Safety Fundamentals (to establish the fundamental safety objectives and principles of protection and safety), Safety Requirements (to be met to ensure the protection of people and the environment, in line with the objectives and principles of the Safety Fundamentals), and Safety Guides (to provide recommendations and guidance on how to comply with the requirements).

1.2 Application of the IAEA’s safety standards
The IAEA has developed several approaches and mechanisms to support Member States to apply the IAEA’s safety standards, including rendering radiation safety services, providing technical cooperation, fostering information exchange, encouraging knowledge management and networking, and promoting education and training. Therefore, education and training activities supported and promoted by IAEA are mainly aimed at fulfilling its statutory safety functions to support Member States in the application of the safety standards.

The IAEA’s education and training activities in radiation safety follow the resolutions of General Conference; the highest policy-making body of the IAEA composed of representatives of all Member States, and reflect the IAEA safety standards [1, 2, 3]. They are developed in line with the general policy principles provided in the IAEA “Strategic approach to Education and Training in Radiation, Transport and Waste Safety, 2011-2020” [4], submitted to the IAEA Policy Making Organs in 2010, where it was endorsed by the General Conference. The Division of Radiation, Transport and Waste Safety in the IAEA Department of Nuclear Safety and Security is responsible for the implementation of the IAEA strategic approach.

2. IAEA strategic approach to education and training

2.1 The vision
The ultimate vision of the IAEA strategic approach is “for Member States to have established a sustainable education and training infrastructure that addresses national needs for building and maintaining competence in radiation, transport and waste safety, and is consistent with the Agency’s safety standards”. In referring to Member States’ education and training infrastructure, that has to reflect the IAEA’s safety standards in line with the objectives of the education and training activities supported by the Agency, the IAEA strategic approach focusses on the development of a sustainable infrastructure. For that purpose, one of the main objectives of the IAEA Strategic Approach is to facilitate the development and implementation of a national strategy for education and training for radiation, transport and waste safety in Members States. This will help governments to comply with the requirements given in the IAEA Safety Requirements on ‘Governmental, Legal and Regulatory Framework for Safety’ [5] on the establishment of national policy and strategy for safety, that should include, inter alia, the need and provision for human resources.

2.1 Key-players and activities
The successful implementation of the IAEA strategic approach will require effective interaction between:

- IAEA, to develop and provide the tools to build competence and to assist Member States to apply the IAEA safety standards. This includes, inter alia, the development

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1 IAEA General Conference Resolution GC(45)/RES/10C, GC(46)/RES/9, GC(47)/RES/7, GC(48)/RES/10, GC(49)/RES/9, GC(50)/RES/10, GC(51)/RES/11, GC(52)/RES/9, GC(53)/RES/10, GC(54)/RES/7 and GC(55)/RES/9.
of training material, syllabi, and the guidance on the methodology to establish a national strategy for education and training in radiation, transport and waste safety;

- Regional Training Centres\(^2\) (RTCs) (Figure 1):
  - to provide training, in collaboration with IAEA, to Member States in the region;
  - to disseminate and promote the guidance on the methodology for establishing a national strategy for education and training;
- Member States, to establish a national strategy for education and training, including the development of education and training programmes in line with the IAEA’s safety standards.

![Fig 1. Member States hosting a Regional Training Centre.](image)

The three main key-players will each be involved in specific tasks as appropriate; but, with each of them playing a major role at certain stages of implementation, as depicted in Table 1.

<table>
<thead>
<tr>
<th>Stage I: Preparation</th>
<th>Stage II: Promotion</th>
<th>Stage III: Implementation</th>
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<tbody>
<tr>
<td>Preparation of the competence building tools and guidance to establish a national strategy for education and training</td>
<td>Dissemination and promotion of tools and guidance at regional level among the Member States</td>
<td>Development and implementation of national strategies in Member States</td>
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<tr>
<th>Key-players</th>
<th>IAEA</th>
<th>RTCs</th>
<th>Member States</th>
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Tab 1: Activities and key-players in the different stages of implementation of the IAEA “Strategic approach to education and training in radiation, transport and waste safety, 2011 – 2020” [4].

To successfully implement the IAEA strategic approach, an adaptable and flexible response is required. Consequently, there is a need for ongoing observation and review to ensure that implementation of the strategic approach continues to be on course to meet the objectives. For that purpose, a steering committee, comprised of experts from RTCs and other

\(^2\) The institutions acting as RTCs have to comply with specific criteria and are regularly appraised through an IAEA Education and Training Appraisal (EduTA) mission followed by a long term agreement signed between IAEA and the authorities of the Member States hosting the RTC.
collaborating institutions in Member States, International Organizations and the IAEA Secretariat, was established, in 2001, to advise the Agency on the implementation of the strategy and to make recommendations as appropriate.

3. National strategy for education and training in radiation, transport and waste safety

3.1 Guidance on the establishment of a national strategy
Guidelines on how to meet requirements for education and training in radiation safety, and in radiation protection aspects of nuclear, transport and radioactive waste safety are provided in the IAEA’s Safety Guide Building Competence in Radiation Protection and the Safe Use of Radiation Sources [2]. It also presents a systematic structured approach to help Member States to establish a national strategy for education and training in order to address training needs in the field of radiation protection and the safety of radiation sources by developing a sustainable education and training programme based on the analysis of training needs and with an effective use of human and physical resources available at national and international level.

Since the publication of the guide, considerable progress has been made, with respect to the development of a range of tools and concepts that can assist Member States with respect to national strategies for building competence, and the establishment of RTCs as centres of resources for the Member States in the region. However, there is little by way of detailed guidance for Member States as to how to approach the development of national strategies for education and training and to make use of the various resources available from the IAEA, including the RTCs, for that purpose. Experience has shown that the availability of such guidance would be of value and help to encourage competence building in radiation protection and safety at the national level.

For that purpose the steering committee recommended the IAEA to develop a guidance providing a methodology to establish a national strategy for education and training in radiation, transport and waste safety. It is primarily addressed to national bodies (e.g. regulatory authorities) and policy decision makers that want to develop and maintain competence and skills of personnel in radiation safety with an effective and sustainable approach by establishing education and training programmes based on the assessment of national training needs. Technical support organizations, education and training institutions, professional organizations, and other relevant stakeholders for education and training in radiation, transport and waste safety are also expected to be interested in the use of the guidance.

3.2 The process
The establishment of a national strategy for education and training can be considered to consist of four interlinked phases, where the outcome of one phase is the starting point for the next phase, with the loop being closed by evaluation and feedback, as shown in figure 2.

Assessment of Needs
The first phase in the process is to evaluate the education and training needs. There are three components within this phase:

- Collection of information about facilities and activities undertaken;
- Analysis of education and training requirements specified in the legal and regulatory framework;
- Evaluation of numbers of personnel within identified professional categories that will require training, including consideration of any on-going needs for refresher training.
Fig 2. Phases to establish and maintain a national strategy for education and training in radiation, transport and waste safety.

Design of the Programme

Based on the output of phase one, the focus of the second phase is to design a national education and training programme \(^3\) that will meet all identified needs.

The current national status and capacity for conducting education and training courses in radiation protection should be analysed to identify the gaps between what is available at national level and what is needed on the basis of the outcomes of the previous phase. The analysis will need to take into consideration, inter alia:

- the availability of training providers with appropriate facilities and human resources;
- the types of education and training events that are required (e.g. basic or specialized, scientific or technical, theoretical or practical, initial or refresher, academic or vocational);
- the need for new regulatory requirements, particularly to fully comply with the IAEA safety standards in the field, and
- the development of syllabi and related training material.

Particular emphasis should be given to ensure that educational and training needs of the qualified experts and radiation protection officers are provided for and that mechanisms are in place for their formal recognition/appointment, given their key role played in the framework of an effective and comprehensive radiation safety system [1].

When during the design, phase gaps were identified between what is currently available and what is needed, decisions will need to be taken whether to develop the expertise/infrastructure nationally or to make use of the resources available at international level, e.g. at the RTCs by sending people to attend the requested courses in other countries or by inviting external experts. Factors to consider in making such decisions will include the

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\(^3\) In simple terms, any national education and training programme can be considered the schedule of activities to be delivered over a specified timeframe in order to meet the identified education and training needs.
current and future demands for education and training, financial resources and possible support from international organizations, possibility of recognizing the courses delivered in other countries whenever required by the national legislation and regulations.

**Development & Implementation**

The third phase of the overall strategy is putting into practice the national education and training programme. There are two components to this phase:

- The development of the appropriate tools and mechanisms, where necessary, for the implementation of the activities outlined in the national education and training programme, and
- The actual delivery (implementation) of the activities within the national education and training programme.

The development will include the setting of criteria for the content and format of the courses and/or for the training providers when required by national regulations, and the establishment of examination procedures, particularly when the successful completion of the training confers qualification or status (for example as qualified expert or radiation protection officer). The implementation will include actions needed for training needs met using regional or international resources (e.g. to ensure that the contents and duration of the training is in line with national requirements), the recognition of training courses and or providers (when required by national regulations), activities to build national training capability (e.g. through train-the-trainers approach; see section 4.1).

**Evaluation of Effectiveness**

In the fourth phase, the effectiveness of the national education and training programme should be evaluated and monitored in order to ensure that:

- The options adopted to meet the needs continue to be effective; and
- The overall programme is kept up to date and improved.

Realistically, any national education and training programme would be expected to change over time in order to meet the changing or evolving needs as a result of, for example, improved national competence, evolving technologies, evolution of the legal and regulatory framework, or further development of the radiation protection infrastructure.

The Education and Training Appraisal methodology [6], used as a self-assessment tool or as an external peer review service may assist in the implementation of the above process.

**3.3 Policy framework**

The national strategy for education and training in radiation, transport and waste safety is expected to be part of the national policy and strategy for safety to be established by the Member States (Requirement 1 in Ref [5]). The operational implementation of the above mentioned four phases requires a long-term commitment of several national stakeholders and key-players (e.g. regulatory bodies, training providers, governmental organizations active in education and training, professional organizations). They are expected to carry out, in a synergistic and timely manner, the activities related to their specific functions in order to put in operation the process to establish the strategy. For this purpose, it is essential that Member States take the ownership of the whole process with a clear commitment at a high level of the national policy organs, by providing the formal framework for the action of the single stakeholders and key-players with a clear identification of roles and responsibilities. For that purpose, the guidance recommends the governments to adopt a general policy document that outlines the national strategy for education and training in radiation, transport and waste safety providing:

- Background information on:
  - The relevance of techniques using ionizing radiations in the national context, considering present status and future development of the applications;
  - The national legal and regulatory framework for education and training and its interface with international requirements.
• A vision that communicates the values inspiring the Member State, giving directions about how national stakeholders and key-players are expected to behave, and shaping international organizations’ understanding of why they should collaborate and support the Member State in the field of education and training in radiation, transport and waste safety;
• An outline of the main elements of the process underpinning the national strategy, reflecting the phases as described in the previous section;
• Identification of the national stakeholders and key-players for the establishment of the national strategy, pointing out their role and responsibilities at national level in the field of education and training and their expected contributions for the operational establishment of the strategy;
• Provisions for mechanisms to review, advice, and report on the progress made in the implementation of the national strategy (e.g. through the establishment of a national committee aimed at monitoring the implementation of the national strategy).

This general policy document should have a formal endorsement from the national authorities with responsibilities in education and training for the personnel in charge of radiation protection, and/or authorities accountable for the safe use of ionizing radiations, or more generally for the development of human resources at the national level. These authorities shall have the power to directly take the actions required for the implementation of the national strategy, e.g. according to the advice provided by the national committee, or to formally request the competent institutions or organizations to take such actions.

3.4 Practical example of establishing a national strategy

In the guidance, an annex illustrates a case study of a hypothetical country that wants to develop a national strategy for education and training. This is aimed at visualizing the implementation of the various steps of the process in a practical way. The case study focuses on the first three phases of the process to build a national education and training programme in radiation, transport and waste safety: assessment of education and training needs, design of the national education and training programme, development and implementation of the programme. For the sake of brevity and simplicity, the case study has been limited only to a restricted number of practices and categories of personnel among all the possible ones. The education and training needs were assessed for practices in the industrial and research field, medical field, other general practices, and practices related to regulatory activities. Furthermore, the categories of personnel considered are qualified experts, radiation protection officers, operators and health professionals [2]. On the basis of the training needs analysis, the national education and training programme was then designed only for practices in the medical field and for three categories of personnel (qualified experts, radiation protection officers, and operators). Finally, an example of some actions to develop and implement the national education and training programme is provided for the training of radiation protection officers in nuclear medicine.

In the annex, several tables are proposed to facilitate the collection of data and information, to present the results of the analysis of training needs, and to summarize the main elements of the national education and training programme. An example of a table with data collected for some practices and categories of personnel relevant to the hypothetical country and with the evaluation of the number of personnel to be trained is provided in Figure 3. Similar tables have been already tested and extensively utilized during the EduTA missions conducted in several Member States.
4. IAEA support to build education and training infrastructures

4.1 Mechanisms to assist Member States strengthen education and training

IAEA provide direct assistance to Member States via a range of mechanisms, such as by offering appraisal missions (e.g. EduTA), running educational and training events (e.g. the postgraduate educational course in radiation protection and the safety of radiation sources; specialized training courses on specific practices or for specific target audience, such as radiation protection officers; and train-the-trainers events), developing standardized syllabi, implementing fellowships and scientific visits. These mechanisms were extensively described in a previous paper [7].

4.2 Cooperation projects to promote the establishment of the national strategy for education and training

Cooperation projects have been jointly designed by the IAEA Secretariat and Member States to build competence in radiation safety and to support Member States to establish national strategies for education and training in radiation, transport and waste safety. Currently, four projects are under implementation, one for each region of the IAEA Technical Cooperation Programme: Africa, Asia and the Pacific, Europe, and Latin America.

Under such projects seven regional workshops were organized in most of the IAEA official languages (Arabic, English, French, Russian and Spanish) to disseminate the guidance on the methodology to establish a national strategy for education and training. The workshops were held in Botswana and Morocco (for the English- and French-speaking participants in the African region), Jordan and Malaysia (for the Arabic- and English-speaking participants in the Asian region), Lithuania and Tajikistan (for the English- and Russian-speaking participants in the European region), and Brazil (for the Spanish-speaking participants in the Latin-American region). The objectives of the workshops were:

- To provide Member States with a general understanding of the IAEA guidance on the methodology for establishing a national strategy for education and training in radiation, transport and waste safety;

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4 The IAEA technical cooperation (TC) programme is the main mechanism through which the IAEA delivers services to its Member States (http://www.iaea.org/technicalcooperation/programme/index.html).
• To familiarize Member States with the relevant IAEA’s safety standards, providing requirements for education and training in radiation protection and safety;
• To collect from Member States preliminary information for the development of national strategies, including regulatory framework for education and training, human resources, and training infrastructures in radiation safety.

The workshops were attended by about 120 participants from more than 80 countries. Participants were familiarized with the IAEA methodology to establish a national strategy for education and training. They gave presentations providing preliminary information and data necessary to establish the national strategy, including practices and activities undertaken in the countries and national legislation and regulations for education and training in radiation, transport and waste safety. The participants also reviewed the guidance on the methodology to establish a national strategy, proposing, inter alia, a road map to facilitate national stakeholders when establishing a national strategy. This proposal has been now included into the guidance as a new annex.

2012 was the first year of implementation of the regional projects. The work plans of the projects for the current year include a second workshop to share experience and report on progress made by Member States on establishing a national strategy for education and training in radiation, transport and waste safety.

4.3 Monitoring the progress made by the Member States
RASIMS (Radiation Safety Information Management System) [8] is a web-based platform that enables Member States and the IAEA Secretariat to jointly collect, analyse and view information regarding the national infrastructure for radiation, transport and waste safety. In addition to facilitating the identification of national and regional needs, the information in RASIMS is used for a range of other purposes including the design of new cooperation projects. RASIMS is therefore focused on Member States that are receiving assistance from the Agency, although all Member States are welcome to provide data on their national infrastructure.

The information in RASIMS is grouped into Thematic Safety Areas (TSA) to ensure that all aspects of the relevant IAEA safety standards are covered in a comprehensive and consistent manner:
• TSA1: Regulatory Infrastructure
• TSA2: Radiological Protection in Occupational Exposure
• TSA3: Radiological Protection in Medical Exposure
• TSA4: Public and Environmental Radiological Protection
• TSA5: Emergency Preparedness and Response
• TSA6: Education and Training in Radiation, Transport & Waste Safety
• TSA7: Transport safety

TSA6 is the specific area focussing on education and training, structured to collect the information about the related legal and regulatory framework, and the establishment of the national strategy.

The presentations from the participants that attended the workshops under the cooperation projects (section 4.2) represent a very important source of information that will be used to update the profiles of the Member States in RASIMS for TSA6.

5. The way forward
The establishment by Member States of a national strategy for education and training in radiation, transport and waste safety, in line with the requirements of the national policy and strategy on radiation safety as given in the IAEA safety standards, is one of the main challenges that will be faced to create a sustainable education and training infrastructure in this area. In addition to assisting States to develop national strategies, future work of IAEA will include monitoring the progress made and analysing challenges faced and difficulties encountered, in order to identify possible solutions to be rendered to Member States. For that purpose IAEA is ready to assist Member States through several mechanisms, including the
development of further guidance, provision of expert missions, and organization of appraisal services. Noting that the prime responsibility and 'ownership' for developing competence through education & training lies with the individual Member States, IAEA’s Division of Radiation, Transport and Waste Safety stands ready to provide the necessary assistance.

REFERENCES


Harmonisation of terminologies and definitions
Enetrap II: WP5
Develop And Apply Mechanisms For The Evaluation Of Training
Events, Material and Providers

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ABSTRACT

To maintain a high level of competence in Europe regarding radiation protection and
to facilitate harmonisation and (mutual) recognition of Radiation Protection Experts
(RPEs) and Radiation Protection Officers (RPOs) quality assurance and quality control
procedures might play an important role. The ENETRAPII project (FP7-EURATOM)
aims at developing European high-quality 'reference standards' and good practices for
education and training in radiation protection. In Work Package 5 (WP5) the quality
issue is addressed. Therefore, WP5 deals with the development and application of
mechanisms for the evaluation of training material, training events and training
providers by means of a transparent and objective methodology. The results can be
used by regulatory authorities to benchmark their national radiation protection training
programme and will be communicated to other networks, e.g. EUTERP. This paper
addresses the comparison table of training events (courses and on the job training).
The comparison table consists of two parts, one part for the comparison of knowledge based events and the other one for the comparison of skills and competence based events.

The knowledge based events are compared on a grading system from 0 (no awareness) up to 3 (detailed understanding). The skills and competence based events can be compared on a grading system yes/no. With this grading system a course can be compared with the ENETRAP training scheme (standard), developed in ENETRAP and more in detail in ENETRAPII, to conclude whether this course meets the standard.

Together they form the comparison table for training events, where competence, knowledge and skills can be compared with the standard (European Radiation Protection Training Scheme (ERPTS))

Since the end of the ENETRAPII project, the table with learning outcomes of the ERPTS can be used as the list of learning outcomes to compare to. The EQF grades can be used to define the level of knowledge, skill or competence that is reached.

1 Introduction

One of today's challenges in the field of radiation protection includes measures to make the work in radiation protection more attractive for young people and to provide attractive career opportunities. In addition, young students and professionals should be supported in their need to gain and maintain high level knowledge, skills and competence in radiation protection. These objectives can be reached by the development and the implementation of a high-quality European standard for initial education and continuous professional development for Radiation Protection Experts (RPEs) and Radiation Protection Officers (RPOs).

The FP7 European Network for Education and Training in Radiation Protection II (ENETRAPII) project is a specific tool for EURATOM policy for E&T implementation in the radiation protection field. In addition, the project is a tool towards a mutual recognition of professional qualifications.

For the purposes of this project the Radiation Protection Expert is defined as:

"An individual having the knowledge, training and experience needed to give radiation protection advice in order to ensure effective protection of individuals, whose capacity to act is recognized by the competent authorities."

and the Radiation Protection Officer as:

"An individual technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant or licensee to oversee the application of the requirement of the Standards".

These are the definitions as proposed during the second EUTERP workshop in Lithuania in 2008. These definitions became part of the draft EURATOM BSS directive [1].

To reach high-quality European standards for initial education and continuous professional development, there has to be an agreement between the European countries concerning the duties and responsibilities of both RPEs and the RPOs. These standards are developed in Work Packages 3 and 4 (WP3 and WP4) of the ENETRAPII project.

Since these standards are developed each country will be able to assess and benchmark their own education and training against the European standards. It will also be possible for a country to benchmark the knowledge, skills and competence of an RPE or RPO, educated and trained in another country, to their national standards. Shortcomings in education and training materials, events and providers, become clear when it is possible to compare national standards of education levels to the European standards. Therefore one of the cornerstone work packages in ENETRAPII was work package 5 (WP5), entitled: Develop and apply mechanisms for the evaluation of training material, events and providers.

In the second deliverable of WP5 (WD 5.2) the comparison table of training events is presented. In this document training events are defined to be both courses and on the job training (OJT). This paper described the outcomes reached in this second deliverable.
1.1 Boundary conditions for the comparison of training events

To build a comparison system for training events a few boundary conditions were set. These boundary conditions are given and explained below.

- Nowadays learning outcomes are not only knowledge based, but also skills and competence based. The comparison model for courses has to deal with all three types of learning outcomes.
- Training events can be followed by students that have different backgrounds. Due to this difference no entrance level can be specified. The comparison model for courses has to be used, without a prescribed entrance level.
- In the future e-learning will become more and more important in the field of radiation protection. This is one of the types of training and education that cannot be defined by the number of hours of a training event. Therefore the comparison model for courses cannot use the numbers of hours as a criterion to compare courses.

2 A mechanism for the evaluation of training events

Within Europe there are different systems that encourage the mutual recognition of different professions. The European project about European credits for vocational education and training is developed to allow the recognition by a given employer of the education and training received from an employee. Examples are ECTS (European Credits and Transfer accumulation system [2]), ECVET (European Credit System for Vocational Education and Training [3],[4]), EQF (European Qualifications Framework for lifelong learning [5], the proposed comparison table for training material [6] and the underlying table with subjects for radiation protection training in the Netherlands [7].

The IAEA syllabus [8] and the European syllabus [9] in the field of radiation protection training were reviewed in WD 5.1 [5], and are existing of a list of topics to be dealt with in a training event with or without spent hours.

2.1 European Credit Transfer and Accumulation System (ECTS)

The European Credit Transfer and Accumulation System (ECTS [2]) is a standard for comparing the study attainment and performance of students of higher education across the European Union and other collaborating European countries. For successfully completed studies, ECTS credits are awarded. One academic year corresponds to 60 ECTS-credits that are equivalent to 1500–1800 hours of study in all countries irrespective of standard or qualification type and is used to facilitate transfer and progression throughout the Union. The entrance level for students in higher education is secondary school.

The ECTS will be complemented by the European Credit transfer system for Vocational Education and Training (ECVET, [3], [4]) which the ministers responsible for vocational training in 32 European countries agreed to develop in the Maastricht Communiqué of 14 December 2004.

2.2 European credit Transfer system for Vocational E&T (ECVET)

ECVET [3],[4] is a European system of accumulation (capitalisation) and transfer of credits designed for Vocational Education and Training (VET) in Europe. It enables the attesting and recording of the learning achievement/learning outcomes of an individual engaged in a learning pathway leading to a qualification, a vocational diploma or certificate. This approach is broader
than ECTS ([2]), since not only high level of education, but all vocational education and training is included. It enables the documentation, validation and recognition of achieved learning outcomes acquired abroad, in both formal VET or in non-formal contexts. It is focused on the individual, based on the validation and the accumulation of his/her learning outcomes, defined in terms of the knowledge, skills and competences necessary for achieving a qualification. ECVET is a system designed to operate at the European level, interfacing with national systems and arrangements for credit accumulation and transfer.

To work within the ECVET framework a Memorandum of Understanding (MoU), must be developed between the employer of the participant and the training provider. The learning outcomes are explicitly stated in this MoU. When the education or training is finished the MoU is evaluated against the learning outcomes achieved. Credits are awarded for each of the learning outcome. Depending on the field of education and training the credits can be summed together or the credits stay apart to form two separate subjects.

The learning outcomes have to be considered not only in the knowledge field, but also in the field of skills and competences. All together learning outcomes are competency based.

2.3 European Qualification Framework (EQF) for lifelong learning

The EQF [5] aims to relate different countries' national qualifications systems to a common European reference framework. Individuals and employers will be able to use the EQF to better understand and compare the qualifications levels of different countries and different education and training systems.

Agreed upon by the European institutions in 2008, the EQF is being put in practice across Europe. It encourages countries to relate their national qualifications systems to the EQF so that all new qualifications issued from 2012 carry a reference to an appropriate EQF level. An EQF national coordination point has been designated for this purpose in each country.

The core of the EQF concerns eight reference levels describing what a learner knows, understands and is able to do – ‘learning outcomes’. Levels of national qualifications will be placed at one of the central reference levels, ranging from basic (Level 1) to advanced (Level 8), see appendix A. This will enable a much easier comparison between national qualifications and should also mean that people do not have to repeat their learning if they move to another country.

The EQF applies to all types of education, training and qualifications, from school education to academic, professional and vocational. This approach shifts the focus from the traditional system which emphasises ‘learning inputs’, such as the length of a learning experience, or type of institution. It also encourages lifelong learning by promoting the validation of non-formal and informal learning.

2.4 Dutch table with subjects for training in radiation protection

As already mentioned in deliverable 5.1 [6] in the Netherlands a reference table [7] is used since 1984 for different levels of training in radiation protection. This table is divided in main subjects and subdivided in more detail. There are no numbers of spent hours in this table, but only a characterisation of the level of detail at which the detailed subjects are covered during the training, together with its training goal (Table 1). The advantage of using grades above hours spent on the different subjects is that the entrance level of students doesn’t have to be set. Theoretical people with different levels can enter all courses.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Covered</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Grades at which subjects are covered in training events (knowledge part)
The second part of the Dutch reference table [7] is about practical exercises that are part of the Dutch training in radiation protection. Since these are not knowledge based, the grades as mentioned in Table 1 cannot be used. The objectives of this part of the table are to learn skills and competences to the trainees. The grades used can be seen below in Table 2.

Table 2 Grades at which subjects are covered in training events (competence and skills part).

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>Necessary</td>
</tr>
<tr>
<td>+/-</td>
<td>Optional</td>
</tr>
<tr>
<td>-</td>
<td>Not necessary</td>
</tr>
</tbody>
</table>

3 The final mechanism for the comparison and evaluation of training events

The ECTS is meant for higher education, so there is a prescribed level of entrance in the competencies of the trainees. The comparison table that will be proposed aims at being independent of the entrance level. For the same reason the IAEA syllabus [8] and the EC syllabus [9] about training in the field of radiation protection cannot be used, because they use class hours, which are dependent on the entrance level of the trainee.

ECVET is a system which can be used for all vocational education and training. Therefore ECVET is used in our approach to come to a comparison table. The comparison table has to be filled with learning outcomes in the three fields of competences needed to address in radiation protection training: knowledge, skills and competence.

ECVET is used for functions within Europe with an EQF of 1 up to 6 at the moment. Since the RPE is an EQF function category 6 or 7, it can be difficult to use the exact approach of ECVET. For the RPO there should be no difficulty, but this is outside the scope of this work package.

In the ENETRAPII project learning outcomes for the RPE are delivered by work package 4 (WP4). In the final report of WP 4 [10] learning outcomes of different modules can be found. The learning outcomes are developed according to Blooms taxonomy, adapted for radiation protection training.

At the end of the ENETRAPII project, the learning outcomes of the European reference training scheme are developed in ECVET style, with grading in EQF numbering (Appendix A). Each learning outcomes in WP4 is assigned to a certain field: knowledge, skills or competences (attitude). Therefore it makes more sense to use the EQF numbering instead of the grades of Table 1, but at the time of research the EQF levels were not known by the consortium.

At the moment, ECVET is in a developing stage. The real number of credits for one year of training is not yet defined. In future ECVET credit points can be used to compare different events in the field of radiation protection. The principle of ECVET that learning outcomes can be described in three different fields (knowledge, skills and competences (attitude) is used in the list of learning outcomes.

3.1 Knowledge based learning outcomes

For the comparison of the training material, a comparison table is developed [5]. Research is carried out to the usefulness of this table in the same report. The conclusion is that it can be
used for the comparison of training material. With the same grading method (Table 1) this table is proposed to use for the knowledge based learning outcomes. For the comparison table the description of the grades in the right column will be used (Table 3), since the description of both the middle and the right column in Table 1 can lead to confusion as they are not unambiguous.

Table 3  Proposed grades for the comparison of training events (knowledge part)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>(basic) awareness of the subject</td>
</tr>
<tr>
<td>2</td>
<td>understanding of the subject</td>
</tr>
<tr>
<td>3</td>
<td>detailed understanding of the subject</td>
</tr>
</tbody>
</table>

At the time of the research to come to a comparison table for the evaluation of training events, the EQF levels were not known by the ENETRAPII consortium. Nowadays the EQF grades 1-8 are preferred above the grades 0-3 as mentioned in Table 3.

3.2 Skills and competence (Attitude) based learning outcomes

For the skills and competence based learning outcomes, the same grades as for knowledge based learning outcomes cannot be used. Therefore, as already mentioned before, other grades are proposed in Table 2. For the comparison these grades cannot be used. It seems more obvious to use ‘fulfilled’ instead of ‘necessary’. Also the grade optional is left out.

The ECVET [3],[4] approach asks for learning outcomes which are either knowledge, skills or competence based. Knowledge and skills can be acquired in training or education. Competence on the other hand is a personal profile, attribute or character, of which, if available, the development can be encouraged by on the job training (OJT) and work experience. For instance the ability to give advice or the ability to be responsible can be trained in other types of training courses or workshops, but cannot reached by education and training alone.

Table 4  Proposed grades for comparison of training events (skills and competence part)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>Fulfilled</td>
</tr>
<tr>
<td>-</td>
<td>Not fulfilled</td>
</tr>
</tbody>
</table>

At the time of research to come to a comparison table for the evaluation of training events, the EQF levels were not known by the ENETRAPII consortium. Nowadays the EQF grades 1-8 are preferred above the grades as mentioned in Table 4 for the skills and competence based learning outcomes.

4 Testing the mechanism for the evaluation of training events

The comparison system for training events consists of two parts. One part is a list of learning outcomes; the other part is a tool for the comparison of the learning outcomes. The list of learning outcomes can be used from the first interim report of WP 4 of the same project [10], where the learning outcomes are described for the European Radiation Protection Training Scheme (ERPTS) for the Radiation Protection Expert (RPE). Not all learning outcomes for the ERPTS were finalized at time of writing this paper. The comparison of the training events is therefore carried out by using only the learning outcomes for Module 1 of the ERPTS.
The table with learning outcomes of Module 1 of the ERPTS course was sent out to all WP5 partners. The learning outcomes were split in two: knowledge based learning outcomes on the one side and attitude / skill bases learning outcomes on the other side. The partners were asked to describe the learning outcomes of their events, which are knowledge based, according to Table 3 and those which are skill / attitude based, according to Table 4.

For the comparison of training events the institutes have chosen one or more of their courses or other training events for RPE, RPO or Radiation Worker (RW). Five partners filled in the list for in total eight events. Apart from that the table was filled in by the WP leader of WP 4 for the ERPTS. At the moment of comparing, the learning outcomes of the ERPTS were ready only for module 1 [10].

All the institutes mentioned the level of the training event. In Table 5 (knowledge) and Table 6 (skills and attitude) the result is shown for the learning outcomes of events A up to H (different training events) and in the last column for the ERPTS Module 1. The indication given by the partner can be found on the last row.

Table 5  The filled list for knowledge based learning outcomes for 8 different events and the ERPTS.

<table>
<thead>
<tr>
<th>Training event</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>ERPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain the different modes of disintegration and desexcitation</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Describe the different type of radiations emitted and their features</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Define the notions of activity, intensity of radiation, half-life.</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Explain the different phenomena of interaction of the radiations with matter (loaded particles, electromagnetic radiations, neutrons)</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Define the linear transfer of energy</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Interpret attenuation of gamma radiation as a function of thickness and Z</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Define the operational quantities and UNITS</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Define the absorbed dose, the doserate of absorbed dose</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Explain the principle of performance of the detectors used in radioprotection</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Indication of the level of the event by the provider*</td>
<td>W</td>
<td>O</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>W</td>
<td>W</td>
<td>E</td>
<td>E</td>
</tr>
</tbody>
</table>

* W: an RW course, O: an RPO course, E: an RPE course.

The knowledge based learning outcome of the standard ERPTS course is met, if the descriptor is at least the same as that in the last column or higher, i.e. in this case the descriptor has to be 3. For all events it was concluded by comparing the descriptors of the events with the ERPTS that there are shortcomings, except for one (training event H). This institute indicated that in their training event all their learning outcomes are covered detailed and quantitative (score 3).

Table 6  The filled list for attitude and skill based learning outcomes for 8 different events and the ERPTS (module 1).

<table>
<thead>
<tr>
<th>Training event</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>ERPTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication of the level of the event by the provider*</td>
<td>W</td>
<td>O</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>W</td>
<td>W</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>Calculate the activity of a source at any time...</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Calculate the range of a beta radiation and the attenuation of a radiation using curves</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Apply relationship between fluence, kerma and absorbed dose</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Calculate the limit of detection, and others characteristics</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Use the appropriate detection device and probe vs. type of radiations</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

| Indication of the level of the event by the provider* | W | O | E | E | E | W | W | E | E |

* W: an RW course, O: an RPO course, E: an RPE course.

The attitude and skill based learning outcome of the standard ERPTS course is met, if the descriptor is at least the same as that in the last column or higher, i.e. in this case the descriptor has to be yes. The descriptor of the ERPTS is yes, because we used the learning outcomes of the ERPTS. If using other learning outcomes it is possible that a skill or attitude based learning outcome is used that is not preferred by the ERPTS. In that case the descriptor in the column of the ERPTS is no. In a comparison the learning outcome is met, when the descriptor in the column of the comparing event is yes or no.

For all events it was concluded by comparing the descriptors with the ERPTS that some events have shortcomings. Events A, B and C do not deal with the skill: ‘calculation of the limit of detection and other characteristics’. Event G only meets the skill: ‘using the appropriate detection device and probe vs. type of radiation’. It is possible that the student however has knowledge about the other skills, but is not trained on the skill itself. Therefore learning outcomes should be considered to be not only one type of learning outcome. Learning outcomes as described above can be both knowledge based and skill or attitude based. In a newer version of WD 4.1 [10] this has been done for all learning outcomes.

5 Conclusions and discussion

The proposed comparison table for learning outcomes consists, for this project, of the learning outcomes of WP4. In future also other existing learning outcomes can be used to fill the table. For the comparison the training provider has to give each learning outcome a grade. For the knowledge based learning outcomes the grades of Table 3 have to be used, for the skills based learning outcomes the grades of Table 4 have to be used. For the competence based learning outcomes there is no comparison model, since these outcomes are personal and cannot be taught by training events alone. When the ECVET approach will become clearer in the future, the credits based on learning outcomes can be used for the comparison.

At the end of the ENETRAPII project, the table with learning outcomes of the ERPTS, developed in WD4.1 can be used as a list of learning outcomes. The EQF grades can be used to define the level of knowledge, skill or competence (attitude) that is reached by event. The mechanism as described above with using the learning outcomes of ERPTS module 1 together with the grades from the Dutch reference can still be used, when applying the other tables and grades.
5.1 Self-assessment

The evaluations showed that the proposed mechanism is very useful instruments. To make the evaluation as efficient as possible, we suggest performing the mechanism as a self-assessment. However we than have to take into account that one can fill in the list arbitrarily or choose the wrong descriptor.

Self-assessment cannot be done without a certain random auditing of an independent organisation or institute. This organisation can randomly judge whether the description of the learning outcomes in the list is carried out at the right way and if there is a certain conformity.

The organisation should exist of different education and training experts in radiation protection, mastering different languages to understand the content of the training event. Since the consequence of this auditing is far-reaching one should not do this task in as a volunteer, but one needs to be assigned to carry out this task.

6 Acknowledgement

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[8] International atomic energy agency, IAEA PGEC basic syllabus; Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources, standard syllabus; training course series no 18; IAEA; 2002.
[10] WD4.1.; final report 2013, Define requirements and methodology for recognition of RPEs; P. Livolsi; CEA / INSTN France; 2013.
<table>
<thead>
<tr>
<th>LEVEL</th>
<th>KNOWLEDGE</th>
<th>SKILLS</th>
<th>COMPETENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>• basic general knowledge</td>
<td>• basic skills required to carry out simple tasks</td>
<td>• work or study under direct supervision in a structured context</td>
</tr>
<tr>
<td>2</td>
<td>• basic factual knowledge of a field of work or study</td>
<td>• basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools</td>
<td>• work or study under supervision with some autonomy</td>
</tr>
<tr>
<td>3</td>
<td>• knowledge of facts, principles, processes and general concepts, in a field of work or study</td>
<td>• a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information</td>
<td>• take responsibility for completion of tasks in work or study • adapt own behaviour to circumstances in solving problems</td>
</tr>
<tr>
<td>4</td>
<td>• factual and theoretical knowledge in broad contexts within a field of work or study</td>
<td>• a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study</td>
<td>• exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change • supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities</td>
</tr>
<tr>
<td>5</td>
<td>• comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge</td>
<td>• a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems</td>
<td>• exercise management and supervision in contexts of work or study activities where there is unpredictable change • review and develop performance of self and others</td>
</tr>
<tr>
<td>6</td>
<td>• advanced knowledge of a field of work or study, involving a critical understanding of theories and principles</td>
<td>• advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study</td>
<td>• manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts • take responsibility for managing professional development of individuals and groups</td>
</tr>
<tr>
<td>7</td>
<td>• highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • critical awareness of knowledge issues in a field and at the interface between different fields</td>
<td>• specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields</td>
<td>• manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches • take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams</td>
</tr>
<tr>
<td>8</td>
<td>• knowledge at the most advanced frontier of a field of work or study and at the interface between fields</td>
<td>• the most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice</td>
<td>• demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research</td>
</tr>
</tbody>
</table>
BILATERAL COMPARISON OF LOW LEVEL RP TRAINING AND EDUCATION COURSES – A TOOL FOR FACILITATING THE MOBILITY OF RPOs AND RADIATION WORKERS

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ABSTRACT

In this contribution we report on a bilateral pilot project to compare the content of low level Radiation Protection (RP) Education and Training (E&T) courses in The Netherlands and Germany. This project has been carried out as part of an apprenticeship of the Dutch course for RP Experts. Attention will be paid to differences in national systems of RP E&T. Recommendations to German and Dutch authorities will be summarized. Finally we will discuss the impact of this project to future activities of HERCA, EUTERP and the possible European project Mobility of Radiation Workers (Morawo).

1. Introduction

Within Europe there are many differences in criteria for radiation workers (RWs), radiation protection officers (RPOs) and experts (RPEs). These differences, which are reflected in the various systems of radiation protection courses and legal recognition of RPOs and RPEs, hampers the free traveling of RWs, RPOs and RPEs within Europe. It is one of the goals of the European Foundation on Training and Education in Radiation Protection (EUTERP) to remove these obstacles within the Member States of the EU. From the workshops held by this platform in 2007 to 2009 it has been concluded that an essential element in achieving this goal is the availability of a good comparison of the content of the RP courses in the Member States.

We point out that, without denying the importance of mutual recognition of RPEs and eventually RPOs, the vast majority of relevant employees crossing EU borders, e.g. in the medical field, are Radiation Workers (RWs). Here, it is important to realize that in general there are no nationally recognized E&T programs in RP for RWs. However, in the Netherlands many employers use the lowest level RP courses as obligatory instruction for
their RWs. Therefore, there exists a great need for comparison of low level RP courses in other European countries with their Dutch equivalent. As a consequence we initiated a bilateral pilot project to make a start with this comparison, paying special attention to low-level RP training, suitable for RWs as well as for RPOs responsible for low risk applications. EUTERP-members from Germany and The Netherlands agreed to participate in this pilot.

2. Objectives

The pilot aimed to reach the following objectives

1. An inventory of the system of RP courses in both countries
2. A comparison concerning the content of various low-level courses based on the IAEA Syllabus[1] or its European equivalent
3. Conclude about equivalence and/or gaps between the various courses offered in both countries
4. Give advice to the competent authorities about mutual recognition of these courses
5. Report on these results via the EUTERP website in order to make the results available to the whole EUTERP-community.

3. Method

The main part of the project was carried out as an apprenticeship by students participating in the Dutch Radiation Protection Course Level 2 that was given in the period 2010/2011. This course is intended for RPEs responsible for high risk and/or complex licences in The Netherlands. Due to the limited amount of available time and the fact that the nuclear field is relatively small in The Netherlands, the pilot was restricted to the medical and technical field.

The students visited the Leibniz University in Hannover and the Landesanstalt für Personendosimetrie und Strahlenschutzausbildung (LPS) in Berlin to get inside information about the German RP E&T system in the technical and medical fields respectively. Subsequently the course material used in both countries was compared.

The apprenticeship was concluded with a draft report, paying attention to the first three objectives of the project. The draft was extended with recommendations and additional information. The final version of the report by Haagen et al is available through the EUTERP-website (www.euterp.eu)[2].

4. E&T System in Germany and the Netherlands

In this chapter we restrict ourselves to the RP Course system in both countries refraining from most of the legal framework of these systems. For the legal framework we refer to the report of Haagen et al.

Roughly speaking the German system is divided into three branches: technical (including research), medical and nuclear. Each branch has a modular structure. In practice there are many different kinds of “Strahlenschutzbeauftragter (SSBs)” – in most cases comparable to RPOs – depending on the kind of source of radiation (sealed or open radioactive sources, an accelerator-system or X-ray devices) and on the potential risk of the respective application. Therefore, different practical experience (depending on the professional education) and different radiation protection courses are required for different applications.

This leads altogether to 37 different kinds of Expert Knowledge Groups for technical applications – resulting in 37 different kinds of SSBs for the technical branch only. In Figure 1 we give the modular system for E&T in RP according to the German Technical Expert Knowledge Directive concerning the handling of sealed and open radioactive sources and accelerator systems[3]. This German directive is based on the German Radiation Protection Ordinance. Table 1 summarizes the modules for obtaining and updating RP
knowledge after the Directive concerning the handling of X-ray tubes which is based on the German Röntgen Ordinance. For each of the 37 Expert Knowledge Groups one or more specific modules are needed to gain the necessary knowledge in RP.

Figure 1. Modular structure of the German system of RP E&T (technical branch, concerning the handling of sealed and open radioactive sources and accelerator systems)

<table>
<thead>
<tr>
<th>Module</th>
<th>Content</th>
<th>In addition to</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM</td>
<td>Basic Module for applications with very low risk</td>
<td></td>
</tr>
<tr>
<td>RG</td>
<td>Basic Module for applications with lower risk</td>
<td></td>
</tr>
<tr>
<td>RH</td>
<td>Basic Module for applications with higher risk</td>
<td></td>
</tr>
<tr>
<td>Z1</td>
<td>Special module for the handling of handheld x-ray fluorescent spectrometers</td>
<td>RG</td>
</tr>
<tr>
<td>Z2</td>
<td>Special module for inspection, testing, maintenance and repair of Roentgen devices and scanning electron microscopes or scanning tunnelling microscopes in the Non medical field.</td>
<td>RG</td>
</tr>
<tr>
<td>Z3</td>
<td>Special module for X-ray scattering, diffraction and analysis</td>
<td>RH</td>
</tr>
<tr>
<td>QS</td>
<td>Special module for inspection, testing, maintenance and repair of Roentgen devices, that are part of the quality assurance according §§ 16 and 17 of the Roentgen Ordinance</td>
<td>RH or RG + Z2</td>
</tr>
<tr>
<td>L</td>
<td>Module for the operation of Roentgen devices on schools</td>
<td>-</td>
</tr>
<tr>
<td>FA</td>
<td>Module for employees working in external facilities</td>
<td>RG</td>
</tr>
</tbody>
</table>

Table 1. Modules to obtain and update the knowledge after the Roentgen Ordinance

For medical applications there exist two similar directives. Each medical professional, whether RPO or not has, according to these directives, to complete one or more of the modules given in Figure 2. Omitted in this figure is a basic course of 8 hours for doctors who don’t have/need expert knowledge.
In the Netherlands only the lower level RP courses are divided into X-ray applications (A-variant) and the use of open sources (B-variant). Sealed sources are covered similarly by all RP Courses. Apart from that there are courses meant for specific medical applications, to be completed by medical professionals who generally do not act as RPOs (with dentists as an exception). The Dutch system, primarily based on the Directive for recognition of RP Training Providers, is summarized in Table 2.

Figure 2. RP Modules for medical applications in Germany[4]

<table>
<thead>
<tr>
<th>Level of Expertise</th>
<th>Characteristics</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (A or B)</td>
<td>Low risk and few sources</td>
<td>X-ray (5A), sealed sources (5A&amp;5B), open sources (5B – only RWs)</td>
</tr>
<tr>
<td>5AM</td>
<td>Low risk</td>
<td>X-ray in dentistry</td>
</tr>
<tr>
<td>4 (A or B)</td>
<td>Moderate risk or low risk and more than ten sources</td>
<td>X-ray (4A), sealed sources (4A&amp;4B) and open sources (4B – only RWs)</td>
</tr>
<tr>
<td>4AM</td>
<td>Moderate risk</td>
<td>X-ray in Cardiology, Pulmonology, Gastro-Intestinal Disease and Orthopedy</td>
</tr>
<tr>
<td>3</td>
<td>Significant risk</td>
<td>small accelerators, X-ray, sealed and open sources</td>
</tr>
<tr>
<td>3M</td>
<td>Significant risk</td>
<td>X-ray in radiology and radiotherapy</td>
</tr>
<tr>
<td>2</td>
<td>High risk / complex licenses</td>
<td>All licenses</td>
</tr>
</tbody>
</table>

Table 2. Summary of the Dutch system of RP E&T.

5. Results from the comparison - Recommendations
For practical reasons only a global and limited comparison of the Dutch and German courses with the IAEA syllabus took place – the scope of the IAEA syllabus is very different from the low level courses that we study here.
Based on the course material of the various courses on one hand, and the detailed requirements laid down in the German Directives on the other hand, a detailed comparison of the content of various low level courses/modules has been made in the report of Haagen et al. From this comparison we have drawn conclusions about the equivalence of the German and Dutch courses:

- There is a global equivalence between the Dutch level 5 courses and the low level modules in the German system.
- The main difference between the content of the courses in both countries is the difference in national legislation.

These conclusions have led to recommendations to the national authorities as well as Dutch employers. The recommendations can be summarized as proposals for mutual recognition of the knowledge level of various RP courses or modules, provided that additional legislative modules are introduced (Table 3). In some cases this recognition is limited to certain applications or expert knowledge groups. We have also made recommendations concerning bridging the legislative gap between both countries. Note that for mutual recognition of RPOs other aspects (such as practical experience) should also be taken into account[2]. We finally suggested our national authorities to disseminate the results of this comparison within Europe and to stimulate further projects in this field.

<table>
<thead>
<tr>
<th>RP courses or modules</th>
<th>Equivalent to</th>
</tr>
</thead>
<tbody>
<tr>
<td>5A</td>
<td>GG, GG+TRG, GG+FA, GH, L, RM, RG, RG+FA, RG+Z1, RG+Z2, RG+Z2+QS, Kenntniskurs (basic course for doctors without expert knowledge), Grundkurs im Strahlenschutz (Basic Module in RP)</td>
</tr>
<tr>
<td>5A</td>
<td>RH and RH+Z3 for specific Expert Knowledge Groups</td>
</tr>
<tr>
<td>5B</td>
<td>GG, GG+TRG, GG+FA, GH</td>
</tr>
<tr>
<td>GG, GG+TRG, GG+FA or GH</td>
<td>5A or 5B, but only for those applications matching with the corresponding German Knowledge Expert Groups</td>
</tr>
<tr>
<td>L, RM, RG, RG+FA, RG+Z1, RG+Z2, RG+Z2+QS, RH or RH+Z3</td>
<td>5A, but only for those applications matching with the corresponding German Knowledge Expert Groups</td>
</tr>
<tr>
<td>GG, GH or GG, GH plus additional modules</td>
<td>Instruction for RWs working with sealed sources for which the employer requires 5A</td>
</tr>
<tr>
<td>GH+OG or GH+OH</td>
<td>Instruction for RWs working with open sources for which the employer requires 5B</td>
</tr>
<tr>
<td>RG, RH or RG, RH plus additional modules</td>
<td>Instruction for RWs working with X-ray devices for which the employer requires 5A</td>
</tr>
<tr>
<td>RM and L</td>
<td>Instruction for RWs working with X-ray devices for which the employer requires 5A, but only for those applications that match with the corresponding German Knowledge Expert Groups</td>
</tr>
<tr>
<td>Basic Module in RP (Grundkurs im Strahlenschutz für Ärzte und Medizinphysikexperten)</td>
<td>Instruction for RWs working with medical applications for which level 5A or 5AM is required</td>
</tr>
</tbody>
</table>

Table 3. Suggestions for mutual recognition of RP Courses and modules in Germany and the Netherlands. Items in the left column are at least equivalent to the corresponding items in the right column.
6. Discussion and future developments

We have shown that it is possible to develop, with relatively little means and time (in total approximately three working months), a bilateral comparison between low-level RP Education and Training Courses between two EU Member States. We have also been able to formulate recommendations to the national authorities to recognize RPOs mutually. It can therefore be concluded that such apprenticeships offer in principle a good opportunity to extend the current project to similar comparisons between other EU Member States.

The method used for comparing both E&T systems turned out to be practicable on one hand, but does on the other hand not compare the various courses on the basis of internationally or even bilaterally agreed learning outcomes. A description of the learning outcomes as prescribed in the European Credit system for Vocational Education and Training (ECVET) would be a major step ahead. Comparison of RP courses would be simplified considerably.

The bilateral comparison based on course material between Germany and The Netherlands has however shown to be a good starting point for a pilot comparing the relevant RP courses on the basis of learning outcomes. Recently a possible European project has been entered for the EU Leonardo da Vinci - Transfer of Innovation program (call 2013). The main objective of this Morawo (MObility of RAdiation WOrkers) project is exactly the comparison of low level RP Courses between EU member states in North-West Europe. More in detail, the results of this Morawo-project should be

1. a global description of learning outcomes for RP Courses for RWs and lower level RPOs in various branches (research, medical, non-destructive testing and exploration/production industry).
2. a comparison of these courses in terms of learning outcomes
3. a recommendation to the authorities to recognise courses (conditionally) in other countries, based on the ECVET system
4. a guideline for the comparison of radiation protection E&T within two countries

In the consortium, under the lead of the Nuclear Research and Consultancy Group (NRG), most of the institutes that were involved in the bilateral comparison are represented. Additional partners from the branch of non-destructive testing were included. Experience gained in the ENETRAP 2 project on defining learning outcomes for RPEs and RPOs will be applied in the Morawo project. Vice versa, experience gained on working with the ECVET system in Morawo could be advantageous for a future ENETRAP 3 project. The results of the Morawo project should be available by the end of 2015.

After completion of the bilateral comparison described here, the report was offered to the board of EUTERP for publication on its website. As the project was also initiated as a result of the EUTERP workshops, the report can in essence be considered a EUTERP report. It also raises the question about the involvement of EUTERP in future activities focused on comparison of RP E&T for RWs and low level RPOs. Of course EUTERP should be considered an indirect stakeholder in projects like Morawo which could facilitate the publication and distribution of results of such projects. The added value of EUTERP could furthermore be the adoption of results of projects like Morawo, and include them into recommendations to e.g. the competent authorities in the EU Member States.

The Heads of the European Radiological Competent Authorities (HERCA) have, among others based on recent results of ENETRAP-2 and our recommendations as given above, initiated a task force on Education and Training in RP [5]. The ultimate mandate of this task force is to present a general picture of the situation on E&T in RP, to identify the current needs for harmonization (probably focused on RPOs) and eventually, if needed, the mandate for a future working group on E&T. With respect to RWs this could e.g. imply the establishment of a database containing results of bilateral comparisons (or recognitions) of RP E&T courses for reference by the member states. A detailed mandate of this task force
will possibly be agreed upon in the course of 2013. Fact is that HERCA should also be considered an important indirect stakeholder for the Morawi project.

The comparison of low level RP E&T courses in Germany and The Netherlands is only a small building block in the whole process for facilitating the mobility of RWs (and low level RPOs) within the EU. We hope and expect it to be a starting point that will lead us in the end to a more effective use of the available budget for training and education of employees, as well as to a larger mobility of employees and, possibly, training institutes.

Acknowledgement
We would like to thank Gerd Koletzko (LPS Berlin) for his contributions to this work.

References
[5] HERCA sets up Task force on Education & Training in Radiation Protection, Notice submitted to EUTERP newsletter (to be published in 2013)
ABSTRACT

This paper presents the work carried out within the Work Package 4 of the ENETRAP II project. The initial work was to develop the training scheme of the Radiation Protection Expert based on a modular structure. A first part dedicated to the common basis of radiation protection issues for the RPE. The second part consists of specific modules depending on the area in which the RPE works (NPPs, gauges, NORM, medical ...). On-Job-Training period will be associated to the training scheme.

During development of this work and due to evolution in the European context of the Vocational Education and Training (VET), we have implemented the ECVET approach (European Credit for Vocational Education and Training) related to the recognition of Learning Outcomes associated to competences.

To do this, we relied on the European Qualification Framework (EQF) to define the RPE training level.

There is no standard framework or formal methodological guide for the implementation of the ECVET process in the nuclear field and more precisely in the radiation protection domain. This is why the work is based on pragmatic and analytical steps leading to the training standard driven by competences and not by content.

In order to draft learning outcomes (LO) associated to Competences described with the triptych of appropriate descriptors (Knowledge-Skills-Attitudes - KSA vs KSC), the need to define the characteristics of a tool to formalize this approach has emerged.

This tool would facilitate the use of a common language in different projects dealing with training standards, with the advantage of being able to add, delete, duplicate and move competences/LO among more than 400 that constitute the framework of the RPE training.

The first developments were made with a spreadsheet program and then with a database application. The need for a dedicated software to describe, extend, duplicate, consolidate, organize Learning Outcomes appears to be indispensable.

This software will be useful for employers, training providers, HR services, future RPE but also to all those who are concerned with the implementation of ECVET.
1 Introduction

This paper presents the establishment of a training program for the Radiation Protection Expert (RPE), one of the actors for the implementation of radiological protection in all domains where ionizing radiations are used.

In the framework of ENETRAP II project, it was decided to implement the ECVET system (European Credit system for Vocational Education and Training) for the RPE training.

Based on the EQF (European Qualification Framework), we have described Competences and Learning Outcomes (LO) for the RPE job profile.

A significant number of studies and recent projects have opened the way for new thinking on the establishment of training programs. CEDEFOP (European Centre for the Development of Vocational Training) has some relevant projects that can serve as an example for the development of the RPE training scheme. The most significant areas investigated by this ECVET approach are at that time, aerospace and automotive industries.

If we take the short definition of the RPE, it is difficult to identify main competences using only this definition. “Persons having the knowledge, training and experience needed to give radiation protection advice in order to ensure effective protection of individuals, whose capacity to act as radiation protection expert is recognized by the competent authorities.”

That is why we started a drafting of competences that must have a RPE by using descriptors such as Learning Outcomes describing Knowledge, Skills and Attitude (KSA).

2 The ECVET system

ECVET is a stand-alone system connected to others European initiatives such as EQF (European Qualifications Framework), EQAVET (European quality assurance in vocational education and training) and Europass.

ECVET system uses components such as Learning outcomes, units and points, Memorandum of Understanding, learning agreements…

Objectives which are quoted in different policy statements of the European Commission started in 2002 with the “Copenhagen declaration”. Every two years meeting with communiqué were established. Following all these conferences, it has been decided to define a strategy to the horizon 2020\(^1\). To implement this ECVET concept, there are some initiatives and tools that support the Life Long Learning pathway.

This pathway is built by the formal education and training (school, university…), the work experience, the informal learning and non-formal learning (by companies, CPD) and in some case the formal training achieved abroad.

In order to support the “validation” of LLL pathway, the Commission has developed four supporting systems, namely ECVET, EQF, EQAVET and Europass.

2.1 EQF

The European Qualification Framework aims to relate different countries’ national qualifications systems to a common European reference framework using eight levels: level 1 (basic) to level 8 (most specialised). The EQF deals with qualification and not with academic diploma.

What are the descriptors used in EQF? In the EQF table\(^2\), the eight levels are described by the three main descriptors: Knowledge, Skills, and Competence

It has to be noticed that this terminology isn’t the same used for instance at the IAEA: Knowledge, Skills, and Attitude in order to describe a competence.

\(^1\) http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=europa-2020

The use of this other set of 3 descriptors is relevant and perfectly acceptable according to the ECVET-Team.

Based on other ENETRAP work package results, the appropriate level for RPE is between 5 to 7, depending of country approach and RPE' roles and duties.

2.2 EQAVET

EQAVET is a quality system combined with quality indicators. They should be used in order the different Member States can trust each other’s on indications of what is the EQF level for a specific training.

2.3 EUROPASS

The Europass should be seen as an extension of traditional CV, so like “a document to make your skills and qualifications clearly and easily understood in Europe”. Europass is based on five documents: CV, language passport; Europass mobility, certificate supplement, diploma supplement and validation of formal and non-formal learning.

2.4 ECVET implementation

The time running corresponded to a preparatory period until end 2012-beginning 2013. From next years on, the objective is to have a period of gradual introduction of ECVET in the different Member States for the different learning experiences. This should run until 2014 with a possibility to make of the European recommendations in 2014.

The ECVET system can be seen as a complex system regarding its numerous different. When create units of Learning Outcomes for a given part of training course and characterised by ECVET points, these LOs are assessed or validated and then recognized. The Commission has also established a tool for partnership which is the Memorandum of Understanding (MoU) between the different partners that, if they join the system with such a MoU, means that it trusts each other on the quality of delivered courses.

There is also the Learning Agreement introduced which is an agreement between a provider and a learner and using a transcript of records (Europass).

a) Learning Outcomes

Learning outcomes are statements about what a learner knows, understands and is able to do on completion of a learning process and which are defined in terms of knowledge, skills and competence.

The descriptors used by the Commission are (KSC):

- **“Knowledge”** means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.
- **“Skills”** means the ability to apply knowledge and know-how to complete tasks and solve problems.
- **“Competence”** means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development.

In the framework of ENETRAP II, we created all different LOs needed to be achieved after a RPE participant has followed a certain part of the course.

It is important to note that ECVET system does not provide a template or a taxonomy concerning the frame of Learning Outcomes descriptions.

As a result of other work packages, the proposal of RPE EQF level should be placed between level 5 to 7 (depending of countries). Then, after creation of LOs for a course, the process is to start adding units.

b) Units

A unit is a component of a qualification, consisting of a coherent set of knowledge, skills and competence (or attitudes – KSA) that can be assessed and validated. Units identify what
learners can learn and describe the Learning Outcomes that learners are expected to achieve. Thanks to ECVET, the credit to this unit can be recognized. Learning Outcomes can be aggregated in a unit because they relate to the same field of knowledge, skills or attitudes. In this project, we combine the different modules of the entire RPE course and we take one module as one unit. For each unit, we have allocated ECVET points.

c) ECVET points
Allocation of ECVET points to a qualification is based on using a convention according to which 60 points are allocated to the Learning Outcomes expected to be achieved in a year of formal full time of vocational and training. Each unit is allocated a number of points based on its relative weight within the qualification.

d) Mobility through transfer and accumulation of ECVET points
The loop that ECVET serves in order to achieve the mobility is represented in figure 1. The process starts from a sending provider, which make a Learning Agreement with the host provider. An individual acquires knowledge, skills and competences (or attitudes – KSA). Credits are awarded to this learner. These LOs are assessed by the provider. The Credits can be recorded in the Europass and transcript. Then they are validated and in a final phase, LOs are recognized and accumulated as part of the intended qualification corresponding to a certain amount of ECVET points.

![Figure 1: Transfer and accumulation serving European mobility](image)

-e) Memorandum of Understanding and mutual trust
If a learner follows a course from provider A or provider B, if they both have a MoU, they will accept the ECVET points that are given by either one of them.

-f) Learning Agreement
Learning agreement is an agreement at operational level in the framework for mobility exchanges. This document incorporates detailed information about qualifications concerned, the mobility exchange and conditions for assessment, and at least validation and recognition of credits. Finally, the decision on who needs to sign such an agreement would also depend on the responsibilities of different actors within the qualifications system (EQAVET).

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3 CEDEFOP, working paper No 10 The development of ECVET in Europe
2.5 ECVET and competence
The definition of “Competences⁴ is not sufficient to describe quantitatively and therefore easy to verify later in terms of knowledge, know-doing and know-being. That is why we have introduced more than the three standard descriptors for competence - knowledge, skill and attitude (KSA system) - the concept of sub competence. Although the use of an action verb to describe a competence, it is important to contextualize this competence by specifying the field, the area in which it operates.

2.6 Sub competences linked to RPE activities
We previously introduced the activity concept which allows to specify the field, the area in which competences are applied. For example, when RPE should have the competence "apply physical dosimetry systems", this competence is too general and should be broken down into sub competence (SC1: List the passive dosimetry devices, SC2: List the active dosimetry devices, SC3: Explain the principles of internal dosimetry).
For each sub competence, we define the Learning Outcomes that will be broken down into Learning Outcomes related to Knowledge (KLo), Learning Outcomes related to Skills (SLo) and finally Learning Outcomes associated to Attitudes (ALo) that will be owned by the RPE. It is important to note that for a given sub competence, the three outcomes are not necessarily present in the table. A sub competence, predominantly "manual" will be described using its descriptor "Learning Outcomes for Skill" and do not necessarily include descriptor associated to an attitude or knowledge. This differentiation allows for each LO, identifying quantifiable indicators to measure achievement of objectives. It is more important for an enterprise to identify what his learner is able to do after a training period rather than what he has learnt.

2.7 Competences and Learning Outcomes tables
The completion of a table to clearly visualize the different components of expertise will facilitate the subsequent addition of competence depending on the evolution and demand of employers and / or authorities and / or stakeholders.
The RPE training is tailed for professionals (VET) and not for students as part of an academic program. However, some academic programs cover the entire spectrum of the RPE training for radiation protection expert. This is the case for example, of the European Master's degree in Radiation Protection (EMRP).

3 Necessity to develop a tool
The establishment of a standard of competences can be a difficult task to achieve. If the profile of the job is very detailed, it will be necessary to describe precisely all associated competence / sub competence / knowledge / skills / attitudes with the job profile. Within the RPE, and taking into account the work of the first ENETRAP program, we knew that the competences list would be long. Therefore, we undertook a study to describe in detail these competences and then to build the RPE training scheme.

⁴ “Competence includes: i) cognitive competence involving the use of theory and concepts, as well as informal tacit knowledge gained experientially; ii) functional competence (skills or knowhow), those things that a person should be able to do when they are functioning in a given area of work, learning or social activity; iii) personal competence involving knowing how to conduct oneself in a specific situation; and iv) ethical competence involving the possession of certain personal and professional values.”
Having initiated the development of the competences framework of RPE, we were quickly confronted with the multitude of entries in the matrix. The analytical approach is transcribed using a spreadsheet, and has quickly showed its limits.

The first table contained more than eighty competences described using approximately 400 learning outcomes. Continue on this path, inevitably led us to a table whose extension was compromised. In the process of developing this competences framework, we have been led to add, modify competences or learning outcomes. It was followed by a long process of renumbering competences or learning outcomes and these operations were highly time-consuming.

### 3.1 Why developing a tool?

We decided to conduct the development of a tool in order to describe a standard of competences respecting the ECVET approach. Numerous researches have been performed to find out if such tools were developed as part of the ECVET approach. In CEDEFOP (European organisation for the implementation of ECVET and professional learning), to our knowledge, no such IT development was undertaken. Sheets describing competences exist but do not have the level of detail to which we wanted to lead.

What should reflect such a tool? What information should be there? How will data be organised?

In this ENETRAP II WP4, the development of software was not planned. However, given the accuracy of competences description, we tried with the help of CEN-SCK team, to develop a prototype to test if for the RPE profile, the use of such tool would be useful.

Although a specification is a prerequisite for any IT project, we conducted a brief study of the existing tools, a needs analysis and specify functional characteristics.

**Needs analysis:** Desire to speak and share the same language - Adaptable, thanks to the EQF level associated with a LOs or competence - Rapid addition of competence at any level of the hierarchical tree - Automatic renumbering (not fully operating because of Access application limitation) - Move (cut and paste) - Copy / paste – Modify - Tracking versions of LOs (not implemented in the prototype) - Specifications of functional characteristics - Sorting competences - Adding fields (bibliography, keywords etc.) - Report printing (export format, not only .pdf but also .docx in order to integrate in a report).

### 3.2 Description of prototype

The development of this prototype is based on an analytical approach. In fact, we start from the competence and we tried to characterize it. But we have to keep in mind that a competence (as IAEA glossary) can be characterized by three descriptors "Knowledge, Skills and Attitude" (KSA).

Competence is usually the combination of several sub-competences. This is why we used the hierarchical relationship as follows:

- Competence → sub competence → Knowledge and/or Skill and/or Attitude

The competences set described can be collected in a teaching unit called Unit or ECVET Unit. For each ECVET Unit, a number of ECVET points is associated.

![Figure 2: Hierarchical relationship of ECVET structure](image)
3.3 Course table
This table is used to enter the highest level of the structure chosen: Unit. The information can be entered either using a list, as shown in figure 3, or as a form. The value of the entry using a list is that it has a broader view of the entire training. Forms for competence and for Learning Outcomes were both developed.

![Course table description](image)

**Figure 3: Course table description**

**a) A specific software could be developed**
A specific software development could be performed, perhaps at the CEDEFOP level or ECVET-Team, to offer a common tool in order to describe properly competences. For example, in a given area of activity, competences frameworks were described in the same way. It would be easy to compare, reuse descriptions of competences, create common set of competences e.g. the nuclear safety culture, radiation protection culture, conventional security culture and so on. These blocks of generic competences can be found in the description of several profiles in a given area. In addition, thanks to the European EQF system, we can adjust the detail level of competence in using the EQF levels ranging from 1 to 8 depending on the depth of the desired level. Beyond the IT approach, such a tool would evolve, enrich and share standard of competences and thus to promote the recognition and mobility inside EU.

3.4 From Learning Outcomes to training scheme
The interest of the ECVET approach is that, once the Learning Outcomes have been identified, they can be translated in terms of Learning Unit. The RPE training scheme use a modular approach. Thus a learner may choose his/her path to capitalize the ECVET credits.
The learner has the choice to follow continuously the modules one after the other or to separate each period of training.

3.5 Are there competences that are not addressed in the previous program?

In the definition of a Radiation Protection Expert, as proposed in the future EU-BSS, it is stated that the expert must provide advices. But, the competence "advice" is not explicitly covered in the first ENETRAP training program. No clearly identified part of the training course does fit with the attitude of one who gives advice. That is why these competences must be updated.

- Communication: in post accidental or incidental situation, in normal situation, with the public, and Communication for learning activities
- Training: Train the trainers. The ability of RPE to conduct training sessions, not part of the core activities of the RPE. However, collected experience suggests that training actions increases significantly.

a) Set of common competences (nuclear field)

Due to the trans-disciplinarity of the radiation protection field, a wide knowledge in a set of topics is required e.g. nuclear safety culture, nuclear security culture, radiation protection culture, ALARA culture which is embedded in the RP culture, and health safety culture.

4 The ENETRAP training scheme

The figure below represents the global European Radiation Protection Training Scheme. The trainee must keep in mind that "Common Basis" is a mandatory part. In addition, at least one specific module must be selected.

![ENETRAP II, the RPE training scheme](Figure 4: ENETRAP II, the RPE training scheme)

The common basis is built around three modules, also called units. It is worth noting that participant, not nuclear worker but one wishing to invest this field, will receive a training enabling him/her to understand the various aspects of radiation protection domain.
This shall be without prejudging the domain in which he/she will practice (research, industry, NORM...). As a result, all the general principles of radiation protection are covered in these three modules. Then, in the specialised modules, further information will be given.

As an example for emergencies issues: in Unit 3 (module 3) of the “Common Basis”, these situations are discussed in a general way. It is from the specialised module that the specificities of emergencies will appear. For example, for a future RPE that will work in the NPPs’ field, a course on emergencies that may be encountered in nuclear power plants, will be offered. It will be different from the one related to NORM for example, but the basics will have been taught in the Common Basis. As part of the implementation of ECVET process, a summative evaluation is foreseen at the end of each of the three modules. Thus it will be possible to assess whether learning outcomes are satisfactory. The definition of criteria and indicators for assessing the achievement of learning outcomes is developed in other ENETRAP II work packages.

Other independent modules, “optional modules” are related to specific topics such as: nuclear plants and research reactors, waste management and decommissioning, research and non-nuclear areas, medical and naturally occurring radioactive materials (NORM). Chosen module(s) depend(s) on the domain in which the RPE is going to be engaged. RPEs should at least follow the part “Common Basis” plus a minimum of one optional module. Each optional module is self-standing and a final summative evaluation is introduced at the module’s end, taking the form of multiple choice questions, exercises or problems to solve.

The following diagram represents the scheme and shows all optional modules offered for the RPE training.

There is a clear need to build a structure of “flexible” training programmes so that supply can meet the training requirements in compliance with the concept of Radiation Protection Experts under the EU Directive. For example, does an expert in radiation protection only working for nuclear power plants, has to undergo special training in radiation protection for the medical field? The answer is no because the only area where such an expert operates, remains the industrial sector. However if an individual who wants to become a RPE, would like to cover several areas, the modular approach allows him to select the modules to be studied. The approach in this project is to achieve a balance between theoretical knowledge and skills best suited to meet the RPE definition.

5 Conclusion

Writing a training reference using descriptors such as Learning Outcomes is a long process. However, the ability to characterize the main competences contributes to the perfect match between the demand expressed by nuclear operators and training programs. Thus, it is possible to reformulate a main competence and also to make it evolve. In this project we tried to apply the European ECVET system, and some difficulties have arisen. On the one hand because the ECVET system may at first seems somewhat complex, it was necessary to deploy a methodology based on a hierarchical structure: Unit → Competence → sub competence → Knowledge and / or Skill and / or Attitude.

On the other hand, given the level of detail used to describe RPE competences in both “Common Basis” units and optional modules, it was necessary to develop a prototype of software based on Access database management. This prototype helped to input and organise the 80 competences and 400 learning outcomes. The features of this prototype could advantageously be used in a specific software development that would describe uniformly competences. These competences whose description would be harmonized, could allow describing in a coherent and consistent way most job profiles for nuclear and other industries.
This would also have the advantage of promoting the use of a common language and a shared methodology. In addition, this software will allow writing several common set of competencies that RPE, but also other nuclear workers, would share (e.g. common elements of safety culture).

In addition, the fact of using different levels of EQF allows adjusting the description of a competence by its level of proficiency.

Finally, the description of the RPE can be used to establish the description of the RPO. The experience gained from this work package provides information on the relative complexity of describing a job profile trying to use descriptors such as "Knowledge, Skills and Attitudes" embedded in the ECVET system.

6 Reference


iv. FP6 ENETRAP WD. 7 Report on European Radiation Protection Training Scheme (WP7) http://www.sckcen.belenetrap


vii. European credit system for vocational education and training (ECVET)
THE EUROPEAN QUALIFICATIONS FRAMEWORK (EQF) AND IT’S APPLICATION IN THE DESIGN OF MEDICAL RADIATION PROTECTION QUALIFICATION AND CURRICULUM FRAMEWORKS IN EUROPE

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ABSTRACT

In 2008, the European Commission (EC) through the European Parliament and Council launched the European Qualifications Framework for lifelong learning (EQF). The EQF is organized into eight levels that span the whole spectrum of education, training and qualifications, from school education to academic, professional and vocational. The EQF builds on the very successful European Higher Educational Area (EHEA) framework. In the EQF the first cycle of the EHEA (Bachelor) is classified at level 6, the second cycle (Master) at level 7 whilst the third cycle (Doctorate) is at level 8 and it is possible to develop programmes which are compatible with both qualification frameworks. It should be noted that higher education programmes are only one means of achieving levels 6 - 8 and the EQF in the spirit of lifelong learning recognises that these levels can also be reached through vocational, informal and non-formal learning. By 2012 each EU member state is required to reference its own national qualification framework to the EQF. The EQF recognises three types of learning outcomes for each level namely knowledge, skills and competences. In the EQF, knowledge relates to facts, principles, theories and practices that are related to a field of work or study, skill is the ability to apply knowledge and use know-how to complete tasks and solve problems whilst competence refers to responsibility and autonomy. The major significance of the EQF is that finally the educational community in Europe has a single set of well defined educational levels and definitions and categorisation of learning outcomes to use in curriculum development. This will go a long way towards reducing the ambiguity arising from the confusing plurality of definitions to be found in the literature. In addition, the categorisation of learning outcomes into knowledge, skills and competence means that all three categories of learning outcomes will be given their due importance. The EQF is particularly important for the radiation protection education community due to its ability to bridge the gap between vocational education & training and higher education. In this presentation we will describe and discuss the EQF framework and its application in the EC funded ‘European Guidelines on the Medical Physics Expert’ and Medical Radiation Protection Education and Training (MEDRAPET) projects.

1. Introduction

The European Qualifications Framework [1] must be one of the shortest recommendation documents put forward by the European Parliament and Council, yet its consequences to the future harmonization of educational processes in Europe and perhaps even wider international qualification frameworks are immeasurable. The document consists of
essentially only four pages: a half-page list of definitions (Annex I), two pages of descriptors defining an eight level framework (Annex II) and a half page of common principles for quality assurance in Higher Education and Vocational Education and Training (Annex III). European curriculum developers and professional leaders have been given a powerful yet simple tool to develop qualification frameworks and international curricula for particular professions [2, 3, 4] and even specific study areas such as radiation protection [5]. This paper will concentrate on the more essential aspects of the EQF document relating to the development of qualification frameworks and learning outcome inventories.

2. Definitions (Annex I of the EQF)

Modern curriculum development is based on inventories of learning outcomes. In the EQF learning outcomes are defined as ‘statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence’. This essentially means that the learning outcomes of a programme of study should be expressed as knowledge, skill and competence (KSC) statements where:

(a) knowledge means ‘assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the EQF knowledge is described as theoretical and/or factual’.

(b) skill means ‘the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the EQF skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments)’.

(c) competence refers to ‘the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development. In the context of the EQF competence is described in terms of responsibility and autonomy’.

3. Descriptors defining the levels of the EQF (Annex II of the EQF)

The EQF is organized into eight levels that span the whole spectrum of education, training and qualifications, from school education to academic, professional and vocational. The EQF builds on the very successful European Higher Educational Area (EHEA) framework. In the EQF the first cycle of the EHEA (Bachelor) is classified at level 6, the second cycle (Master) at level 7 whilst the third cycle (Doctorate) is at level 8 and it is possible to develop programmes which are compatible with both qualification frameworks. Annex II of the EQF document consists of a description of the eight levels of the EQF in terms of the required levels of the KSC. These are shown in Table 1.

<table>
<thead>
<tr>
<th>Level</th>
<th>Knowledge</th>
<th>Skills</th>
<th>Competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Basic general knowledge</td>
<td>basic skills required to carry out simple tasks</td>
<td>work or study under direct supervision in a structured context</td>
</tr>
<tr>
<td>Level 2</td>
<td>Basic factual knowledge of a field of work or study</td>
<td>basic cognitive and practical skills required to use relevant information in order to carry</td>
<td>work or study under supervision with some autonomy</td>
</tr>
<tr>
<td>Level 3</td>
<td>Knowledge of facts, principles, processes and general concepts, in a field of work or study</td>
<td>out tasks and to solve routine problems using simple rules and tools</td>
<td>take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems</td>
</tr>
<tr>
<td>Level 4</td>
<td>Factual and theoretical knowledge in broad contexts within a field of work or study</td>
<td>a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information</td>
<td>exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities</td>
</tr>
<tr>
<td>Level 5</td>
<td>Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge</td>
<td>a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems</td>
<td>exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others</td>
</tr>
<tr>
<td>Level 6</td>
<td>Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles</td>
<td>advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study</td>
<td>manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups</td>
</tr>
<tr>
<td>Level 7</td>
<td>Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research. Critical awareness of knowledge issues in a field and at the interface between different fields</td>
<td>specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields</td>
<td>manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams</td>
</tr>
<tr>
<td>Level 8</td>
<td>Knowledge at the most advanced frontier of a field of work or study and at the interface between fields</td>
<td>the most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice</td>
<td>demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research</td>
</tr>
</tbody>
</table>

Tab 1: The descriptions of the eight levels of the EQF in terms of KSC levels.
4. Applying the EQF principles to the development of qualification frameworks and learning outcome inventories for a given profession: The ‘Guidelines on the Medical Physics Expert (MPE)’ project

The objectives of the EC project ‘Guidelines on Medical Physics Expert’ are to provide for improved implementation of the provisions relating to the MPE within Council Directive 97/43/EURATOM and the proposed recast European Basic Safety Standards directive. This includes the development of a qualification framework for the MPE. It also includes detailed Core (i.e., applicable to all specialties of Medical Physics) KSC inventories for the MPE and specific inventories for each of the three specialties of Medical Physics i.e., Diagnostic and Interventional Radiology, Nuclear Medicine and Radiotherapy. The qualification framework for the MPE is shown in Figure 1 below. To demonstrate the use of KSC inventories, the Core KSC for the key activity of the MPE ‘Clinical Involvement’ are shown in Table 2.

**Fig 1: The qualification framework for the Medical Physics Expert in Europe (status January 2013).**
<table>
<thead>
<tr>
<th>K1</th>
<th>K2</th>
<th>K3</th>
<th>K4</th>
<th>K5</th>
<th>K6</th>
<th>K7</th>
<th>K8</th>
<th>K9</th>
<th>K10</th>
<th>K11</th>
<th>K12</th>
<th>K13</th>
<th>K14</th>
<th>K15</th>
<th>K16</th>
</tr>
</thead>
<tbody>
<tr>
<td>K16</td>
<td>Explain basic concepts in health informatics such as unique patient anatomy, physiology, biology (including radiobiology), pathology as related to the main clinical applications in own area/s of medical physics practice.</td>
<td>K9</td>
<td>Describe and explain protocol optimization principles in own area/s of medical physics practice.</td>
<td>K12</td>
<td>Explain the principles and implementation of Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) and Good Laboratory Practice (GLP) in own area/s of medical physics practice.</td>
<td>K13</td>
<td>Describe general indications and contra-indications for the use of devices in own area/s of medical physics practice.</td>
<td>K14</td>
<td>Understand the nature of anatomical / pathological medical images as the visualization of the 3D distribution of physical variables.</td>
<td>K15</td>
<td>List the main sources of evidence from within the general physics, medical physics and general healthcare (e.g., the Cochrane Collaboration) literature essential for the carrying out of a systematic survey in own area/s of medical physics practice.</td>
<td>K16</td>
<td>Explain basic concepts in health informatics such as unique patient anatomy, physiology, biology (including radiobiology), pathology as related to the main clinical applications in own area/s of medical physics practice.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>Design patient plans in own area/s of medical physics practice.</td>
<td>S3</td>
<td>Adhere to procedures regarding hygiene.</td>
<td>S4</td>
<td>Participate in patient preparation and positioning prior to data acquisition.</td>
<td>S5</td>
<td>Analyze critically protocol proposals in terms of feasibility, effectiveness and safety.</td>
<td>S6</td>
<td>Define the limits of acceptability of clinical procedures.</td>
<td>S7</td>
<td>Assess patient and operator risks for a given experimental procedure.</td>
<td>S8</td>
<td>Handle and analyze medical images including the extraction of parametric data / images.</td>
<td>S9</td>
<td>Set up devices, experiments and protocols for the measurement of physical variables relevant to clinical practice.</td>
</tr>
</tbody>
</table>
5. Applying the EQF principles to a particular subject area across professions: The Medical Radiation Protection Education and Training (MEDRAPET) project

The main aim of the MEDRAPET project is the identification of needs in radiation protection education and training for the various professions involved in healthcare (including CPD). The project is defining the KSC in radiation protection for each profession or role including the EQF level to which these KSC should be developed for each particular profession. Table 3 shows the KSC for referrers, Table 4 the Core KSC for Radiographers. The learning outcomes for referrers should be taught to level 5, outcomes of radiographers to level 6, those of Medical Physicists to level 7 whilst those of Medical Physics Experts to level 8.

6. Conclusion

The major significance of the EQF is that finally the educational community in Europe has a single set of well defined educational levels and definitions and categorisation of learning outcomes to use in curriculum development. This will go a long way towards reducing the ambiguity arising from the confusing plurality of definitions to be found in the literature. In addition, the categorisation of learning outcomes into knowledge, skills and competence means that all three categories of learning outcomes will be given their due importance. The EQF is particularly important for the radiation protection education community due to its ability to bridge the gap between vocational education & training and higher education.

References


5. MEDRAPET project http://www.medrapet.eu/
<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Skills</th>
<th>Competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>K18. Explain the principle of justification and its application at different levels including for asymptomatic individuals and on a case by case basis</td>
<td>S13. Apply the principle of justification to specific groups of patients and individuals including the exposure of asymptomatic individuals</td>
<td>C14. Take responsibility for justification in accordance with requirements in European and national legislation and guidelines of professional bodies</td>
</tr>
<tr>
<td>K19. List the diagnostic and therapeutic practices that are formally approved through legislative or administrative acts at the national or state level.</td>
<td>S14. Identify situations in which the use of ionising radiation is justified in the case of pregnant women, women of reproductive age, children or breastfeeding mothers</td>
<td>C15. Implement published referral criteria in own practice</td>
</tr>
<tr>
<td>K20. Explain why certain groups are more susceptible to harmful effects of ionising radiation (e.g., children, pregnant patients).</td>
<td>S15. Assess the cumulative effective dose for a series of exams for a given individual patient</td>
<td>C16. Provide necessary information in referral for imaging facility to aid in optimisation of an examination</td>
</tr>
<tr>
<td>K21. Explain the joint responsibility of referrers and imaging specialists in the justification process of a radiological examination as specified by European and national legislation.</td>
<td>S16. Carry out a review of the literature to aid justification in cases for which referral criteria are not yet available</td>
<td>C17. Advise actions in case of inadvertent radiation exposure of a pregnant patient</td>
</tr>
<tr>
<td>K22. List approximate values of radiation doses for common diagnostic examinations</td>
<td>S17. Explain benefits and risks of particular procedures to specific patients</td>
<td>C18. Be competent to diagnose radiation induced skin injury and other potential radiation effects in a patient or a worker in a radiation facility and avoid unnecessary referral</td>
</tr>
<tr>
<td>K23. Explain the importance of the utilisation of clinical and radiological information from previous examinations in the process of justification</td>
<td></td>
<td>C19. Act as a role model for junior colleagues to support the processes of justification and optimization of RP</td>
</tr>
<tr>
<td>K24. Discuss few clinical situations where a test with non-ionising radiation is better than one using ionising radiation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K25. List and describe available referral criteria and guidelines applicable in your area of practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K26. Discuss the information to be provided to patients with respect to benefits and radiation risk and risk of procedures in own area of practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K27. Explain principles governing the use of ionising radiation in woman of child-bearing age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K28. Discuss the pros and cons of an examination involving the use of a radiopharmaceutical for breastfeeding women and action warranted to protect the child.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K29. Explain circumstances in your practice where use of ionising radiation on a child is justified</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tab 3. Radiation Protection KSC for referrers from the MEDRAPET project (status January 2013).
<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Skills</th>
<th>Competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1. Explain physical principles of radiation generation, interaction, modification and protection</td>
<td>S1. Use the appropriate medical devices in an effective, safe and efficient manner</td>
<td>C1. Practise effectively, accurately and safely and within the guidance of legal, ethical and professional frameworks</td>
</tr>
<tr>
<td>K2. Explain radiation physics, radiation hazards, radiation biology and dosimetry</td>
<td>S2. Use effective, safe and efficient RP methods in relation to staff, patients and the general public applying current safety standards, legislation, guidelines and regulations</td>
<td>C2. Use appropriate and correct identification, address and treatment of the patient (and any accompanying carer if appropriate)</td>
</tr>
<tr>
<td>K3. Understand risk: benefit philosophy and principles involved in all aspects of radiography</td>
<td>S3. Effectively justify and optimise all examinations</td>
<td>C3. Justify the need to minimize unnecessary radiation exposure of humans</td>
</tr>
<tr>
<td>K4. Identify current national and international RP legislation and regulations relating to staff, patients, carers and the wider general public</td>
<td>S4. Use and undertake clinical audits</td>
<td>C4. Seek consent for any examination/treatment to proceed</td>
</tr>
<tr>
<td>K5. Explain physics underpinning non-ionising imaging techniques including magnetic resonance imaging and ultrasound along with associated safety considerations</td>
<td>S5. Identify the principles of evidence-based practice and the research process</td>
<td>C5. Carry out work in a safe manner when using ionising radiation, taking into account current safety standards, guidelines and regulations</td>
</tr>
<tr>
<td>K6. Describe professional roles and responsibilities in terms of aspects of justification and optimisation</td>
<td>S6. Critically reflect on and evaluate his/her own experience and practice</td>
<td>C6. Participate in the process of creating and guaranteeing maximum safety for the patient, oneself and others during examinations /treatments involving ionising radiation and maintain the ALARA principle</td>
</tr>
<tr>
<td>K7. Explain QA and QC practices to include: legislation, regulations and guidelines, test equipment and methodologies, programme design and implementation and reporting to thus ensure the provision of an effective, safe and efficient service</td>
<td>S7. Participate in clinical audits</td>
<td>C7. Refuse to accept or carry out a request or referral which, in his/her professional opinion, is dangerous or inadvisable</td>
</tr>
<tr>
<td>K8. Understand occupational risks, health and safety that may be encountered such as safe moving and handling of patients and equipment</td>
<td>S8. Recognize the complicated situation pertaining to RP regarding scientific knowledge on the one side and societal concern and personal emotions on the other side</td>
<td>C8. Recognise the limitations to his/her scope of competence and seek advice and guidance accordingly</td>
</tr>
<tr>
<td>K9. Describe the importance of audit, research and evidence-based practice to include: the stages in the research process, research governance, ethics, statistics and statistical analysis to facilitate a deeper understanding of research findings and clinical audit</td>
<td>S9. Identify different image quality standards for different techniques</td>
<td>C9. Apply available relevant national and international (scientific) insights, theories, concepts and research results to issues with which radiographers are confronted in their professional practice</td>
</tr>
<tr>
<td>K10. Identify the different determinants of radiation risk perception; know the pitfalls of communication on radiation risks</td>
<td>S10. Apply the concepts and tools for RP optimisation</td>
<td>C10. When taking decisions about care for (individual) patients be able to make use of relevant national and international (scientific) insights, theories, concepts and research results and integrates these approaches in one’s own professional actions (evidence-based practice)</td>
</tr>
<tr>
<td>K11. Understands the particular protection aspects of pregnant women (includes pregnant radiographer/employee), carers and children and knows how to take care of these persons</td>
<td></td>
<td>C11. Recognize the radiation hazards associated with their work and take measures to minimize them</td>
</tr>
<tr>
<td>K12. Describes the risk to pregnant women and foetus involved in radiotherapy, NM, and diagnostic and IR</td>
<td></td>
<td>C12. Monitor their radiation exposures with the use of a personal dosimeter</td>
</tr>
<tr>
<td>K13. Explains dose, quantities and units and their relevance to own professional practice</td>
<td></td>
<td>C13. Establish safe working conditions according to the recommendations and the statutory requirements of European, national, regional legislation, where applicable</td>
</tr>
<tr>
<td>K14. Explain the management of accidental/unintended exposures</td>
<td></td>
<td>C14. Instruct other personnel participating in matters relating to appropriate RP practices</td>
</tr>
<tr>
<td>K15. Explain the concepts and tools for RP optimisation</td>
<td></td>
<td>C15. Carry out short-term and practice-oriented research or clinical audit, either independently or in collaboration with colleagues, to improve the quality of care</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C16. Participate in clinical audit and applied research for the further development of professional practice and its scientific foundation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C17. Place radiation risks in relation to other risks within a societal context</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C18. Reflects on their own radiation risk perception</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C19. Evaluate the results of routine QA tests</td>
</tr>
</tbody>
</table>

Tab 4 Core KSC in Radiation Protection for Radiographers (status January 2013)
Efficiency & Effectiveness of Training
SYSTEM OF EDUCATION AND TRAINING IN RADIATION SAFETY OF THE STAFF BELONGING TO A RADIOACTIVE FACILITY

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ABSTRACT

The Centre of Isotopes (CENTIS) produces radiopharmaceuticals and labelled compounds and executes import, production, transport and export of the radioactive materials in the Republic of Cuba. The objective of this paper is illustrated the education and training system in this facility. The Cuban Regulatory Body establishes that licensees should define all requirements by workplace which implies responsibility respect to protection and safety, including basic formation and needed trainings to accomplishment attributed functions. Four courses of education were realized and twelve trainings are executed with a total of 60 persons by year and as a mean of 96 hours per course. Basic course is an obligatory condition for the authorization of staff for to work with radioactive materials in correspondence with its functions. Thematic included are: state of the art on ionizing radiation effects, new regulations, occupational exposure, radiological occurrences, surveillance of workplaces, detected deviations, optimization of exposure, experiences from transport of radioactive materials, management of radioactive wastes and safety culture in our institution. The teachers are 3 specialists in radiation safety which have between 5 and 20 years of experiences, received the regional course of IAEA in Argentina and participated in basic education courses in 1998 and in trainings each two years. Certification of competence of those courses was performed by the Regulatory Body. An online course was used once in 2005 and the staff interviews showed a good results and acceptance by workers as a useful way of training. The efficiency and effectiveness of education system in CENTIS is analyzed by results of occupational exposure and radiological events. The dose constrains are taken as reference considering the achievement of ALARA principle is the main purpose of the radiation safety system.

1. Introduction

The Centre of Isotopes (CENTIS) of the Republic of Cuba has an Education and Training Program for its staff, which belonging of the radiation safety management system with an initial education and another one of training, each two years. The assessment of the efficiency, effectiveness and improvement of this program is included and for this reason is considered as an education system, directly related with accomplishment of the ALARA principle.

Since 1998 to 2012, initial and periodic education activities are executed. Their preparation is developed by three specialists with an experience of more than 5 years in the plant. The success of these activities is analyzed taking into account results of theory and practical tests; interviews of participants and review of some safety performance indicators (SPI) (amount of radiological incidents and behaviour of occupational exposure).
2. Materials and Methods

2.1 Requirements of the Regulatory Body

The Regulatory Body in Cuba is the National Centre of Nuclear Safety (NCNS). This establishes the requirements for the selection of employees which has safety and protection responsibilities and the needed activities for education and training for the achievement with their functions.

Besides, it is specified the continuous training with regularity and for this purpose, the facility should has an education and training program which include all of persons with functions of importance to safety and protection of practices.

NCNS regulates that self taught training could be used among possible methods [2] and for this reason for first time it was organized an on line course with good results [3]. Nevertheless, lectures and practical exercises have been used for more time.

2.2 Preparation of instructors

The instructors are 3 specialists belonging of Radiation Safety Department which have between 5 and 20 years of experiences in CENTIS. Two of them have made regional courses of the International Atomic Energy Agency (IAEA) on radiological and nuclear safety in 2000, 2009, 2010 and 2012 in Argentina, respectively and participated as teachers in initial education activities in 1998 and in the training all over period. They have participated in others IAEA’s courses on radioactive wastes management, transport of radioactive material, operational safety and security of radioactive sources.

2.3 Program of courses for up to dating in radiation safety

Taking into account the experience of the initial education, which is approved by NCNS, were prepared 11 lectures about these topics:

- State of the art of the epidemiologic study on biologic effect of ionizing radiations.
- New Cuban regulations on radiation safety.
- Analysis of occupational exposure behaviour during the correspondent period of time.
- Experiences from the occurrence of radiological events.
- Analysis of results from radiological surveillance by workplace.
- Analysis of detected violations of radiation protection procedures.
- Acquired experience from packaging and transport operations of radioactive materials.
- Management of radioactive wastes.
- Analysis of behaviour of relevant systems for safety.
- Optimization of radiation safety.

Lectures were prepared in Word and Power Point. In 2005 was created a web site of the Radiation Protection Department as a course on line, with access by INTERNET in CENTIS. The course RADIOR [4] and the methodology aspects of [5] and [6] are used as references.

For first time are used the SPI in lectures related with occupational exposure, public exposure, emergency, management of radioactive waste and optimization. Operating instructions for hot cells, glove boxes and fume hoods, instructions for input and output in plant (controlled and supervised areas) and emergency procedures could be taken from this web site.
Persons with safety and protection responsibilities were participants. They are Director of CENTIS, personal of direction and supervision related with radioactive materials, occupationally exposed workers and bosses of brigades of operation and maintenance. During a month they studied the lectures and after that were tested.

Basic courses and recent training are obligatory conditions for the authorization of staff for to work with radioactive materials in correspondence with its functions.

Staff related with transport of radioactive material has received different lectures considering the experiences from these operations, the manual of radiation safety with procedures (including emergency procedures), exposure of personal and requirements for radioactive materials and for packagings and packages. They also have written and practical tests according with this purposes.

In the last three years, lecture about safety culture has been included in the training program with intention of incidence in the performance and achievement this objective in the organization. Through incorporating radiation safety as an element of diary conducts of workers and an adequate perception of risk in their activities, we have as a purpose to achieve more communications of deviations and active attitude for performance occupational and public exposures.

For improvement the accomplishment of safety procedures were prepared training with operating staff of plant, where a direct interchange was propitiated with the personal of radiation safety in 2012.

As we can see different modalities have used for training staff of CENTIS accordingly his workplace (functions) and results of radiation safety of practices.

2.4 Assessment of success of courses for current radiation safety

The assessment of efficiency and effectiveness of education and training activities are organized through results of tests, staff interviews and analyzing the SPI behaviour.

Written tests are in two variants as minimum and answers are by selection of correct possibilities. The main evaluated objectives are basic aspects of biologic effect of ionizing radiations, politics of radiation safety in the centre, lections from radiological incidents, identification of practices and locals with the biggest risk and contribution to the occupational exposure, means of reducing of amount of radioactive wastes and emergency procedures for workers. In the last two years the developed answers are used.

Practical tests evaluate operating instructions for hot cells, glove boxes and fume hoods, instructions for input and output in plant and emergency procedures taken into account functions of workers by workplace.

3. Results

In the Table 1, the list of courses executed in CENTIS is showed. The CNSN recognized their competence and elaborated the respective certificates with permanent validity [7 y 8].

Two conferences on security of radioactive sources and security in the transport of radioactive material were realized in 2009 for the staff related with the transport and they are not included in Table 1 for the specific of these topics and their realization in another time with respect the training in radiation safety.

Despite is required a biggest percent of accepted answers of the total points (70%) for the
staff related with production and transport, all of persons have obtained good results in tests. For the periodical retraining of staff is introduced the analysis of SPI as a tool for get better the feedback process and training. For assessment the efficiency of these courses following are analyzed the radiological events happened and the occupational exposure.

There is a maximum of 5 events by year during 2001-2002 and 4 events in the period of 2006-2007; this can be observed in Figure 1. Can be seen the reduction of this SPI during the rest of the time.

In the Table 2 is presented the relationship between the behaviour of annual handling activity of \(^{131}\)I, \(^{99}\)Mo and \(^{32}\)P, radionuclides of the main contribution to occupational exposure, and S. In spite of increasing 1.45 times for the sum of activities of \(^{131}\)I and \(^{32}\)P in the last two years, S has an increment up to 1.78 times.

Figure 2 shows S’ liaison with the number of monitored workers. The increase of personnel implies the same behaviour of S, but reduces E. The increment of individual radiation doses \(^{32}\)P contributed to 75.4E-03 man-Sv y\(^{-1}\) in 2003. Besides, it should be observed in this figure the appreciable reduction of the individual exposures determines the decreasing of S during 2006-2008. In spite of this, there is the biggest value 98 man-mSv y\(^{-1}\) in 2011 due to the increment of \(^{131}\)I activity. It was estimated an annual collective dose of 200E-03 man-Sv y\(^{-1}\) [9]. Table 2 allows seeing the biggest figure of S is 0.49 times lower than this value. This is caused by CENTIS yet does not reach to the maximum activity of the basis its design for \(^{99}\)Mo and \(^{32}\)P.

Groups of Radiopharmacy and Quality Control are the most contribution to S. Their S for E equal or superior 2 mSv is 9-53 % of total S. It can be appreciated in Figure 3 there is a larger medium value of S for the group of Radiopharmacy in 2002-2003, 2005 and 2009-2011, as a result of the increment in handling activities before analyzed. The biggest contribution to occupational exposure belongs to production of Technetium generators.

The percentage of the monitored workers organized by adopted E’ intervals can be seeing in the Table 3. For the purposes of this paper, monitored workers are people to whom a dosimeter was issued. For the majority of workers (equal or more than 63 %), there is E below 2 mSv y\(^{-1}\).

The relationship between the maximum annual value of dosimetric magnitudes and their respective dose constrains can be observe in Table 4. It should be observed that a new recommended limit for Hp(3) of 20 mSv y\(^{-1}\) is adopted [10]. In 1996 and 1997 it is indicated as not controlled (NC) for Hp(3). The biggest values appear in year 2000 for E, 2006 for Hp(0.07) and in 2003 for Hp(3). It should be appreciated that dose constrains are overcame in these two first moments. A worker of the group of Inspection and Trial made all of the elutions of generators and received 25.77 mSv, superior value of the limit as average for 5 years [11]. The work load was redistributed and a shielding of lead with 5 cm was situated. In the second case the procedure of intervention in hot cell with \(^{131}\)I was analyzed. There was an incorrect manipulation for part of worker and this is the cause of the biggest value of Hp(0.07).

There were incorporated the SPI of quotient of maximum values of E, Hp(0.07) and Hp(3) and their respective dose constrains for each group of workers since 2010. Can be seen in the Table 5 the group of Inspection and Trial received a biggest values respect E and its dose constrain (6 mSv y\(^{-1}\)) in 2011. This is due to the contribution of E(50) caused by the occurrence a radiological event when one worker was related. Besides, the group of Metrology overcomes the SPI of Hp(0.07), which it should not repeat again. Both situations were analyzed in the course of 2012, with a more direct interchange with the workers from process of production.
In the last two years, increase of handled activities has conducted the same behaviour of occupational exposure; because a superior communication with operating staff have needed and taking some measures for improve radiation safety of process of production. Training activities have been a tool for this purpose and performance these activities in function of better results is our permanent labour.

<table>
<thead>
<tr>
<th>Number</th>
<th>Year</th>
<th>Course</th>
<th>Time (hours)</th>
<th>Amount of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1998</td>
<td>Elements of radiation protection</td>
<td>40</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>1998</td>
<td>Basic course of radiation protection for workers</td>
<td>60</td>
<td>31</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Radiation safety for the transport of radioactive material</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>1999</td>
<td>Radiation safety for staff with safety and protection responsibilities</td>
<td>60</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>2002</td>
<td>Current in radiation safety aspects for workers and staff with safety and protection responsibilities</td>
<td>60</td>
<td>52</td>
</tr>
<tr>
<td>6</td>
<td>2005</td>
<td>Current in radiation safety aspects for workers and staff with Safety and Protection Responsibilities</td>
<td>96</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Current in radiation safety aspects for the staff related with the transport of radioactive material</td>
<td>60</td>
<td>11</td>
</tr>
<tr>
<td>8</td>
<td>2007</td>
<td>Current in radiation safety aspects for workers and staff with safety and protection responsibilities</td>
<td>96</td>
<td>53</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Current in radiation safety aspects for the staff related with the transport of radioactive material</td>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>2008</td>
<td>Current in radiation safety aspects for the staff related with the transport of radioactive material</td>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>2009</td>
<td>Current in radiation safety aspects for the staff related with the transport of radioactive material</td>
<td>40</td>
<td>16</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Current in radiation safety aspects for workers and staff with safety and protection responsibilities</td>
<td>96</td>
<td>9</td>
</tr>
<tr>
<td>13</td>
<td>2011</td>
<td>Current in radiation safety aspects for workers (including them related with the transport of radioactive material)</td>
<td>20</td>
<td>57</td>
</tr>
<tr>
<td>14</td>
<td>2012</td>
<td>Current in radiation safety aspects for workers related with the process of production</td>
<td>20</td>
<td>30</td>
</tr>
</tbody>
</table>

Tab 1. List of radiation safety courses executed in CENTIS
Fig 1. Amount of radiological incidents by year in CENTIS

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity $^{131}$I (Bq y$^{-1}$)</th>
<th>Activity $^{99}$Mo (Bq y$^{-1}$)</th>
<th>Activity $^{32}$P (Bq y$^{-1}$)</th>
<th>$S$ (Man Sv y$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>Not handled</td>
<td>3.20E+11</td>
<td>Not handled</td>
<td>0.025</td>
</tr>
<tr>
<td>1997</td>
<td>7.33E+11</td>
<td>5.92E+11</td>
<td>Not handled</td>
<td>0.016</td>
</tr>
<tr>
<td>1998</td>
<td>4.90E+12</td>
<td>5.39E+11</td>
<td>1.19E+10</td>
<td>0.039</td>
</tr>
<tr>
<td>1999</td>
<td>4.87E+12</td>
<td>6.60E+11</td>
<td>3.43E+11</td>
<td>0.036</td>
</tr>
<tr>
<td>2000</td>
<td>4.84E+12</td>
<td>5.35E+11</td>
<td>2.35E+11</td>
<td>0.063</td>
</tr>
<tr>
<td>2001</td>
<td>4.88E+12</td>
<td>1.38E+12</td>
<td>2.35E+11</td>
<td>0.075</td>
</tr>
<tr>
<td>2002</td>
<td>4.60E+12</td>
<td>1.59E+12</td>
<td>2.35E+11</td>
<td>0.079</td>
</tr>
<tr>
<td>2003</td>
<td>3.94E+12</td>
<td>1.49E+13</td>
<td>2.35E+11</td>
<td>0.075</td>
</tr>
<tr>
<td>2004</td>
<td>4.71E+12</td>
<td>2.73E+13</td>
<td>2.35E+11</td>
<td>0.026</td>
</tr>
<tr>
<td>2005</td>
<td>4.08E+12</td>
<td>2.77E+13</td>
<td>2.35E+11</td>
<td>0.035</td>
</tr>
<tr>
<td>2006</td>
<td>3.28E+12</td>
<td>2.29E+13</td>
<td>2.35E+11</td>
<td>0.022</td>
</tr>
<tr>
<td>2007</td>
<td>4.91E+12</td>
<td>2.52E+13</td>
<td>2.35E+11</td>
<td>0.017</td>
</tr>
<tr>
<td>2008</td>
<td>4.33E+12</td>
<td>2.32E+13</td>
<td>2.35E+11</td>
<td>0.018</td>
</tr>
<tr>
<td>2009</td>
<td>5.76E+12</td>
<td>4.01E+13</td>
<td>2.35E+11</td>
<td>0.042</td>
</tr>
<tr>
<td>2010</td>
<td>7.09E+12</td>
<td>3.19E+13</td>
<td>3.17E+11</td>
<td>0.055</td>
</tr>
<tr>
<td>2011</td>
<td>1.05E+13</td>
<td>3.19E+13</td>
<td>3.12E+11</td>
<td>0.098</td>
</tr>
</tbody>
</table>

Tab 2. Annual activities of the main radionuclides and collective doses (S)
The existence of an education and training system in CENTIS has guaranteed a prevalence of lower levels of occupational exposure and deviations have been analyzed in the organized activities within this system. This is an instrument for the accomplishment and maintaining of the ALARA principle in our plant [12]. Obtained results and here showed, allow give a satisfactory evaluation to this system but also require maintain them.

Fig 2. Collective doses and annual controlled workers

Fig 3. Annual collective doses annual for the group of Radiopharmacy with respect to its medium S for the studied period
<table>
<thead>
<tr>
<th>Year</th>
<th>E&lt; 2 mSv</th>
<th>(2 ≤ E&lt; 6) mSv</th>
<th>(6 ≤ E&lt; 12) mSv</th>
<th>(20≤ E &lt; 50) mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>87</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>94</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td>86</td>
<td>14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>83</td>
<td>17</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>84</td>
<td>13</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2001</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>63</td>
<td>34</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>81</td>
<td>19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>95</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>89</td>
<td>9</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>94</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>98</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>98</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>90</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>72</td>
<td>28</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>81</td>
<td>14</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Tab 3. Percentage of the monitored workers organized by interval of $E$

Achieve a safety culture in our organization is another objective of the training activities, where a change of attitudes with respect not accomplishment safety procedures and performance staff behaviour during handling radioactive materials, are promote in the feedback process with workers. An adequate perception of radiological risk, taking into account the results of historic exposure and experiences here explained, is the message that our instructors have transmitted to staff during the training organized activities in CENTIS, the main radioactive facility in Cuba.

<table>
<thead>
<tr>
<th>Dose constrains</th>
<th>$E$ (mSv)</th>
<th>$H_{p}(0.07)$ (mSv)</th>
<th>$H_{p}(3)$ (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>4.73</td>
<td>8.15</td>
<td>NC</td>
</tr>
<tr>
<td>1997</td>
<td>4.02</td>
<td>8.56</td>
<td>NC</td>
</tr>
<tr>
<td>1998</td>
<td>10.27</td>
<td>17.85</td>
<td>2.60</td>
</tr>
<tr>
<td>1999</td>
<td>4.85</td>
<td>49.38</td>
<td>4.38</td>
</tr>
<tr>
<td>2000</td>
<td><strong>25.77</strong></td>
<td>65.43</td>
<td>1.27</td>
</tr>
<tr>
<td>2001</td>
<td>3.22</td>
<td>117.97</td>
<td>1.90</td>
</tr>
<tr>
<td>2002</td>
<td>7.06</td>
<td>97.94</td>
<td>8.47</td>
</tr>
<tr>
<td>2003</td>
<td>5.89</td>
<td>91.47</td>
<td><strong>12.09</strong></td>
</tr>
<tr>
<td>2004</td>
<td>4.17</td>
<td>73.41</td>
<td>5.14</td>
</tr>
<tr>
<td>2005</td>
<td>6.52</td>
<td>145.17</td>
<td>5.89</td>
</tr>
<tr>
<td>2006</td>
<td>6.09</td>
<td><strong>232.71</strong></td>
<td>3.49</td>
</tr>
<tr>
<td>2007</td>
<td>2.96</td>
<td>117.70</td>
<td>3.86</td>
</tr>
<tr>
<td>2008</td>
<td>4.28</td>
<td>168.38</td>
<td>2.18</td>
</tr>
<tr>
<td>2009</td>
<td>5.32</td>
<td>172.49</td>
<td>4.85</td>
</tr>
<tr>
<td>2010</td>
<td>5.14</td>
<td>60.68</td>
<td>3.85</td>
</tr>
<tr>
<td>2011</td>
<td>9.13</td>
<td>194.60</td>
<td>12.05</td>
</tr>
</tbody>
</table>
### Tab 4. Maximum values of dosimetric magnitudes and relationship with the dose constrain

<table>
<thead>
<tr>
<th>Group of workers</th>
<th>Maximum E / E constrain</th>
<th>Maximum Hp(0.07) / Hp(0.07) constrain</th>
<th>Maximum Hp(3) / Hp(3) constrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiopharmacy</td>
<td>0.76</td>
<td>0.97</td>
<td>0.34</td>
</tr>
<tr>
<td>Inspection and trial</td>
<td>1.26</td>
<td>0.40</td>
<td>0.80</td>
</tr>
<tr>
<td>Research</td>
<td>0.61</td>
<td>0.15</td>
<td>0.16</td>
</tr>
<tr>
<td>Metrology</td>
<td>0.22</td>
<td>3.57</td>
<td>NC</td>
</tr>
<tr>
<td>Distribution</td>
<td>0.15</td>
<td>NC</td>
<td>NC</td>
</tr>
</tbody>
</table>

### Tab 5. Quotient of maximum values of E, Hp(0.07) and Hp(3) and their respective dose constrains for each group of workers in 2011

### 4. Conclusions

- **a)** The education and training system which is described in this paper allows maintaining the preparation of the staff in radiation safety in accordance with its safety functions, which was certified by the Regulatory Body in Cuba.
- **b)** Assessment of the efficiency and effectiveness of education activities requires analyzing the behaviour of SPI related with occupational exposure and radiological events.
- **c)** The analysis of SPI behaviour in the training of the staff is a good experience since this allows improvement the feedback process and contribute to perform different aspects related with the optimization of radiation safety.
- **d)** The education and training system is used as a tool for the achievement of safety culture in the organization and accomplishment and maintaining of the ALARA principle in the diary labour of CENTIS.

### 5. References


EMERGENCE OF COMPETENCY BASED TRAINING WITHIN RADIATION SAFETY TRAINING IN AUSTRALIA AND REDEVELOPMENT OF THE AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION’S TRAINING COURSES INCORPORATING THESE UNITS.

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Locked Bag 2001, Kirrawee DC, NSW, 2232, Australia

ABSTRACT

Radiation regulatory requirements across Australia are governed by different state and territory regulators. As a result radiation training requirements are different in each state and territory of Australia. In an effort to develop nationally uniform courses and harmonise radiation safety training across Australia, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) initiated a project with Government Skills Australia to develop competency based training units in radiation safety. This project has been undertaken with the support and review of the major players within the radiation protection industry, such as: mining, industry, universities, and with each individual state and territory regulators. Recently the Australian Nuclear Science and Technology Organisation (ANSTO) have reviewed these units so that they can be incorporated into the various commercial radiation safety training programs it has been conducting for the past 15 years.

Competency based training has long been a part of the Vocational Educational Training (VET) system in Australia. The VET system is dedicated to education and training that focuses on providing skills for work. It is fair to say that many VET courses focus more on providing occupational skills, whilst university courses are better known at focusing on theory and professional career paths.

In this paper we will provide an overview of the challenges ANSTO has faced in the development and implementation of these competency based training programs, including: organisational structures, the subject areas covered, recognition of skills and experience, regulatory specified radiation training requirements, how training is provided, and a discussion of the benefits from implementing the VET training system and harmonisation of radiation safety training across Australia.

1. Background

In 1997, to promote uniformity of radiation protection and nuclear safety policy across the Commonwealth, States and Territories [1] of Australia, the Australian Government established a national radiation body, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). ARPANSA created new and vital underpinning legislation known as the Australian Radiation Protection & Nuclear Safety Act (ARPANS Act) 1998. The objective of the ARPANS Act is to protect the health and safety of people, whilst protecting the environment, from the harmful effects of radiation [2]. It deals with both radiation safety and security issues in areas of medical and industrial applications, and continues to deal with significant and on-going risks to the staff of government agencies and the community in general.

The Australian radiation regulatory system consists of the national body ARPANSA and the six states and two territories, each of which is governed by its own radiation control act and regulations. Each of these entities have certain regulatory powers, which include: regulating the use of radioactive substances and radiation equipment in medical, research, industrial and mining organisations; and the safe use, transport, storage and disposal of radioactive substances across that state or territory. The states or territories have responsibilities with regards to radiation control, including licencing, registrations and accreditation for companies and/or persons possessing and working with radiation. For persons working within their jurisdiction the states and territories regulate and approve radiation training courses and their
providers. Radiation control acts and regulations differ from each state/territory. As such the requirements for radiation licences, registration, accreditation and requirements for radiation safety training also differ. ARPANSA’s role is to bring uniformity to radiation safety and the expertise and skills of workers in the radiation industry across Australia.

In 2007, ARPANSA in partnership with the Radiation Health Committee (RHC)\(^1\) and Government Skills Australia (GSA)\(^2\) started an initiative to establish a nationally consistent training and skills recognition system that was competency based. GSA, as the industry skills council, undertook the project to develop and recommend competencies and skill sets for the creation of nationally accredited vocational qualifications for those working with and around radiation. The objective was to enable training providers to deliver courses that would fit workplace requirements which recognise current skills and competencies of employees already working in this area, who did not previously have a formal qualification [3].

The outcomes of the GSA Project are [4]:
1. To increase the levels of competency of individuals specifically in the area of radiation protection through a nationally recognised training and assessment regime.
2. To promote career pathways for people working in the radiation industry with a range of competencies using the Australian Quality Framework (AQF) qualifications - Level 2 to Level 7, see Diagram 1.
3. To ensure the availability of appropriate vocational qualifications in training standards and suitable for public sector requirements.
4. To complete a flexible set of vocational qualifications and skill sets for radiation protection appropriate for people working in the radiation industry.

![Diagram 1: Australian Qualifications Framework: Level 1 - 10 qualifications [5].](image)

2. **Vocational Education and Training (VET)**
ARPANSA moved to introduce competency based training in radiation safety because of the wide and diverse uses of radiation throughout Australian government agencies, universities

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\(^1\) Radiation Health Committee (RHC) - is a group that advises the CEO of ARPANSA and the Radiation Health & Safety Advisory Council on matters relating to radiation protection, including formulating draft national policies, codes and standards for consideration by the Commonwealth, States and Territories.

\(^2\) Government Skills Australia (GSA) is a national industry skills council for government and community safety. Its primary role is working with industry experts to develop the workforce in its portfolio and actively support the development and implementation of quality skills training arrangements and related services.
and industry with varied background, qualifications and skills, and to align with the educational framework provided by the VET system.

Competency-based performance is a current concept in business and government. One comprehensive definition of "competency" is: "A cluster of related knowledge, skills, and attitudes that affects a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development." [6]. For persons to be assessed as competent they must demonstrate their knowledge and skills in the workplace rather than just attend a training course and pass examinations. Within the radiation industry workforce are many persons working with skills and knowledge that can be recognised with the introduction of competency based training packages. These people have diverse backgrounds and skillsets which match the various levels of qualifications offered in the VET system.

As the *UNESCO Revised Recommendation on Technical and Vocational Education and Training* notes: “Given the immense scientific, technological and socio-economic development, either in progress or envisaged, which characterizes the present era, particularly globalization and the revolution in information and communication technology, technical and vocational education should be a vital aspect of the educational process in all countries” [7], vocational educational and training forms an integral piece of the Australian education system and is designed to deliver workplace specific skills and knowledge based competencies. Our national VET system is informed by industry and is client focused to deliver flexible, relevant and responsive education and training. Therefore, the workforce aligned with the radiation industry offers a diverse range and skills and expertise for persons working with radiation; ranging from engineering, science and medical professionals, technicians and trade workers, managers and clerical workers.

The VET system works under the Australian Qualifications Framework (AQF). The system is designed to provide a national framework that regulates the standard of education across the country, across all education levels and to allow students to move easily from one level and from one region to another. One way in which AQF provides for all this is through recognition of prior learning (RPL). This means you don’t necessarily have to start at the very, very beginning of a course if you already have several years’ work experience [8].

The main purpose of aligning with the AQF/VET system is the emergence of competency based training in radiation safety to support the development and maintenance of educational pathways. These pathways provide access to qualifications and allow people to move easily and readily between different education and training sectors and, between those sectors and the labour market and through recognition of prior learning.

These AQF/VET system objectives provide an aid to ARPANSA in harmonising radiation safety training within Australia. The major players in the radiation industry are building strategies to both increase and deepen skills in Australia for the future and, to manage the approach for highly specialised skills needed in the radiation industry workforce due to expanding growth, especially in the areas of mining. The Australian VET system and competency based training could offer the broad range of educational skills and knowledge to match the developing radiation industry workforce.

### 3. ANSTO competency based training program development and implementation

Across Australia there are multiple providers of radiation safety training who provide training in either a range of courses to suit licensing requirements or specialise in a specific area of radiation safety, such as industrial radiography. Universities offer specialised courses for staff conducting experiments with radiation substances as part of research work on site. The Australian Nuclear Science and Technology Organisation (ANSTO) plays an important role
as a leading advisor on radiation safety issues and is recognised as a leader in radiation safety training across Australia industry and by government agencies, including regulatory agencies.

Using the new units of competency developed by Government Skills Australia ANSTO has encountered a number of challenges through: incorporating these into our existing training and; development of new material to align with the requirements on the competency units.

3.1. Review of Competency based units
A shortfall which impacted on the overall technical quality and scope of the competency units was that the nominated Government Skills group managing the project and formulating the design of the units were restrained by time and funds to complete the project. This was reflected in the consultation on the development of the units which resulted in competency units of limited scope and restrained review of the units and their contents.

ANSTO staff review of the competency units:

a) The information within the units is complicated and repetitive, as a result, difficult in designing a training program.

b) The units of competency only cover a certain range of skills and knowledge and not all the areas required for radiation licensing, especially in areas of x-rays and unsealed sources are covered by the current units.

c) Elements and performance criteria fail to link with required skills and knowledge; hence if persons designing training did not have a sound knowledge of radiation safety, crucial background evidence would be omitted and difficult to meet to learning outcomes of the unit.

d) Scope of the skills sets includes, areas of industry that require different levels of expertise, such as industrial radiography and fixed gauge.

ANSTO has already conducted preliminary consultative processes with GSA to endeavour to provide recommendations and evidence to support the current problems and aid in the implementation of improving and designing new units and skill sets to cover the current shortfalls in these units.

The coding of the units was not aligned to the expected learning outcome of competency with regards to the required skills and knowledge associated with the units. All the units were originally accredited as level 7 (equivalent of bachelor’s degree) although most of the units were developed with expected learning outcome at a more basic approach of level 2 and 3 (cert II & III qualification respectively). Details of the units are in Appendix I where table columns 1 and 2 outline the changes in levels, and column 4 the expected learning outcome for the unit.

Due to the work in the development of new radiation safety training at ANSTO, we highlighted the problems and produced evidence to support recoding of the units at the levels submitted by ANSTO, the correct coding appeared in the new version PSP12 of the public sector training package released in November 2012.

3.2. ANSTO knowledge and expertise
Problems encountered in developing the course material by the ANSTO workforce were focused in learning how the vocational education system works. ANSTO staff involved in the development of the new training program had a strong background in radiation safety and training but limited expertise developing training associated with the VET system. Completion of the certificate IV in training and assessment, proved only a stepping stone in understanding the key elements required in developing a new training package in the VET system.

3.3. Mapping current training against the new VET system
A key area to undertake is mapping of the ANSTO current training material to the competency units, which was especially difficult when this topic is not addressed in the current training curriculum. The project was fraught with new challenges, which enabled ANSTO staff, “a sink or swim attitude” in identifying what was required to develop the training material knowledge. Challenges included:

a) identifying and correcting the problem regarding coding of the units,

b) identifying missing key areas of knowledge and skills required to reach the learning outcomes, and

c) in some cases unexpected complexity of the unit in comparison with expected leaning outcomes.

3.4. Broad unit scope
A significant challenge was identifying within the skill sets, how to target the curriculum and train the target audiences, when the target group worked in very diverse fields: e.g. PSP04 Radiation Sealed Sources Safety Skill Set – target groups covers industrial radiography equipment or gamma sources and fixed source gauges. The level of skills and expertise required is much higher for the industrial radiographer compared with the persons working with the isolating a fixed gauge, see Appendix II for comparison.

3.5. Restructure of the VET training system
Another area of challenge was the restructure of the VET training system and accreditation process for which has occurred over the past 12 months, so while ANSTO was developing its new training material due to changes in the VET system meant some of the new material became redundant and required changes review and redevelopment.

3.6. Radiation regulations which specify training requirements
As discussed each state and territory are responsible for regulating radiation and the approval process for courses in radiation safety. Some states provide a detailed outline for course submissions whereas other states provide no guidelines. Therefore, specified training requirements can be quite different from state to state and standards of content and hours of attendance, required for skills and expertise; e.g. Portable Nuclear Gauge in one state require 3 days training compared with a one day course in another state. Three of the states require a mandatory legislative course and exam to completed following attendance of radiation safety training conducted by an approved provider in that state.

It is hoped through implementing this new standard of national accredited training programs using competencies that radiation workers in Australia may have reciprocity over state boundaries and not require additional training or licensing requirements to work in any particular state or territory.

4. Benefits of implementing the VET system
The VET system is the ideal choice to provide the platform for nationally uniform radiation safety training. This is due to the fact that the current system only offers individual state regulation as opposed to a nationally recognized program. It is an independent platform which works with not only the educational system, but also the industry and the regulators. Providing a comprehensive and uniform system, this includes all key components in developing a comprehensive educational program.

Benefits to implementing training based on the VET system include:

a) Reaching the goal of nationally accredited radiation safety programs for those working in the radiation industry to cross state and territorial boundaries.

b) Introduction of a nationally accredited training platform that focuses on “learning activities of the workplace and developing technical competency as well as abilities to use relevant technologies”. This learning is supplemented by knowledge about the regulatory environments and industry codes of practice which affect them in work [8].
c) A learning environment best suited to meet the demands of changing workforce due to both technological change and impact of the expanding mining growth on the radiation industry in Australia.

d) For persons currently working in the industry, the opportunity and satisfaction to have their professional skills and expertise recognised through the VET system and attain nationally accredited qualifications, if they undertake courses using recognition of prior learning.

e) At ANSTO, formal recognition of staff for their skills and expertise following the implementation of the training scheme to cover job roles such as the radiation surveyors on site.

ANSTO will be the first training provider to implement these changes in radiation safety training and deliver competency based training, which will be the first step in nationally recognised radiation safety training.

ANSTO staff undertaking the project have developed a unique set of skills that many currently working in the VET systems for many years haven’t yet developed, due to fact that no formal training courses cover the areas required to fully develop a training package in VET system and staff have to acquire these skills through both trial and error and referencing.

The new qualifications and skill sets will provide pathways for new entrants to this area and provide for transfer and skill development between the diverse areas of radiation with an emphasis on skills needed in the workplace for radiation protection and safety.

5. The future
Over the next two years ANSTO plans to take the lead in radiation safety training with the introduction of:

a) Nationally accredited courses and nationally recognised qualifications for both staff working at ANSTO and clients attending training conducted by ANSTO.

b) Industry endorsed competency based training including customised industry training programs.

c) New and endorsed competency units and skill sets to fill the voids required in the areas of X-ray and unsealed sources by the current units.

d) Flexible delivery options including online learning options and specialist short courses using units of competencies required for the client.

e) Endorsed & accredited radiation training by all Australian radiation legislative bodies and regulators.

6. Conclusion
Like every new system the first units released for use in radiation safety may have flaws but, with due diligence and reforms in the VET system, in the years to come Australia will be able to implement a new training system that will complement the needs of the radiation safety workforce. To achieve this goal we need to build on the skills and expertise of the current workforce and in the future provide a nationally recognised training program in radiation safety for Australia.
7. References
[8] Responding to the changing skills demands – training packages and accredited courses NCVER, page 8, Josie Misko.

8. Appendix I – Outline of new radiation safety units of competency

<table>
<thead>
<tr>
<th>NO</th>
<th>1. First release unit code at Level 7 Endorsed Oct 2011</th>
<th>2. New codes Endorsed Nov 2012</th>
<th>3. Name of Unit of Competency</th>
<th>4. AQF qualification type learning outcome descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PSPRAD701A</td>
<td>PSPRAD701</td>
<td>Work safely in a radiation environment</td>
<td>Level 2 – Certificate II Basic factual, technical and procedural knowledge in a defined area of work and learning</td>
</tr>
<tr>
<td>2</td>
<td>PSPRAD702A</td>
<td>PSPRAD702</td>
<td>Work safely with radioactive ores and minerals</td>
<td>Level 2 – Certificate II Basic factual, technical and procedural knowledge in a defined area of work and learning</td>
</tr>
<tr>
<td>3</td>
<td>PSPRAD703A</td>
<td>PSPRAD703</td>
<td>Perform basic radiation measurements</td>
<td>Level 3 – Certificate III Factual, technical procedural and theoretical knowledge in an area of work and learning</td>
</tr>
<tr>
<td>4</td>
<td>PSPRAD704A</td>
<td>PSPRAD704</td>
<td>Consign radioactive material</td>
<td>Level 3 – Certificate III Factual, technical procedural and theoretical knowledge in an area of work and learning</td>
</tr>
<tr>
<td>5</td>
<td>PSPRAD705A</td>
<td>PSPRAD705</td>
<td>Handle and transport radioactive material</td>
<td>Level 3 – Certificate III Factual, technical procedural and theoretical knowledge in an area of work and learning</td>
</tr>
<tr>
<td>6</td>
<td>PSPRAD706A</td>
<td>PSPRAD706</td>
<td>Work safely with radiation-sealed source equipment</td>
<td>Level 3 – Certificate III Factual, technical procedural and theoretical knowledge in an area of work and learning</td>
</tr>
<tr>
<td>7</td>
<td>PSPRAD707A</td>
<td>PSPRAD707</td>
<td>Monitor radiation</td>
<td>Level 4 – Certificate IV A broad factual, technical procedural and theoretical knowledge in a specialised area of work and learning</td>
</tr>
<tr>
<td>8</td>
<td>PSPRAD708A</td>
<td>Remained unchanged</td>
<td>Coordinate radiation safety</td>
<td>Level 7 – Bachelor degree A broad and coherent body of knowledge with depth in the underlying principles and concepts in one or more disciplines as a basis for independent lifelong learning</td>
</tr>
<tr>
<td>9</td>
<td>PSPRAD709A</td>
<td>Remained unchanged</td>
<td>Select, commission and maintain radiation measuring instruments</td>
<td>Level 7 – Bachelor degree A broad and coherent body of knowledge with depth in the underlying principles and concepts in one or more disciplines as a basis for independent lifelong learning</td>
</tr>
<tr>
<td>10</td>
<td>PSPRAD710A</td>
<td>Remained unchanged</td>
<td>Apply radiation safety knowledge to develop and implement ionising radiation management plans</td>
<td>Level 7 – Bachelor degree A broad and coherent body of knowledge with depth in the underlying principles and concepts in one or more disciplines as a basis for independent lifelong learning</td>
</tr>
</tbody>
</table>
### Appendix II – Outline of skills sets and unit application

<table>
<thead>
<tr>
<th>Name of Skill Set /Qualification</th>
<th>Application of the unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PSP04 Radiation Environment Safety Skill Set</strong></td>
<td>This skill set is for those who require radiation protection and site safety training in addition to induction training, prior to undertaking operational, technical, and/or maintenance tasks in a radiation environment. Such personnel may work in mines, construction sites, hospitals and laboratories and may include:</td>
</tr>
<tr>
<td>PSPRAD701A Work safely in a radiation environment</td>
<td></td>
</tr>
<tr>
<td><strong>PSP04 Radiation Sealed Sources Safety Skill Set</strong></td>
<td>This skill set is for authorised personnel who work at geotechnical, construction, mining and manufacturing or analytical/research sites with any of the following sealed sources or equipment:</td>
</tr>
<tr>
<td>PSPRAD703A Perform basic radiation measurements</td>
<td>• industrial radiography equipment or gamma sources</td>
</tr>
<tr>
<td>PSPRAD705A Handle and transport radioactive material</td>
<td>• portable density/moisture gauges</td>
</tr>
<tr>
<td>PSPRAD706A Work safely with radiation-sealed source equipment</td>
<td>• fixed source gauges (e.g. level, density, thickness and proximity)</td>
</tr>
<tr>
<td>PSPRAD707A Monitor radiation</td>
<td>• bore hole logging</td>
</tr>
<tr>
<td>PUAWER009B Participate as a member of a workplace emergency initial response team</td>
<td>• portable XRD and XRF instruments.</td>
</tr>
<tr>
<td><strong>PSP04 Radiation Technician Safety Skill Set</strong></td>
<td>This skill set is for authorised personnel who perform a radiation monitoring role and who are trained to participate as a member of a workplace emergency initial response team, and who work:</td>
</tr>
<tr>
<td>PSPRAD703A Perform basic radiation measurements</td>
<td>• at a mine or plant that processes radioactive ore and/or minerals</td>
</tr>
<tr>
<td>PSPRAD705A Handle and transport radioactive material</td>
<td>• with instruments that emit ionising radiation at geotechnical, construction, mining and manufacturing sites or analytical/research facilities</td>
</tr>
<tr>
<td>PSPRAD706A Work safely with radiation-sealed source equipment</td>
<td>• in a laboratory or licensed facility that handles radioactive materials</td>
</tr>
<tr>
<td>PUAWER009B Participate as a member of a workplace emergency initial response team</td>
<td>• in a nuclear facility.</td>
</tr>
<tr>
<td><strong>Direct Workplace Emergency Initial Response Skill Set</strong></td>
<td>This skill set is for radiation safety professionals (such as radiation safety officers) who may be called on to perform a leadership role in a radiation or other incident, who are trained to direct a workplace emergency initial response team, and who work:</td>
</tr>
<tr>
<td>PUAWER010B Lead a workplace emergency initial response team</td>
<td>• at a mine or plant that processes radioactive ore and/or minerals</td>
</tr>
<tr>
<td></td>
<td>• with instruments that emit ionising radiation at geotechnical, construction, mining and manufacturing sites or analytical/research facilities</td>
</tr>
<tr>
<td></td>
<td>• in a laboratory or licensed facility that handles radioactive materials</td>
</tr>
<tr>
<td></td>
<td>• in a nuclear facility.</td>
</tr>
<tr>
<td><strong>Vocational Graduate Certificate in Radiation Safety</strong></td>
<td>This qualification supports people with responsibility as radiation safety officers (RSOs) and is particularly relevant for those whose responsibilities as an RSO form a significant part of their role. The candidate may work in a department, organisation, division or business unit that provides advice and guidance to others on radiation safety matters and the development and implementation of ionising radiation management plans. They will have responsibility developing and/or sustaining a radiation safety culture and ensuring that all legislative and organisational requirements are met.</td>
</tr>
<tr>
<td>7 units of competency are required for the award of this qualification.</td>
<td></td>
</tr>
<tr>
<td>BSBAUD503B Lead a quality audit</td>
<td></td>
</tr>
<tr>
<td>PSPRAD704A Consign radioactive material</td>
<td></td>
</tr>
<tr>
<td>PSPRAD707A Monitor radiation</td>
<td></td>
</tr>
<tr>
<td>PSPRAD708A Coordinate radiation safety</td>
<td></td>
</tr>
<tr>
<td>PSPRAD709A Select, commission and maintain radiation measuring instruments</td>
<td></td>
</tr>
<tr>
<td>PSPRAD710A Apply radiation safety knowledge to develop and implement ionising radiation management plans</td>
<td></td>
</tr>
<tr>
<td>PUAWER009B Participate as a member of a workplace emergency initial response team</td>
<td></td>
</tr>
</tbody>
</table>
Radiation protection is an interdisciplinary field attracting several emergency organizations in the same way. To ensure a smooth and safe communication and cooperation it is necessary to perform at least parts of the training at the same level.

This is the reason why the radiation protection training award (Strahlenschutz-Leistungsbefähigungen) was established half a century ago and became a nationwide success in Austria. Today it is training at a high international level, which is done by emergency personnel from Austria up to the United Arab Emirates. And the trend of a close collaboration concerning the radiation protection training still continues!

1. History

To act professionally as a first responder it is necessary to possess a certain basic knowledge of practical and theoretical know-how in the field of radiation protection and the possibility of a good communication between the participating emergency services.

On the one hand there is a large variety of radiation protection trainings for emergency services in Austria as well as internationally coexisting in a refreshing way, on the other hand there has been the overarching trend to a general radiation protection training for all emergency services in Austria since several decades (starting 1962) which has been encouraged from the Seibersdorf Laboratories. It is worth mentioning that at that time no legal documents concerning radiation protection existed. The Austrian Radiation Protection Law was passed in 1969. In 2003 a multistage radiation protection training system was established officially with the ÖNORM standard S 5207 (Radiation protection training for intervention personnel).
In 2007 the training content of the mentioned ÖNORM standard was transferred completely into the radiation protection intervention regulation and so it got a legal relevance. [1]

2. Trainings

The “basic training” for intervention personnel takes place in different emergency services and provides the basic knowledge for successfully collaborating on a radiation protection operation.

The “advanced training I”, the successful completion of the radiation detection training, imparts the knowledge for leading a radiation detection team and working independently in the radiation area. It is finished with the examination of the radiation protection training award in bronze, taking place at the Seibersdorf Laboratories.

Participants of the “advanced training II” possess special knowledge of the middle radiation protection management. They are able to assess the situation in the event of an incident or a disaster involving radioactive or nuclear materials. They also know how to instruct their team in an efficient and safe way. This training qualifies for getting the radiation protection training award in silver.

Special trainings require the completion of the “advanced training” and contain a further specialization. They cover the field of the emergency services as well as the conjunction to technical applications like monitoring, disaster management, nuclear crime, disposal of radioactive materials and several other topics.

Owner of the radiation protection training award in gold possess a very broad knowledge on the field of radiation protection. They are able to organize and develop the field of radiation protection in their organizations.
2.1 Conclusion on general trainings

In retrospect establishing this training system has been a great success because since 1962 there have been more than 30,000 members of emergency services completing the training until the training award in bronze. [2], [4]

The next step will be the conjunction of this training system with international standards to have better cross-border cooperation as well as a better integration of promising information technologies like geoinformation systems, unmanned systems and data processing systems.

3. Hot zone decontamination training

3.1 Scenarios

Dealing with „unsealed radioactive substances“ is of particular importance for emergency services. [3] In the event of an accident at a nuclear power plant, a transport accident involving the release of radioactive substances or in case of a terrorist attack using a „dirty bomb,“ decontamination measures for people and objects may be necessary.

In this module, the participants learn the correct way to detect radioactive contamination and to eliminate it, with self-protection being the top-priority.

Whereas the Basic-Training, Bronze- and Silver-Modules use sealed radioactive substances, the Decon-Bronze-Module, makes use of unsealed radioactive substances in order to make deployment scenarios as realistic as possible.
3.2 Safety

The main priority is the safety of the participants. All participants are supervised by our radiation protection experts throughout the entire training. In the Decon Bronze module they are also examined for incorporated radioactive substances using a whole body counter. The entire module has been inspected and approved by the Austrian radiation protection authorities in accordance with Austrian radiation protection laws.

3.3 Decontamination training

Decontamination is an important task for emergency response personnel that guarantee their own protection and the protection of the people, they provide help for.

To know the right approach is as important as the knowledge of the right techniques and decon-solutions. Combined with a special training under real “dirty” conditions this is the right way to prepare emergency services for their hard and dangerous work. [5]

The Seibersdorf Laboratories have developed a hot-zone training for emergency response personnel. The training includes theoretical knowledge as well as working in personal protective equipment under real hot-zone conditions. Despite hot-zone working conditions, the safety is on highest levels. The training is a good evaluation for the personnel as well as for the used personal protective equipment and the decon-material.

The standard course, which is called “Strahlenschutz Leistungsabzeichen Dekontamination in Bronze” (radiation protection training award decontamination in bronze) provides the practical training for common, all action force comprehensive tasks.

Fig 5. Decon Bronze - Award

The tasks are in detail: decontamination of a car with basic equipment (decontamination sprayers), contamination control of persons and their decontamination as well as material decontamination, first aid in contaminated areas, the correct use of personal protective equipment as well as the correct contamination control of emergency personnel and its decontamination.

Fig 6. Tasks during the unsealed source training

In additional courses, tasks can be adapted to the requirements of the specific organisation, performing the training.

Summarizing it's a unique and challenging training for emergency response personnel.
4. Radiation protection training at the Seibersdorf Laboratories

The Seibersdorf Academy is Austria's largest training centre for radiation protection. Additional to an extensive training program for the civilian sectors of medicine, technology, and research, we also offer a special modular training system in radiation protection and disaster control for members of the military and emergency services, i.e. police, fire departments, and rescue services. We have to date more than 50 years of experience in providing radiation protection training. More than 50,000 emergency services members have been trained in Seibersdorf.

The Seibersdorf Academy has its own facilities for the training of handling unsealed and sealed sources of radiation and X-ray equipment. Big variety of different measuring devices, materials, and radiation sources are also available for training purposes.

5. References


[4] Radiation protection training for emergency services in Austria; A. Stolar; CHERNE (6th Workshop on European Collaboration for Higher Education and Research in Nuclear Engineering & Radiological Protection, Coimbra, Portugal, 07.-09.06.2010; poster & article in conference proceedings page 44.


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(Inter)national collaborations and networks, (inter)regional approaches and collaborations
MEDICAL PHYSICS EDUCATION AND TRAINING: REGULATORY ASPECTS IN LATIN AMERICA

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ABSTRACT

Despite all efforts made so far, the medical physicist is not recognized by law as a profession in most part of Latin America. Requirements regarding to the medical physicist such as education and training, qualification and responsibilities are not well established in the legislation. Moreover, the labour task of medical physicist is not a mandatory requirement in medical facilities. The aim of this study was to verify the main aspects that affect the current status of medical physics education and training in the region.

1. Introduction

Due to economic development in some Latin America countries the ionizing radiation applications in medical practices have been increased significantly in the last few years. Advanced methods of treatment and diagnostic are carried out in radiotherapy, nuclear medicine and diagnostic centers. However, the rules and regulations are not implemented in many countries leading to technological development without proper regulatory control.

According to Pan American Health Organization (PAHO) resolution (1), the recommendations established in IAEA General Safety Requirements - GSR Part 3 (2011) (2) should be applied firstly by the government and by the national regulatory bodies. However, the requirements regarding to medical physicists duties and their qualification, training and competence are not included in the legislation and consequently have not been complied in most countries. The problem is more significant in nuclear medicine and diagnostic radiology field where historically the medical physicist has not been considered essential and therefore has not been accepted as to radiotherapy field.

The scenario also indicates an insufficient number or even a lack of specialized courses. In many countries, formal education in medical physics should be taken abroad which becomes impracticable for most professionals. Consequently, the demand for qualified medical physicist to attend academic, research and especially clinical activities increased significantly. However, in the last decade, only a few countries have implemented medical physics courses to provide formal education, training and clinical practice for all specific areas. In general, these courses are not accredited and don’t follow any standard or a minimal curriculum to assure that the course provide the current needs of medical physics.

There are some controversies in the legislation and the current situation. The medical physicist is not recognized by law as a profession in most part of Latin America. However, there are requirements regarding to the presence of medical physicist in radiotherapy centers, or even in nuclear medicine and radiology centers. Also, in these same countries there are no specialized centers to provide theoretical and practical education in medical physics. The country has the law but don’t have how to comply with.

As member states of the United Nations, Latin America countries have to be prepared to implement the GSR Part 3. In this work was verified the main actions in education and training that the regulatory body should consider in order to comply with the new international requirements.
2. **Material and Methods**

An electronic survey was carried out during 2011-2012. The presidents of medical physics societies were contacted and where a society was not implemented a representative of the national regulatory body was invited to participate. The countries which collaborated with data were: Argentina, Brazil, Costa Rica, Colombia, Chile, Ecuador, El Salvador, Guatemala, México, Nicaragua, Peru, Panamá, Republic Dominican, Uruguay and Venezuela. Although there are 27 countries in Latin America in this survey it was possible to obtain the data only from 19 countries, some not completely.

The main topics of the survey were: status of medical physicist recognition, legislation and regulatory body issues related of this professional, number of installations and equipment per area education and training, beyond certification program.

3. **Results and Discussion**

3.1 **Medical Physics Associations**

The first part of the survey has initiated with the MP associations. Only 9 countries have established associations. This fact affects all the process related to the medical physicist. It is well known the association duty in the recognition and strengthening of the MP profession, supporting the professional activities, advising regulatory authorities, promoting courses, training, congress and other relevant actions.

Among 27 countries, 19 answered the questionnaire. In this group, only 50% have a MP association in place. It is important to verify that only in 11% of the countries the MP profession is recognized (Figure 1). Even though in most legislation the medical physicist is required in the facility, in fact, this profession is not recognized by law. It also should be noted that the certification process is established only in 17% of the participating countries.

![Figure 1: Frequency of countries which have established MP associations, certification process, and the MP profession recognition by law](image)

3.2 **Distribution of Medical Physicist by Clinical Area**

Historically, most of the medical physicists are dedicated to radiotherapy area mainly due to specific legislation requirements. Different from other regions, the currently status of medical physics in Diagnostic Radiology and Nuclear Medicine didn't change significantly in Latin America, especially regarding to the legislation. The Figure 2 shows the actual situation in LA where 72% of the medical physicists work in Radiotherapy and the other part in diagnostic and nuclear medicine areas.
Figure 2: Distribution of Medical Physicist in the different areas (Radiotherapy RT, Nuclear Medicine NM, and Diagnostic Radiology DR)

Even considering RT as a priority regarding the radiological risks involved in this field, in most of the countries the number of MP is insufficient to fulfill the demand (Figure 3) making the regulatory body requirements difficult to comply.

A complex situation can be observed in nuclear medicine. This specialty is increasing very fast in the region, not only because of increasing number of devices but also due to the complexity of the technology. In the last years there is a significant number of cyclotrons, radiopharmacies, hybrid techniques, new therapies which require individualized dosimetry and an expertise in physics and physiology. However, the number of medical physicist is restricted (Figure 4) and increase very gradually. Besides, there is no requirement in law or established by the regulatory bodies regarding to a medical physicist in nuclear medicine. In general, the nuclear physician is in charge of all activities in the installation including patient dosimetry and release, radiation protection and equipment quality control.
In diagnostic radiology there is a huge difficulty to obtain a confident statistic of the current number of RX equipment in the countries. Neither the president of MP associations nor the regulatory body of most countries has updated information; the numbers presented in Table 1 are approximate. The concern in DR is the very low number of medical physicist and, as in NM, there is no requirement in the legislation regarding to their duties.

Table 1: Distribution of RX equipment and medical physicist in Latin America

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of equipment in DR</th>
<th>MP in DR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>No data</td>
<td>10</td>
</tr>
<tr>
<td>Brazil</td>
<td>160000</td>
<td>63</td>
</tr>
<tr>
<td>Chile</td>
<td>10000</td>
<td>0</td>
</tr>
<tr>
<td>Colombia</td>
<td>20000</td>
<td>5</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>No data</td>
<td>2</td>
</tr>
<tr>
<td>Cuba</td>
<td>1200</td>
<td>9</td>
</tr>
<tr>
<td>El Salvador</td>
<td>170</td>
<td>0</td>
</tr>
<tr>
<td>Equator</td>
<td>3000</td>
<td>0</td>
</tr>
<tr>
<td>Guatemala</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Honduras</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>México</td>
<td>16000</td>
<td>27</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>120</td>
<td>0</td>
</tr>
<tr>
<td>Panama</td>
<td>-</td>
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<tr>
<td>Paraguay</td>
<td>1309</td>
<td>3</td>
</tr>
<tr>
<td>Peru</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Uruguay</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>
3.3 Education and training in medical physics

Among twenty seven Latin American countries, only eight have medical physics courses, considering undergraduate and postgraduate degrees, residence and continuing training. The distribution of these courses is presented in Figure 5.

![Distribution of Medical Physics courses in Latin America (2012)](image)

Figure 5: Distribution of Medical Physics courses in Latin America (2012)

The main problem is the lack of an accreditation process of these institutions. In some of them, there is one formal process conducted by Ministry of Education. However, there is no evaluation regarding to a specific syllabus for medical physics courses neither a minimum curriculum established by the authorities. This is fundamental in order to guarantee that these courses meet the minimum standards requirements.

It is also important to notice the reduced number of residences in place. Most MP doesn't have the opportunity to get the practical training in hospitals.

In many countries the lack of education programs affect directly the regulatory body, especially where the presence of MP is mandatory but there is no course in place to train and provide qualified specialists.

3.4 Legislation

The national legal system of Latin America countries does not meet the international standards recommendation.

In general there are no requirements or duties regarding to MP established by the government or other parties which have responsibilities in relation to protection and safety in medical facilities. However, in many countries where the legislation includes these requirements there is no condition to fulfill them. Also, it seems controversial to require a medical physicist in the facility when this professional is not recognized by law.

Another concern is regarding to assure the competence of the medical physicist to perform their activities. Even in the countries where there is medical physicist, it is necessary to have a certification process in place. If the regulatory body is not in charge of this issue, it should be provided in the legislation which organization is officially designed to certificate the medical physicist in the country and the respective criteria.

3.5 Regulatory Bodies

According to BSS, “the regulatory body should ensure the application of the requirements for education, training, qualification and competence in protection and safety of all persons engaged in activities relevant to protection and safety”. Considering the number
of courses presented in the item 3.3 and the shortage of requirements cited in item 3.4 it is evident the lack of commitment of the regulatory bodies with this issue. In many countries, the regulators probably do not have a real understanding of this specific requirement of GSR or unawareness of need for this professional.

In the licensing and control process, the regulatory body should adopt an evaluation criterion, through a specific regulation or by the application of international recognized standard. However, although new technologies are implemented in most LA countries, respective criteria are not included in the legislation. Consequently, regulatory body activities would be affected.

Another important point to consider is that most countries have more of one regulatory authority. In some cases, the competencies are well established; nevertheless in others the responsibilities are not evident and sometimes end up generating conflicts. Many times it can be verified different criteria, legislation and competencies depending on the regulator, for the same area in a country.

4. Conclusions

Both government and the regulatory body have responsibilities in establish the regulatory framework. The government is also responsible for ensure, if necessary, education, training and technical services. However, these requirements have not been fulfilled by the national authorities in Latin America. It could be observed that there are only 2.8% (Brazil) up to 38% (Cuba) of MP than necessary working in NM field and 0.03% (Colombia) up to 0.8% (Cuba) in DR. Only 30% of the countries have residence programs for clinical practice and about 28% have graduation courses. Despite the complexity of the new technologies and reports of high doses, the medical physicist is not recognized as essential in Diagnostic Radiology facilities. In order to change this situation is recommendable to establish a work plan involving the regulatory bodies and the relevant organizations in medical physics.

The medical physics associations in Latin America are very concerned about the potential consequences for patients and for professionals involved in the practices. Are the procedures safe and optimized? The actions should be implemented urgently, including academic requirements, continuing training and a standard process for medical physicist accreditation which could be accepted in any country of the region. These actions have as main objective the strengthening of medical physics in Latin America.

5. References


Acknowledgments
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CONTRIBUTION OF THE TRAINING CENTER OF NATIONAL CENTRE FOR NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY (CNESTEN) TO BUILDING COMPETENCIES IN RADIATION PROTECTION IN THE AFRICA REGION: POST GRADUATE EDUCATIONAL COURSE (PGEC) / MOROCCAN EXPERIENCE

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Under its law of creation, Law No. 17-83, the CNESTEN "contribute to education and training of specialists needed for national nuclear power program, and other areas using nuclear techniques". During its twenty six years of its existence, CNESTEN have significantly contributed to building competencies in radiation protection in Morocco and in the Africa region. In CNESTEN, there is a pool of about one hundred and fifty experts in radiation protection, nuclear safety, nuclear security and various nuclear techniques spread across a wide range of applications that include the health sector, energy production, environment, industry, agriculture, water resources, and management of radioactive waste. Recognizing the importance of education and training in building and strengthening radiation protection, and considering national and regional needs, CNESTEN made a strategic decision to establish a regional training centre for training in radiation protection. In collaboration with IAEA and in association with several national partners, CNESTEN have organized the IAEA Postgraduate Regional Education Course in Radiation protection and Safety of ionising radiation sources (PGEC) on seven occasions, training some 157 participants from 19 nationalities of French-speaking African countries. In 2012 CNESTEN was recognized by the AFRA / IAEA system as a “Regional Designated Centre” (RDC) in “Education and Training in Radiation protection and Safety of Waste Management”. Our objective is to continually improve radiation protection in a sustainable manner, both nationally and regionally, through education & training. Experience of running the IAEA PGEC has led to the development of other specific training courses and has built a fruitful network in the region. This paper presents the CNESTEN experience in the organizing and running the IAEA Postgraduate Regional Education Course in Radioprotection and Safety of ionising radiation sources.

1. Introduction

Recognizing the importance of education and training in building and strengthening radiation protection, and considering national and regional needs, CNESTEN made a strategic decision to establish a regional training centre for training in radiation protection.

In collaboration with IAEA and in association with several national partners, CNESTEN have organized the IAEA Postgraduate Regional Education Course in Radiation protection and Safety of ionising radiation sources (PGEC) on seven occasions, training some 157 participants from 19 nationalities of French-speaking African countries.

In 2012 CNESTEN was recognized by the AFRA / IAEA system as a “Regional Designated Centre” (RDC) in “Education and Training in Radiation protection and Safety of Waste Management”.

Experience of running the IAEA PGEC has led to the development of other specific training courses and has built a fruitful network in the region.
2. National Centre for Nuclear Energy, Science and Technology (CNESTEN)

CNESTEN is a Public Institution founded in 1986 under the supervision of the Ministry of Energy, Mines, Water and Environment it has Legal and financial autonomy, Controlled by Administration Council.

Its missions are:
- Promoting nuclear applications (Research and services),
- Technical Support of the national Authorities (safety Radioprotection, radioactive waste...),
- Preparing the technological base of Nuclear Power Option.

Its human resources are 264 individuals:
- 87 Doctors and Engineers,
- 80 Technicians,
- 97 Administrative and Support.

3. CNESTEN Training Centre

Under its law of creation, Law No. 17-83, the CNESTEN “contribute to education and training of specialists needed for national nuclear power program, and other areas using nuclear techniques”. During its twenty six years of its existence, CNESTEN have significantly contributed to building competencies in radiation protection in Morocco and in the Africa region. In CNESTEN, there is a pool of about one hundred and fifty experts in radiation protection, nuclear safety, nuclear security and various nuclear techniques spread across a wide range of applications that include the health sector, energy production, environment, industry, agriculture, water resources, and management of radioactive waste.

3.1. Three levels of intervention:
- National level: For setting a national infrastructure for Education, Training and Research in nuclear fields over various socio-economic areas,
- Regional level: For contributing to develop regional capabilities for safe use of radioactive sources,
- International level: For sharing experience and developing networking.

In the field of education and training CNESTEN developed a local, regional and international partnership. A thousand of professionals and students are trained per year totalling more than 20 000 man-days of training per year, of which 20% are from foreign countries.

CNESTEN was recognized by the AFRA / IAEA system as “Regional Recognised Centre” (RDC) in three areas: “Education and Training in Radioprotection and Safety of Waste Management”; “Isotopic Hydrology” and “Nutrition”. CNESTEN host and cordon the “Nuclear Security Support Centre” (NSSC).

3.2. Infrastructure supporting Education and Training activities:
- TRIGA MARK II Reactor and associated Laboratories on CNESTEN's Maamora Nuclear Studies Centre (CENM).
- CNESTEN's Al-Irfane Training Facilities.
- Specific Facilities of CNESTEN partners.
- CNESTEN has a project for building an International Training Centre.
4. Regional Training Centre (RTC) and Regional Designated Centre on Education and Training (RDC) on Radiation protection: IAEA and AFRA approach

In 2000, the 44th General Conference mandated the Secretariat (resolution GC (44)/RES/13) to intensify Post Graduate Educational Course (PGEC) activities and to develop syllaubuses and training material for specific target groups and specific uses of radiation sources and radioactive materials.

The Secretariat was also urged to strengthen, within existing resources, the role of Regional Training Centres (RTCs) and to develop national training centre and to facilitate cooperation between such centres’, on the one hand, and national and regional authorities and professional bodies on the other.

Over the years RTCs have been established with the Agency’s support. The RTCs offer training in Arabic, English, French, Russian, Spanish and Portuguese; and they represent strong regional resources with respect to the implementation of the strategy.

The inter-governmental African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA) is one of the regional agreements under the IAEA. AFRA entered into effect in 1990. The AFRA Member States have been carrying out cooperative projects in various fields of nuclear science and technology for socio-economic development. As an intergovernmental agreement AFRA translates the political commitment of Member States into regional cooperation and mutual assistance under the umbrella of Technical Cooperation among Developing Countries (TCDC). AFRA focuses on Capacity Building and networking among its member states. AFRA is fostering sustainable regional self-reliance and mutual assistance in Africa. This aim can be consolidated through the recognition of regional institutions in high priority fields (AFRA Regional Designated Centres (RDCs)).

The RDCs and RTCs on education and training in radiation protection are considered equivalents. Both procedures for the recognition of RDC/RTC include IAEA Education and Training Appraisal (EDUTA) mission and then conclusion of Memorandum of understanding for RDC and Long Term Agreement for RDC.

The RDCs/RTCs can act as a resource for building competence in radiation, transport and waste safety within the regions and play a useful and cost-effective role by complementing and supporting the activities of national institutions operating in similar fields.

One of The criteria set by IAEA/AFRA to the selection of RTCs/RDCs is “Regional centres should be established only in countries with adequate radiation protection infrastructure and national capability for training at the PGEC level”.

In 2011 the AFRA committee recognized the following institutions as RDCs for Education and Training in Radiation protection:

- Nuclear Research Centre of Algeria (CRNA),
- School of Nuclear and allied Sciences of the University of Ghana (SNAS),
- National Centre for Nuclear Energy, Science and Technology (CNESTEN) Morocco.
5. Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources – PGEC

The aim of the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources is to meet the needs of professionals at graduate level, or the equivalent, for initial training to acquire a sound basis in radiation protection and the safety of radiation sources. The course also aims to provide the necessary basic tools for those who will be recognized as qualified expert in radiation protection in the later years and be involved in education and training in radiation protection and Safety of Radiation Sources in their home countries. It is designed to provide both theoretical and practical training in the multidisciplinary scientific and/or technical bases of international recommendations and standards on radiation protection and their implementation. The participants should have had a formal education to a level equivalent to a university degree in the physical, chemical or life sciences or engineering and should have been selected to work in the field of radiation protection and the safe use of radiation sources in their countries.

- The PGEC is based on the IAEA syllabus.
- The original version of the standards syllabus of PGEC was published in 1995.
- The first revised version has been published in 2002. TRAINING COURSES SERIES No. 18. (Official publication).

The Standard Syllabus of the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources is divided into eleven parts. The total minimum suggested duration is 18 weeks.

The second revised version in 2008 has been approved by the steering committee on education and training in radioprotection and waste safety (SC).

The third revision in 2010, approved by the SC, is under processes of Publication.

The revision takes into account the requirements of the IAEA Revision of Safety Series No. 115 (1996) and related Safety Guides, and recommendations of the Steering Committee as well as experience gained from the Postgraduate Educational Course in Radiation Protection regularly conducted in several regional training centres in recent years in Argentina, Morocco, Syria, Greece, Malaysia and Belarus.

Now PGEC is also conducted by Ghana and Algerian RDC’s.

6. Moroccan experience on conduction of PGEC

6.1. Background

Recognizing the importance of education and training in building and strengthening radiation protection, and considering national and regional needs, CNESTEN made a strategic decision to establish a regional training centre for training in radiation protection.

In the first stage, a tripartite partnership between CNESTEN-IAEA-INSTN France has been done. In 1998 CNESTEN, on collaboration with IAEA, and INSTN France organized, in association with national partners, organized a pilot session at Morocco. The duration of this session was 09 weeks.

In 2001 CNESTEN was considered by the IAEA as a Regional Centre for African French speaking countries in Radiation Protection and the Safety of Radiation Sources.

The first session of PGEC-Morocco was conducted in 2002 with 20 weeks duration.
Since CNESTEN conducts regularly PGEC-Morocco with 21 weeks duration. In collaboration with IAEA, CNESTEN organized, in association with national partners, seven editions of the Postgraduate Regional Education Course (PGEC) in Radioprotection and Safety of ionising radiation sources. 157 participants from 19 nationalities of French-speaking African has been trained.

In 2007 CNESTEN received IAEA EduTa mission.

In 2010 he received AFRA/IAEA EduTa mission.

In 2012 CNESTEN was recognized by the AFRA / IAEA system as a “Regional Designated Centre” (RDC) in “Education and Training in Radiation protection and Safety of Waste Management”.

6.2. Context

The principals’ points of Moroccan PGEC context are:

- Collaboration between IAEA and Government of Morocco through the CNESTEN,
- Host agreement between IAEA and Government of Morocco under projects RAF/9/028; RAF/9/035,
- Agreement between CNESTEN and School Mohammadia of Engineers (EMI). EMI give a certificate to the participants who succeed on final exam,
- Partnership between CNESTEN and national Institutions,
- National Partners: School Mohammadia of Engineers, National Centre of Radiation protection (CNRP); Scientific University, Medical and Pharmacy University; National Institute of Oncology (INO), Military hospital Mohammed V, National Institute of Agronomic Research (INRA).

6.3. Organization

Fig.1: Organization of the PGEC.
According to this organization the role and responsibilities of the actors in PGEC team are clearly defined on document of organisation. This team is the work force for success and continual improvement of the PGEC.

6.4. Program

- The program of the Course is based on the IAEA Standard Syllabus and articulated around 11 modules;
- The duration of the course is 21 weeks;
- Content:
  - 242 Lecture sessions;
  - 86 Exercises sessions;
  - 62 of Practical Exercises sessions;
  - 27 Tutored sessions;
  - 41 Sessions of Examination, 1 Final Exam;
  - 11 Technical Visits,
  - 30 Sessions Project assignment.

- Lectures’ Institutions:
  - CNESTEN;
  - Moroccan Institutions;
  - IAEA.

- Program:

<table>
<thead>
<tr>
<th>Module</th>
<th>Title</th>
<th>Duration (week)</th>
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<tbody>
<tr>
<td>I</td>
<td>Review of fundamentals</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>Quantities Measurements</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>Biological effects of Ionizing Radiation</td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>Principles of radiation protection and Regulatory control</td>
<td>2</td>
</tr>
<tr>
<td>V</td>
<td>Assessment of external and internal exposure</td>
<td>2</td>
</tr>
<tr>
<td>VI</td>
<td>Protection against occupational exposure</td>
<td>4</td>
</tr>
<tr>
<td>VII</td>
<td>Medical exposure</td>
<td>1,5</td>
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<tr>
<td>VIII</td>
<td>Public exposure</td>
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</tr>
<tr>
<td>IX</td>
<td>Accidental exposure</td>
<td>2</td>
</tr>
<tr>
<td>X</td>
<td>Training the trainers</td>
<td>1</td>
</tr>
<tr>
<td>XI</td>
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<td></td>
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<td>1,5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>

Table 1: Program of Moroccan PGEC
• **Technical visits:**
  - Technical visits TRIGA MARK II reactor;
  - Technical visits to radioisotopes production lab;
  - Technical visit to Environment monitoring Unit;
  - Technical visit to Dosimeter lab
  - Technical visit to an irradiator facility;
  - Technical visits to private and public hospitals;
  - Technical visit to an industrial radiography facility;
  - Technical visit to an SSDL facility;
  - Technical visit to CNRP.

• **Social Program**
  - Visits
    - to Rabat;
    - to Casablanca;
    - to Tangier;
    - to Fes ;
    - to Marrakech.
  - Others special social events: (Aïd Al Adha, Chrismes, Achoura, etc.)

6.5. **Mechanisms of evaluation and feedback from students and lecturers**

The evaluation of PGEC consists on Evaluation of knowledge acquisition and Evaluation of the course.

  - Evaluation of knowledge acquisition:
    - Knowledge evaluation for modules,
    - Finale exam,
    - Project assignment.
    - Evaluation of the course:

  - Intermediate evaluations
    - Questionnaire/module (feedback students),
    - Oral Intermediates evaluations (students, pedagogical and logistic committees),
    - Feedback lecture.
  - Global evaluation
    - IAEA questionnaire (students),
    - Oral evaluation (students, represented of IAEA, steering committee, pedagogical and logistic committees),
    - Modules coordinators feedback (Module report).

  - Key Indicators:

• **Evolution of % Local Lecturers / Total: 70% to 90%**

<table>
<thead>
<tr>
<th>Edition</th>
<th>non local lecturers</th>
<th>local lecturers</th>
<th>% of local lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-2003</td>
<td>19</td>
<td>45</td>
<td>70 %</td>
</tr>
<tr>
<td>2003-2004</td>
<td>11</td>
<td>49</td>
<td>80 %</td>
</tr>
<tr>
<td>2004-2005</td>
<td>8</td>
<td>49</td>
<td>85 %</td>
</tr>
<tr>
<td>2005-2006</td>
<td>8</td>
<td>49</td>
<td>85 %</td>
</tr>
</tbody>
</table>

20/03/2013


Table 2: Evolution of % Local Lecturers / Total: 70% to 90%

<table>
<thead>
<tr>
<th>Year</th>
<th>Local Lecturers</th>
<th>Total</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2007</td>
<td>5</td>
<td>49</td>
<td>90%</td>
</tr>
<tr>
<td>2008-2011</td>
<td>5</td>
<td>50</td>
<td>90%</td>
</tr>
</tbody>
</table>

- Evaluation of the course by the participants:

<table>
<thead>
<tr>
<th>Value</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To be strongly improved</td>
</tr>
<tr>
<td>2</td>
<td>To be improved</td>
</tr>
<tr>
<td>3</td>
<td>Well</td>
</tr>
<tr>
<td>4</td>
<td>Very well</td>
</tr>
<tr>
<td>5</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Table 3: Scale of IAEA Questionnaire (Evaluation of the course by the participants)

- Knowledge Improvement:

**knowledge of Subject**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>1,5</th>
<th>2</th>
<th>2,5</th>
<th>3</th>
<th>3,5</th>
<th>4</th>
<th>4,5</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>2,53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>4,07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig 2: Knowledge Improvement

- Participants’ Course assessment

Fig 3: Participants’ Course assessment
• Number of trained:
  - Trained, total number : 157
  - Country : 19 nationalities
  - Profiles :
    • Exploitation and regulation (25%)
    • Regulatory body (20 %)
    • Medical sector (20%),
    • Mining Sector (09 %)
    • Students (16 %)
    • Industries, Environment, Emergency response, Research (10 %)

6.6. Academic and other systems of recognition

• EMI (Mohammedia Engineering School) gives certificate to the participants who
success the exams.
• EMI fellow all the process of running PGEC. It has to be compatible with The EMI
  system (prerequisites, conditions of Knowledge evaluation of the participants,
  experience of lecturers, etc.).

6.7. Quality management system

According to the commitment of the Top Management for continue improvement of the
PGEC and Recommendations of the EduTa Mission, CNESTEN mad decision to go through
PGEC Quality management system. The quality approach could be summarized as billow:

➢ Quality Approach :

• Design of Quality Committee;
• Call for 02 experts for evaluation and implementation of quality system;
• Quality Action Plan based on the process approach according to the following
  standards :
  - ISO 9001:2008 QMS;
  - ISO 10015:1999 Guidelines for Training;
• Definition and mapping of Process;
• Drafting documents and definition of the organization and responsibilities;
• Drafting and approval the first version of the Quality Manual;
• Overall assessment of the previous session PGEC;
• Review of Quality Manual;
• Drafting processes, procedures and record;
• improvement and locking management training system;
• Certification ISO 9001;
• Use this experience to bring the system to the training centre;

➢ Mapping process

The following figure 2 illustrates the mapping process of the PGEC training course.
7. Conclusions

- Sustainability of the Training;
- Enriching experience feedback;
- Our objective is to continually improve radiation protection in a sustainable manner, both nationally and regionally, through education & training;
- Experience of running the IAEA PGEC has led to the development of other specific training courses and has built a fruitful network in the region.

8. References:

1. Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC) standard Syllabus. IAEA Training Course Series 18, Vienna 2002
9. IAEA SC on E&T on radioprotection reports
10. PGEC course Directors meeting reports
11. PGEC revised syllabus
12. AFRA/IAEA EDUTA questionnaire
13. CNESTEN law of creation, Law No. 17-83
14. Moroccan PGEC Quality manual
15. Mu-RDC E&T in Radiation Protection
16. Moroccan IAEA annual reports on E&T in Radiation protection
SARA – AN INTENSIVE PROGRAM COURSE FROM THE CHERNE NETWORK

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ABSTRACT

To enhance the cooperation between mainly academic institutions offering programs in the nuclear field and in radiological protection the CHERNE network was founded in 2005. Besides bilateral mobility of students and staff the network aims to offer common educational activities. The intensive program SARA (Safe Application of Radiation) is one of these activities. Its first edition was organized at the SCK•CEN Mol (Belgium) and at the FH Aachen Campus Jülich in Jülich (Germany). Main objectives of the program are to provide theoretical and experimental information and to expose the participants to close to real life experience in an international environment. This first edition was attended by 18 students and 15 persons teaching staff from 9 different institutions representing 6 European countries.

1. Introduction

The use of ionizing radiation and radioactive isotopes in other areas than the production of energy through nuclear power is still increasing. Increasing awareness of the risks involved with these practices results in increasing constraints concerning radiological safety and environmental protection. Countries using nuclear power but also those going to phase out from nuclear power will be in need of well-trained man power over a long period after the shutdown of the last power plant and countries which never ran a nuclear energy program require knowledgeable persons to judge the possible impact from neighboring countries. In contrast to the increasing demand for jobs like “radiation expert” or “medical physicist” the situation in the educational domain is deteriorating. The safe use of ionizing radiation and radioactive material requires besides a strong theoretical background also practical experience. The globalization requires that the experts will also have to be able to work in an international environment. Even to maintain laboratories with basic equipment in nuclear techniques is too expensive for many institutions. Up to date laboratories can only be offered for some special areas.
The access to large scale facilities like nuclear reactors or accelerators are also difficult to organize on an individual basis. Moreover the teaching staff in the institutions is highly specialized and cannot cover all subjects especially at the Master level in great detail. To make use of the existing possibilities the CHERNE network was founded in 2005. The main objective of the network is to enhance the quality of the educational programs by exchanging teaching staff, initiating scientific co-operations resulting in increasing student mobility, and to organize common courses. Common courses have the advantage over the exchange of teaching staff that students from different countries are working together and thus not only the knowledge aspect but also the social competence of intercultural communication is considered. The financial support through a grant from the Erasmus-Intensive Programs (1) enables members of the network to offer common courses at very low costs for the participants. This is of high value since it avoids the need to ask for grants from industry or to have to select participants not according to their academic record but according to their financial situation. The IP “SARA (Safe Application of Radiation)” addresses the above mentioned problem. It aims at offering the students information and practical experience on radiation safety not only in the field of technical applications but also in medical applications. From the network 10 members agreed upon to send students to the three editions of the program.

### 2. Organization

The administrative tasks and the contact to EU are taken care of by the Technical University Prague (CVUT). For the first edition the research center SCK•CEN in Mol agreed to host the course for a one week period. In addition the Joint Research Center for Reference Materials and Measurements (JRC-IRMM) in Geel contributed with 3 experimental activities covering a full day of the program. The contact between Mol, Geel and the participants was taken care of by the Haute-Ecole Spaak Brussels (HE Spaak). A task group of the local organizers FH Aachen, SCK•CEN Mol (represented by HE Brussels) and CVUT set up the detailed program. Due to the fact that academic calendars in Europe are differing vastly it is already extremely difficult to find a common period to gather a large number of different institutions for period of two weeks. This is the reason why the IP was planned with the number of minimum number of days set by the rules. A task group from CVUT, HE Brussels, and FH Aachen detailed the schedule of the course as well as logistics such as housing, transport, and excursions. The educational program was organized in such a way that experimental activities were in way introduced by a lecture giving an overview of the subject under special consideration of safety aspects related to the practice. The SCK•CEN installations cover practically all safety aspects encountered in nuclear industry (nuclear reactors, hot cells, environmental control...). IRMM is operating two accelerators which are also used as a source for fast neutrons. Thus it was decided to devote the first week to safety aspects in nuclear applications in research and industry. The research center FZ-Jülich covers of course the same aspects but has also an excellent infrastructure for medical applications (imaging, production of radiopharmaceuticals etc.) Also the educational laboratories of the FH Aachen offer the possibility to address safety aspects in medical imaging using X-ray tomography and nuclear medicine. Therefor the main emphasis in the 2nd week was placed on imaging techniques and related safety aspects.

### 3. The course

Participants were assigned to three groups which were working together during the exercises. The participants were instructed that the assessment at the end of the course would include the performance in the presentation of the synthesis of the results. To avoid that students would concentrate primarily on exercises which they would have to present in the end, they were also told that new groups would be formed at the end of the course and that only then the individual tasks would be assigned. The course schedule
presented in table 1 lists the different lectures and experimental activities. The titles of the lectures, experimental activities, and excursions give an impression on the content. Even though some of the experiments performed at the research centers in Belgium are also offered in university laboratories, the surrounding and infrastructure of the large facilities enabled a close to “real life” experience. The different activities familiarized the students with a large variety of methods and tools. Depending on their home institutions some of the techniques were already known. On the other hand the experience to work in a mixed group in an entirely new surrounding was stimulating everyone. A very intense working atmosphere developed in the preparation of the final presentation at the end of the 2nd week. Since new groups had been formed the students had to interact strongly to gather all the information.

The ALARA workshop posed an additional challenge to the participants. They had to present a paper detailing the implementation of the ALARA principle for practices either of their own working environment or from examples which attracted their interest. Experiences from this activity will be presented in another contribution to this conference.

(2)

<table>
<thead>
<tr>
<th>Stage of the project (start-end dates)</th>
<th>Activities undertaken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1 (18/03/12)</td>
<td>Travel from home, transfer to Mol from Brussels airport Registration, social event: welcome party</td>
</tr>
<tr>
<td>Day 2 (19/03/12)</td>
<td>AM: access formalities at SCK•CEN, Introduction to the course, presentation of first week, presentation of participants Lecture L4: Dosimetry in radiation protection Lecture L2: Radiological emergencies PM: SCK•CEN: 3 exercises in parallel E1: Activation measurements at the reactor BR1 / E2: Radiological emergency exercise / E3: Anthropopogammetry</td>
</tr>
<tr>
<td>Day 3 (20/03/12)</td>
<td>AM: Lecture L3: Health risks of radiation and radioactive contamination SCK•CEN: 3 exercises in parallel E1-E2-E3 PM: visits at SCK•CEN geological waste disposal (HADES), hot cells</td>
</tr>
<tr>
<td>Day 4 (21/03/12)</td>
<td>AM: visit of Belgoprocess (radioactive waste treatment) PM: Lecture L1: Activation analysis: applications and safety aspects SCK•CEN: 3 exercises in parallel E1-E2-E3 Evening: social event: course dinner 1</td>
</tr>
<tr>
<td>Day 5 (22/03/12)</td>
<td>AM: presentation of IRMM IRMM: 3 exercises in parallel E4: Safety training / E5: Dose mapping / E6: Cross section measurement PM: IRMM: 3 exercises in parallel E4-E5-E6</td>
</tr>
<tr>
<td>Day</td>
<td>Activities</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>6 (23/03/12)</td>
<td>AM: ALARA workshop&lt;br&gt;PM: IRMM: 3 exercises in parallel E4-E5-E6</td>
</tr>
<tr>
<td>7 (24/03/12)</td>
<td>Transfer to Jülich</td>
</tr>
<tr>
<td>8 (25/03/12)</td>
<td>Cultural activity: visit of the city of Köln</td>
</tr>
<tr>
<td>9 (26/03/12)</td>
<td>AM: presentation of the second week&lt;br&gt;lecture L5: Control of environmental radioactivity&lt;br&gt;lecture L6: radioactive waste monitoring&lt;br&gt;lecture L7: Positron emission tomography and its safety aspects&lt;br&gt;Radiation protection briefing&lt;br&gt;PM: 3 exercises in parallel&lt;br&gt;E7- PET scanner / E8- X-ray fluorescence and X-ray tomography / E9- Radioactive waste monitoring</td>
</tr>
<tr>
<td>10 (27/03/12)</td>
<td>AM: lecture L8: X-ray techniques and their safety aspects&lt;br&gt;3 exercises in parallel E7-E8-E9&lt;br&gt;PM: visit to research centre: MRT/PET installation</td>
</tr>
<tr>
<td>11 (28/03/12)</td>
<td>AM: 3 exercises in parallel E7-E8-E9&lt;br&gt;PM: Conference-debate ‘radiological safety aspects in the countries of the CHERNE-members’&lt;br&gt;Supervised synthesis of results&lt;br&gt;Evening: social event: course dinner 2</td>
</tr>
<tr>
<td>12 (29/03/12)</td>
<td>Supervised synthesis of results, preparation of exam and presentations&lt;br&gt;Meeting of the IP task group (CVUT, HE Spaak, FHA, U.Coimbra)</td>
</tr>
<tr>
<td>13 (30/03/12)</td>
<td>AM: MCQ exam, presentation of the synthesis by the students&lt;br&gt;PM: meeting of the jury + filling evaluation forms&lt;br&gt;Round table: discussion and evaluation of the course by the students&lt;br&gt;Social event: Farewell drink</td>
</tr>
<tr>
<td>14 (31/03/12)</td>
<td>Departure, transfer to airports, travel back home</td>
</tr>
</tbody>
</table>

Table 1: Activities at the IP SARA in Mol and Jülich

![Fig.2 Discussion during an experimental activity](image)

4. Assessment

To assess the course not only the performance of the students had to be evaluated but may be even more important the feedback from the participants. As mentioned earlier the assessment of the students was not only based on a simple knowledge check. One major problem in the assessment of students from different countries is the language. The course was taught entirely in English language, but students were selected according to their performance in the major chosen and not according to their performance in the English language. To minimize the influence of the language the knowledge based assessment was performed using a multiple choice test. Still the results revealed that some students had problems in understanding the questions and the different choices. For the final grade a jury of participating teachers also evaluated the individual
contribution and performance of each student in the presentation of the final results and in the discussion parts of the course. The CVUT issued a certificate awarding the course with 4 ECTS credit points. 6 out of the 10 participating institutions (1 institution did not send participants) recognize the course as an elective module or as a substitute to other modules in their study program, 4 universities do not include the course in their study program and acknowledge the ECTS points as an external activity. On the other hand the students gave their feedback to the course filling a questionnaire and during a round table in which participants and teaching staff reflected the course. Ranking from 1 to 5 the average score of the student questionnaire was 2.0. Averaged scores ranged between 1.2 and 3.1. Very much appreciated were the excursions and social events during the course. The students were somewhat disappointed that there was not enough time for discussion and comments after their presentations.

5. Discussion

The course had an overall very positive feedback from the participants. They were enthusiastic to have experienced an exciting scientific program in conjunction with the possibility to make contacts to fellow students from other European countries. In this respect the course was very successful. Considering that many activities were guided by researchers from SCK•CEN and JRC-IRMM and scientific staff from FH Aachen the course reached an extremely low ratio of students to teachers. In the experimental activities there were at most 6 students per tutor. These conditions cannot be reached in standard educational environments. On the other hand this ratio is required to successfully run a multinational and multidisciplinary group of students. This diversity in the knowledge of the participants represents a challenge in the design of such courses. It has to be tailored such that the level is not too high for the majority but that still there is challenging new information for those being more experienced in the respective field. It would thus be desirable that participants get early information on the subjects treated in the course and that they can interact with their local supervisors to ensure that basic understanding is present. The 2 weeks program is very tight. In the feedback to the course many participants stated that there wasn’t enough time to discuss the results and the presentations with the teaching staff. On the other hand it is very difficult to bring together such a multinational group of students and teaching stuff for a longer period. Another challenge to the organization is posed by the requirement of establishing sustainability. University budgets are not at all increasing in any European country and to convince sponsors from industry to invest in educational programs on radiation safety is especially in the period of a financial crisis an extremely difficult task if not a “mission impossible”.

Fig 3. Participants of SARA 2012
6. Acknowledgments

Without the hospitality and the engagement of the researchers from SCK•CEN, JRC-IRMM, and FZ-Jülich the course would not have been as successful as it was. Special thanks are due to Dr. Coeck and her crew from the Center of Education and Knowledge Management of SCK•CEN for the support during the stay in Mol. The authors gratefully acknowledge the financial support of the EU Education and Culture DG. The good spirit among the students was probably the most important contribution to the success of this course.

7. References

(1)  http://ec.europa.eu/education/erasmus/ip_en.htm
(2)  ETRAP2013-A0037 Sustainable Development, Alara Culture and Ethics in the E&T Programs of the Cherne Network, Janssens, H., contribution to this conference
EUROPEAN REGIONAL WORKSHOPS ON ESTABLISHING A NATIONAL STRATEGY FOR EDUCATION AND TRAINING IN RADIATION, TRANSPORT AND WASTE SAFETY. THE ROLE OF IAEA’S REGIONAL TRAINING CENTRES

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3. Greek Atomic Energy Commission

ABSTRACT

Two European Regional Workshops on Establishing a National Strategy for Education and Training in Radiation, Transport and Waste Safety were carried out in 2012, under the IAEA TC programme RER9109/9001/01 “Strengthening Education and Training Infrastructures and Building Competence in Radiation Safety”. The first one, in the English language was held in Vilnius, Lithuania, on 18-20 April, while the second one, in the Russian language in Dushanbe, Tajikistan on 16-18 May, respectively. The two Workshops were attended by 45 participants in total, coming from 25 Member States of the region. These workshops were organized and realized by the Agency and conducted by the IAEA’s staff, in collaboration with and the technical support of experts coming from the two IAEA’s European Regional Training Centres (RTCs), hosted in Belarus and Greece respectively.

The Specific objectives of the Workshops were: (a) To familiarize participants with the relevant IAEA safety standards and guidance, providing requirements for education and training in radiation safety and supporting the development of national strategies; (b) To brief participants on mechanisms to collect information and type of information necessary to the development of national strategies, including regulatory framework for education and training, human resources and training infrastructures in radiation safety; and (c) To collect from Member States preliminary information for the development of national strategies, including regulatory framework for education and training, human resources and training infrastructures in radiation safety.

The Expected Outputs of the Workshops were: (a) Dissemination of IAEA methodology for developing national strategies for education and training in radiation transport and waste safety; (b) identification of areas where the national regulatory framework for education and training in radiation safety needs to be improved; and (c) draft of Member States’ radiation safety profile.

The present paper, focuses on the crucial role the RTCs are assigned in the development of competence at the regional level and in disseminating among the Member States, in collaboration with the IAEA, the methodology to establish a national strategy for building competence through education and training. Furthermore the final conclusions on the outcomes of the aforementioned regional workshops on Establishing a National Strategy are presented and discussed.

1. Introduction

The IAEA Regional Training Centres (RTCs) for education and training in the field of radiation protection are centres that provide training in collaboration and with the support of IAEA for all the Member States in region. The RTCs have to comply with the criteria established by the IAEA’s Steering Committee on education and training in radiation protection and radiation safety. They receive an IAEA Education...
and Training Appraisal (EduTA) mission and, on the basis of the outcomes of the mission, a long term agreement is signed between IAEA and the authorities the Member States hosting the RTC.

According to the 9th Steering Committee Report, for the establishment and recognition of RTCs, the following agreed core criteria should be fulfilled:

- The distribution of actual and potential training centres within a region shall be taken into account in order to optimize resources.
- The training activities of a regional centre should be conducted in a language widely understood by potential participants.
- Regional centres should be established only in countries with adequate radiation protection infrastructure and national capability for training at the PGEC level.
- Countries hosting regional training centres should provide easy entry access for foreign participants, and be accessible by common transportation means.
- The regional centre shall be able to comply with Agency requirements and guidance on training.
- The regional centre should have the resources to carry out the experiments and practical exercises needed for the PGEC and/or should demonstrate that it has the cooperation of all the necessary bodies to provide high quality education and training in the different practices addressed in the various modules of the standard syllabus.
- The centre should have an adequate administrative and logistic capability, appropriate training facilities, a methodology for selection of participants and trainers, and a formal system for assessing the students.
- The regional centre should have an appropriate quality management system in place for these training activities.
- The regional centre should have the ability to add value to its education and training activities by carrying out on-the-job fellowship training, conducting seminars, hosting workshops and refresher courses.

The RTCs in Europe are hosted in Belarus and Greece, providing training and support to other Member States. The RTC in Belarus is hosted in the International Sakharov Environmental University (ISEU) in Minsk, while the RTC in Greece is hosted in the Greek Atomic Energy Commission (GAEC) in Athens. The fulfillment of an IAEA's RTC's role, entails mainly the conduction of E&T courses in the Russian and English language respectively. Their main activity is the operation of the Regional Post Graduate Educational Course in "Radiation Protection and Safety of Radiation Sources", based on the IAEA's relevant syllabus [1]. The duration of this course is of 22 weeks and it is addressed to young professionals of the region, providing them with a sound basic knowledge in radiation protection. They also conduct specialized training courses with smaller duration in various thematic areas in the field of radiation safety, including nuclear security, emergency response, radiation detection techniques, medical applications of ionizing radiation, training-the-trainers courses etc.

According to the new IAEA's Strategic Approach to Education and Training in Radiation, Transport and Waste Safety 2011-2020, [2], Member States, supported by the IAEA, are invited to establish a sustainable education and training infrastructure that addresses national needs for building and maintaining competence in radiation, transport and waste safety. For that purpose they are invited to consider developing a national strategy for education and training, in compliance with IAEA safety requirements [3]. To this end, the RTCs are assigned a paramount role in the development of competence at the regional level and in disseminating among the Member States, in collaboration with the IAEA, the methodology to establish a national strategy for building competence through education and training [4].

The IAEA TC programme RER9109/9001/01 “Strengthening Education and Training Infrastructures and Building Competence in Radiation Safety” is designed and
implemented specifically for the needs of the European Region. In the framework of this project, two European Regional Workshops on Establishing a National Strategy for Education and Training in Radiation, Transport and Waste Safety were conducted in 2012. The first one, addressed to English speaking participants was held in Vilnius, Lithuania, on 18-20 April, while the second one, addressed to Russian speaking participants was held in Dushanbe, Tajikistan on 16-18 May, respectively.

The present paper deals with the role the RTCs in disseminating among the Member States, in collaboration with the IAEA, the methodology to establish a national strategy for building competence through education and training. Furthermore, it presents the specific objectives, the scope and nature, as well as, the expected outputs of the aforementioned two regional workshops on Establishing a National Strategy. The corresponding final conclusions on the outcomes of these Workshops are also discussed.

2. The role of RTCs in the establishment of National Strategies on E&T at regional level

The RTCs, along with their national network of collaborating institutions providing high quality services in the field of radiation safety education and training, in order to prove compliance with the criteria established by the IAEA’s Steering Committee on education and training in radiation protection and radiation safety. They have received upon request, an IAEA Education and Training Appraisal (EduTA) mission. Consequently they have already an agreed action plan as a result of this mission, which includes milestones to promote the establishment of the national strategy at national level; According to the new IAEA’s Strategic Approach to Education and Training in Radiation, Transport and Waste Safety 2011-2020, [5] their role is of paramount importance as the RTCs are expected to be the leading country in their region, providing their expertise and advice to other Member States in the region on how to establish the national strategy. In particular, RTCs can act as a resource for building competence in radiation, transport and waste safety within the regions being involved specifically in the following areas of work:

- Continued delivery of education and training activities;
- Collaboration with the Agency in the promotion of Agency safety standards and the development of standardized training materials;
- Assistance to individual Member States, in collaboration with the Agency, in establishing and implementing national strategies for building competence through education and training.

To this end, their main role in the region is the promotion of the IAEA approach to establishing the National Strategy on E&T, and the dissemination of the IAEA material to be implemented in the National programmes. They may also provide assistance to the Member States in the form of an action plan for establishing a national strategy and make provision for, delivery of an agreed E&T programme in the region. The role of the RTCs can be accomplished by:

- providing, upon request, expert missions to the Member States to support them establishing their National Strategy
- assisting upon request the Member States of the region to establish their Strategy and implement their National E&T programme
- providing E&T in the region, in order to create professionals, capable to support the implementation of the E&T strategy in their country
- organizing, conducting and hosting in collaboration with the IAEA, meetings, and workshops on how to establish the national strategy.
3. Background of the European Regional Workshops

According to the IAEA “Strategic Approach to Education and Training in Radiation, Transport and Waste Safety 2011–2020” [5], Member States are expected to establish sustainable education and training infrastructures through the development and implementation of national strategies to strengthen education and training in radiation, transport and waste safety. Within this framework, a draft document entitled “IAEA methodology for developing national strategies for education and training in radiation transport and waste safety” [4], was prepared to provide guidance to the Member States on how to establish the national strategies. One of the tools to disseminate this approach in the Member States is the organisation and the conduction by the IAEA in collaboration with its RTCs, of workshops dedicated to the establishment and implementation of National Strategies on E&T.

4. Realisation and Conduction of the European Regional workshops

The two European Regional Workshops on Establishing a National Strategy for Education and Training in Radiation, Transport and Waste Safety were conducted in 2012, under the IAEA TC programme RER9109/9001/01. The first one, in the English language was held in Vilnius, Lithuania, on 18-20 April, in collaboration with the Radiation Protection Centre of Lithuania. The second one, in the Russian language was held in Dushanbe, Tajikistan on 16-18 May, in collaboration with the Nuclear and Radiation Safety Agency of Tajikistan, respectively. These workshops were organized and realized by the Agency and conducted by the IAEA’s staff, in collaboration with and under the chairmanship and support of experts coming from the two IAEA’s European Regional Train Centres (RTCs), hosted in Belarus and Greece respectively.

The purpose of these Workshops was:

- To provide Member States with a general understanding of the IAEA methodology for developing a national strategy for education and training in radiation, transport and waste safety
- To familiarize Member States with the relevant IAEA safety standards and guidance, providing requirements for education and training in radiation safety and supporting the development of national strategies;
- To collect from Member States preliminary information for the development of national strategies, including regulatory framework for education and training, human resources and training infrastructures in radiation safety

The main Expected Outputs of Workshops were:

- Dissemination of IAEA methodology for developing national strategies for education and training in radiation transport and waste safety;
- identification of areas where the national regulatory framework for education and training in radiation safety needs to be improved;

The two Workshops were attended by 45 participants in total. The participants were representing 25 Member States of the regions as follows:

A. Workshop in Lithuania (English):
Albania, Azerbaijan, Bosnia and Herzegovina, Bulgaria, Croatia, Estonia, Georgia, Kazakhstan, Lithuania, the Former Yugoslav Republic of of Macedonia, Montenegro, Moldova, Romania and Serbia

B. Workshop in Tajikistan (Russian):
Armenia, Azerbaijan, Belarus, Kyrgyzstan, Latvia, Moldova, Russian Federation and Ukraine

The two workshops were conducted in the form of plenary sessions and in working groups. Experts gave presentations and reviewed the work of the breakout
groups. The main reference IAEA documents for the workshops, dealing with E&T issues [3], [4], [6], [7] were presented by the experts and discussed in plenary. The participants gave presentations on national regulatory frameworks for education and training and on human resources and training infrastructures in the field of radiation safety.

5. Outcomes from the participants’ presentations

In most of the Member States the existing legal and regulatory framework provides requirements for the E&T of individuals involved in radiation protection. There are also similarities concerning the requirements on the competence of those individuals. However, there are significant differences in the distribution of responsibilities and corresponding competencies of the relevant duties of specialists among the different Member States. The sum of the functions of the Qualified Expert (QE) and those of the Radiation Protection Officer (RPO), as stated in the IAEA Safety Standards, are distributed among the responsible person with highest level of responsibilities and the one with the medium and lowest level respectively. Most of the countries of the region have not adopted yet the IAEA’s terminology for QEs and RPOs [6], a fact that creates problems firstly in the harmonization of recognition requirements a secondly in establishing a common methodology to assess the national and mainly the regional training needs. To this end an additional obstacle to achieve harmonization among the countries of the region, is the fact the that among them, there are EU countries and also EU applicant countries whose legislation is in line with the EU BSS. According to the EU Standards the Radiation Protection Experts and the RPOs have similar but not the same functions and recognition requirements as stated in the IAEA’s BSS. It is emphasized that as far as the competencies of these specialists are concerned, efforts to achieve some harmonization among Member States of the region, is desirable and maybe a facilitating factor, in order to implement the IAEA methodology in establishing a National Strategy on E&T. Furthermore, differences in the methodology of organization of E&T in the Member States of region were denoted. The absence of a developed national wide methodology for evaluation of training needs in most of the Member States plays also a negative role in the establishment of the above Strategy. As the developed by the IAEA RAIS sytem, is implemented in the majority of Member States of the region, its complete exploitation can be a possible effective tool for collection information in order to asses the training needs.

6. Discussion and conclusions

The two European Regional Workshops on Establishing a National Strategy for Education and Training in Radiation, Transport and Waste Safety, conducted in 2012 and presented above, proved to be of great value in “kick-starting” the process to establish national strategies by way of disseminating the IAEA methodology for developing national strategies for education and training in radiation transport and waste safety. According to the presentations of the participants and the provided information in the workshops, it was shown that all Member States of the region have in place requirements and programmes for E&T on Radiation Protection, which however are not always relevant/compatible with the international BSS. It became clear that although data available were insufficient/inadequate, in most of the Member States of the region, there are elements that may consist a National Strategy for E&T, but no Member State has in place a single self standing document reflecting a National Strategy relevant to the IAEA safety standards so far. However, since the Guidance
document has only been available to Member States for less than 1 year, it is
understandable that only a limited progress in its establishment and implementation is
anticipated for the time being. According to the outcomes of the workshops, the main
instruments, resources available, and activities carried out to support Member States in
the region, to improve this situation are:

- The continuation of Regional project RER/9/109 on “Strengthening Education
  and Training Infrastructure, and Building Competence in Radiation Safety”;
- The continuation of the Regional Workshops on National Strategies for
  education and training in radiation, transport and waste safety, as a follow-up of those
  held in 2012 under RER/9/109;
- The support from IAEA Regional Training Centres (Belarus and Greece) in the
  European region.

To this end the role of the IAEA Regional Training Centres in the European region,
might be of great importance, as in principal, they can provide the Member States
with an example of a “model country” that has successfully established and
implemented the national strategy according to the IAEA methodology. In addition
they can assist upon request Member States of the region to establish their Strategy
and implement their National E&T programme, and provide expert missions for this
reason.

It also worth mentioning that the impact of the work for the region performed by
the two RTCs in Europe, hosted in Belarus and Greece, becomes more evident
considering the fact that in many neighboring countries the development of the
national radiological protection infrastructure is in progress. The need for
professionals capable of disseminating their knowledge on international and
European safety standards is constant. To this regard, both RTCs acknowledge their
responsibility as IAEA RTC to share their competence with these countries. In the
long term, the expected outcome is the creation of synergies among E&T and several
aspects of the national radiation protection programmes, such as the improvement of
safety culture.

7. References

[1] IAEA Training Course Series No. 18, Postgraduate Educational Course in
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IAEA, Vienna, 2002.
[2] IAEA, Strategic approach to education and training in Radiation, Transport and
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[6] IAEA, Radiation Protection and Safety of Radiation Sources: International Basic
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Requirements Part 1, GSR Part 1
Summary

This paper presents the public EUROPEAN DB ON E&T IN RP developed by the work package 6: database of training events and providers conform to the agreed standards. The public database is accessible through the ENETRAP II website and is thus available for all interested parties.

The objective of the WP6 in the ENETRAP project was focussed on the development of a database (DB) to collect the main education and training (E&T) events in radiation protection (RP) in Europe, as well as the information about the E&T providers, including its possibility of On-the-Job-Training (OJT) incorporating and an overview of institutes hosting on-the-job-training possibilities, conforming to the agreed standard identified in previous working packages (WP 3, WP 4). Such a move would add credibility to the recognition process and would help to provide reassurance to RPE candidates and to employers that the training obtained satisfies an agreed European standard.

Web access to the DB, where the users can do their searches through different easy mechanisms (a search box, a filtered search by different criteria, a search through a calendar, etc.). The categories included in the DB are those involved in the project ENETRAP II: E&T providers and E&T events. The database also takes special attention over the internships in the stakeholders’ organisations, with emphasis on coaching and/or mentoring schemes, whenever appropriate.

The events included in the DB are focussed on RPE, RPO and EW, belonging to different kind of training programmes as INITIAL, REFRESH, SPECIALIZATION, ON THE JOB TRAINING (OJT) PROGRAM and OTHERS and the training could be organized as different type event: COURSES/MASTERS, WORKSHOP and OPPORTUNITIES (grants, PhD topics, job offers). The ENETRAP DB database is composed by 3 modules.

The database module has the aim to store the information related to the E&T providers, the E&T events and the roles associated to the management: National Contact Point (NCP) and Global Coordinator (GC).

The maintenance module is the key point of all the system: allows the connection with the DB to the 3 roles (PROV, NCP and GC) with different levels of permission, and it is capable to generate the required notifications via email.

The web search module allows to the users looking for the required quality information about E&T in RP in an agile and easy way.

In the future, beyond ENETRAP II, EUTERP platform will take over from ENETRAP II embers to manage and maintain the DB.
1.- INTRODUCTION.

Ionizing radiation, whether of a natural or artificial origin, has a profound impact on numerous areas of human activity. One of the main purposes of ENETRAP-II Project is to provide reliable Education and Training references to the sectors that require specialized trained workers.

The ENETRAP II project has been focussed on develop European high-quality "reference standards" and good practices for education and training (E&T) in radiation protection (RP), specifically with respect to the RPE and the RPO.

These "standards" will reflect the needs of the RPE and the RPO in all sectors where ionising radiation is applied (nuclear industry, medical sector, research, non-nuclear industry).

The introduction of a radiation protection training passport as a mean to facilitate efficient and transparent European mutual recognition was another important goal of this project.

In the field of RPE training the ultimate goal has been focused in the development of a European mutual recognition system for RPEs and in the establishment of the mechanisms to disseminate, communicate and exchange E&T activities developed at the European level in a virtual dimension to increase the number of channels of communication with the scientific community and with society in general. With respect to the RPO role the desired end-point is an agreed standard for radiation protection training that is recognised across Europe.

These actions will contribute to facilitate mutual recognition and enhanced mobility of these professionals across the European Union.

The expected outcome of this project will be instrumental for the cooperation between regulators, training providers and customers (nuclear industry, medical sector, research and non-nuclear industry) in reaching harmonization of the requirements for, and the education and training of RPEs and RPOs within Europe, and is an important tool to building competence and career development in radiation protection to meet the demands of the future.

The specific objectives of the project have been reached through the project working packages. This paper presents the public EUROPEAN DB ON E&T IN RP developed by the work package 6: “database of training events and providers conform to the agreed standards”.

2.- OBJECTIVES

The objective of the WP6 in the ENETRAP project was focused on the development of a data base (DB) to collect the main education and training (E&T) events in radiation protection (RP) in Europe, as well as the information about the E&T providers, including its possibility of On-the-Job-Training (OJT) and incorporating an overview of the research institutes which have the possibilities to host on-the-job-training. Such a move would add credibility to the recognition process and would help to provide reassurance to RPE candidates and to employers that the training obtained satisfies a European standard.

The DB based on a Web access is an infrastructure where the users can do their searches through different easy mechanisms (a search box, a filtered search by different criteria, a search through a calendar, etc.). This database also incorporates an overview of institutes hosting on-the-job-training possibilities. Special attention will also be given to internships in the stakeholders' organisations, with emphasis on coaching and/or mentoring schemes, whenever appropriate. A link can be made with the existing ENEN database.
The DB has been elaborated conforming to the agreed standard identified in previous working packages belonging to the project (WP 3, WP 4), these requirements contained in the document [1] WD6.1 “Report on training events and training providers. Degree of conformity with the standards approved by the Steering Committee”. The agreed standards were approved in the intermediate ENETRAP II Steering Committee meeting (SCM) held on 28 March 2011, during the EUTERP Workshop and after several discussions carried out during the 4th SCM in Bucharest [3].

The DB was finalized at the end of February and the WP 6 has been testing and making the necessary setting to correct operation.

Considering that Radiation Protection professionals have a variety of responsibilities and specific professional aims, but there is a common need for:

- Basic education and training providing the required level of understanding of artificial and natural radiation;
- The opportunity to update and test acquired knowledge on a regular basis (Continuous Professional Development); and
- The standards for the recognition of skills and experience

The DB should be a good tool to help professionals to improve the professional development through E&T and maintain high level radiation protection knowledge.

3. EUROPEAN DATABASE OF EDUCATION AND TRAINING IN RADIATION PROTECTION

The system developed is composed by three modules:

DATABASE MODULE, focused to store the information related to the E&T providers, and E&T events.
MAINTENANCE MODULE, which allows, in an agile and safety way, the effective maintaining of the information contained in the DATABASE MODULE with the aim of being permanent actualized. This module allows the authorized people (by different roles of access) to manage the information, updating the information of the national contact points, the E&T providers and the E&T events. This module must be capable of generating the needed notifications required by the different actors to be informed of the actualized data of their self interest.
WEB SEARCH MODULE, that allows to the final users looking for the demanded information (E&T events and E&T providers) through different criteria.

The categories included in the DB are those involved in the project ENETRAP II: E&T providers and E&T events. The events included are those aimed to the RPE, the RPO and the exposed workers (EW) and they are categorized by the level of the event: initial training, refresh training, specialization training and other events like workshops, conferences, symposiums, etc., and opportunities like grants, PhD topics, job offers, etc. Through the place devoted to the E&T providers, the user can see all the information about the provider as well as all the active events at the moment of the search.

The design of a good management system, the MAINTENANCE MODULE, was the key point. This module permits defining different roles of access with 3 levels of permission: Providers, National Contact Points, and Global coordinator/ administrator of the system. This organization must allow sharing the tasks of the process between all the producers of the information. This permits to have the most actualized information in the DB in a self-sustainable system but with the level of quality necessary to offer the best events to the users.
3.1 DESCRIPTION OF THE DATABASE
As we have mentioned, the events are focussed on RPE, RPO and EW, belonging to different kind of training programmes as INITIAL, REFRESH, SPECIALIZATION, ON THE JOB TRAINING (OJT) PROGRAM and OTHERS and the training could be organized as different type event: COURSES/MASTERS, WORKSHOP and OPPORTUNITIES (grants, PhD topics, job offers)
The information included in the database is:

<table>
<thead>
<tr>
<th>RECORD</th>
<th>ABBREVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>E&amp;T Events</td>
<td>EV</td>
</tr>
<tr>
<td>E&amp;T Providers</td>
<td>PROV</td>
</tr>
<tr>
<td>National contact point (local coordinator)</td>
<td>NCP</td>
</tr>
<tr>
<td>Global coordinator</td>
<td>GC</td>
</tr>
</tbody>
</table>

Table 1 Records registered in the DB

3.2 MAINTENANCE MODULE.
The maintenance module is the restricted area of the web site, where the different roles (PROV, NCP and GC) can access after logging into the system
Due to the different capacities of acting and responsibilities over the system, different roles have been established in order to manage the data maintenance module as is shown in the table 2.

<table>
<thead>
<tr>
<th>ROLE</th>
<th>DESCRIPTION OF TASKS</th>
</tr>
</thead>
</table>
| E&T provider | • Update the information related to their organizations.  
• Create/disable E&T events of their own institutions.  
• Modify the information of those events. |
| National Contact Point | • Create/disable PROV in the system of their own country  
• Modify the information of those PROV.  
• Publish the EV of their PROV  
• All the tasks associated to the E&T Providers. |
| Global Coordinator | • Create/disable NCPs in the system.  
• Modify the information of the NCPs.  
• Evaluate the conformity of the EV of their PROV: INDEPENDENT ENTITY-EUTERP  
• All the tasks associated to the NCPs. |

Table 2. Roles of the maintenance module and their tasks
3.3 WEB SEARCH MODULE OR WEB PORTAL.

The results of the previous modules are materialized in the web search module. This application is a web portal of free access, where the final users can search the information of their interest. The portal is the ENETRAP DATABASE which includes an email for contact, the accessibility logo and the static text: 2011 © ENETRAP II-project.

The menu structure is shown in the next figures:

![Figure 1. Providers page](image1)

![Figure 2. Event page](image2)

4. CONCLUSIONS.

The DB based on a Web access, is a new tool or infrastructure where the users can do their searches through different easy mechanisms (a search box, a filtered search by different criteria, a search through a calendar, etc.). The database is open, is easy to use and with a quality control protocol in order to check and actualize the data. The categories included in the DB are those involved in the project ENETRAP II: E&T providers and E&T events. The database also takes special attention over the internships in
the stakeholders' organizations, with emphasis on coaching and/or mentoring schemes, whenever appropriate. The events included are focused on RPE, RPO and EW, belonging to different kind of training programs as INITIAL, REFRESH, SPECIALIZATION, ON THE JOB TRAINING (OJT) PROGRAM and OTHERS and the training could be organized as different type event: COURSES/MASTERS, WORKSHOP and OPPORTUNITIES (grants, PhD topics, job offers).

ENETRAP Database is a complete management system and web based to spread R&P events. The system has two parts: 1) the first one to manage the different levels of users and the relationship between them and the loading of the events, and 2) the second one which consists off a visualization system with searching capabilities and selecting possibilities. Both are been included in a CD which includes

1) Documentation:
Users Guide: Containing all the information relative to how to use the Enetrap Portal. Installation and Configuration and which contains all the information relative to how to install the portal and all the details about its configuration

2) Software needed to install the portal
DataBase – Contains the Enetrap data in sql format
LiferayPortals – Contains all the neccesary lar files to configure the portal
LiferayPortlets – Contains all the neccesary portlets to configure the portal
Software Base – Contains the recommended bundle (Liferay Portal on Tomcat).

During ENETRAP II project, the managers were the ENETRAP II members, and the first providers included. After now, EUTERP will take over, and we expect the number of E&T providers will be incremented with all of those interested providers.

From this kind of system it's possible to extract highly valuable information of the searches of the users as user's country, number of pages visited, average time per visit...

5.- REFERENCES
2. Coek SCK•CEN, M., Minutes of the intermediate ENETRAP II Steering Committee meeting. 2011: Cyprus.
3. Coek SCK•CEN, M., Minutes of the fourth ENETRAP II Steering Committee meeting. 2010: Bucharest, Romania.
Employees, appointed to act as radiation protection officers (RPO) in hospitals, private practices, industrial companies (such as industrial radiography or pharmaceutical and biotech industry), nuclear installations or teaching and research institutions should have an adequate level of understanding of concepts related to radiation protection and understand the radiation protection issues pertinent to their radiation application. Therefore, the level and format of training required by an RPO is dependant on the complexity of that application. It is essential, on the European level, (i) to define requirements for the competencies of RPO according to their area of work and specific radiation protection tasks, and (ii) to establish European guidance or RPO training. This is the objective of the ENETRAP II Work Package WP3.

In order to cover RPO radiation protection training and work experience for all job categories and/or practices involving ionising radiation, 4 tables are proposed, summarising radiation protection courses and work experience necessary to act as RPO:

- Table RPO in the field of handling of radioactive substances, radiation sources, and practices in installations producing ionising radiation
- Table RPO in the field of x-ray equipment (does not cover x-ray equipment used for patients)
- Table RPO in the field of medicine
- Table RPO in nuclear power plants or research reactors

The variety of jobs/practices, which could be in all areas of medicine, industry or research has been grouped into a number of competence groups with appropriate subgroups. For each subgroup, radiation protection training courses and work experience are necessary to build competence. Learning outcomes based on the European Qualifications Framework (EQF) are proposed.

1. Introduction

As part of the ENETRAP project, education and training with respect to the Radiation Protection Officer (RPO) has already been given some consideration [1], although the main focus was on the Radiation Protection Expert (RPE). The RPO has been described as individual appointed by the licensee to "supervise or oversee the execution of the work (practices)". This description has been refined and discussed at EUTERP Workshops (EUTERP = European Training and Education in Radiation Protection Platform) [2] and finally, a definition of the RPO has been suggested to the European Commission (EC). This definition was adopted in the Draft Euratom Basic Safety Standards Directive - Version 30 May 2012 [3] which is still in discussion and will supersede the Council Directive 96/29/Euratom [4].
2. Role and function of the RPO

One of the findings of the ENETRAP project [1] was that there appears to be a sliding scale in approach to the RPO role. At one end of the scale (e.g., Ireland, the UK,), the role is restricted in effect to local supervision of working practices, requiring only a fairly basic understanding of radiation protection issues. In other countries (e.g., Germany, Finland, Croatia) the role is more substantial, requiring a more in-depth level of knowledge and ability in order to take a lead on radiation issues on behalf of the employer, which might include provision of training to the workforce, dose analysis, complex measurements etc. In these situations, the RPO is often formally approved by the relevant Regulatory Body. At the top end of the scale (e.g., France, Czech Republic), the role of the RPO is the primary radiation protection position with the input expected, and the degree of education and training required, being dependant on the complexity of the application.

The results of a questionnaire to the regulatory bodies in EU countries show a blurring of the margins between RPO and RPE. This is a factor that has an influence on the management of radiation protection expertise within a country and on the consequent approach to education and training. RPO and RPE can be the same person but in different roles/functions.

The RPO is often the point of reference for radiation protection and might even be the only one knowledgeable in radiation protection in an undertaking. As such, the RPO is the main contact point for the RPE as external adviser and for competent authority (for example, for radiation protection conditions of the license and during on site inspections of the authority).

The role of the RPO can be seen as interface between the licensee, the RPE and the regulator.

The RPO concept applies to all sectors. In the medical sector, there might be RPO and MPE (Medical Physics Experts) in the same hospital where the RPO carries out the tasks described above while the role of the MPE is mainly to take care of the radiation protection of the patient. However, some MPE might also have the function of an RPO in a hospital when appropriate.

In most cases, a person carries out the tasks of an RPO on a part-time basis, in addition to his other duties as an employee. For example, in undertakings where the use of radiation is incidental to the company’s main work such as gauges, static eliminators etc., the RPO is likely to be an existing employee with a role that already involves supervising general work with the sources of radiation. In industrial organizations where the use of radiation is fundamental to the main work of the company, such as industrial radiography and industrial irradiators, the person appointed by management to be the RPO is likely to have some existing background or some training involving radiation protection. For example, in an industrial radiography company, the RPO is likely to be a senior (or experienced) radiographer; in an industrial irradiator facility the RPO may be a production manager.

In medical facilities that use radiation there is likely to be a range of people with some background in radiation protection who may be suitable for appointment as RPO, for example, medical physicists, technicians, medical doctors etc.

In all cases senior management needs to ensure that the RPO is appropriately trained and competent in radiation protection and should ensure that the RPO is given sufficient time to carry out the required duties.

The specific duties and responsibilities of the RPO will depend very much on the practice being undertaken, and the availability of radiation safety expertise within the practice. In a large facility, for instance, the RPO may have well-defined functions relating to a specific area, with other RPO and radiation protection experts carrying out related duties in different parts of the plant as it is typically the case in nuclear power plants. By contrast, the RPO in a company with a straightforward application like a level gauge may be the only person with any knowledge of radiation safety and may have a wider range of duties to perform.

It follows that the duties of RPO are very dependant on the practice in which they work and the existing safety infrastructure of the facility. However, there are a range of ‘core duties’ that RPO are likely to carry out, regardless of the practice in which they work, such as:
- Supervision of work to ensure compliance with local rules and national regulations;
- Carrying out, or supervision of, workplace monitoring;
- Supervision of arrangements for individual monitoring;
- Keeping of source records;
- Responsibility for ensuring the maintenance of equipment and safety systems relating to the practice;
- Responsibility for ensuring the performance testing of new installations, or ensuring the validation of new procedures;
- Implementation of emergency plans.

In the majority of practices, the RPO role may only be a small component of the person’s work. In more complex practices, the role of RPO may be a full time post, or it may be divided among several people. Regardless of the approach adopted, however, it is very important that RPO receive sufficient training to carry out their function.

3. European guidance for RPO training

The European Qualifications Framework for lifelong learning (EQF) [6] relates different countries’ national qualifications systems and frameworks together around a common European reference – its eight reference levels. The levels span the full scale of qualifications, from basic (Level 1, for example school leaving certificates) to advanced (Level 8, for example Doctorates) levels. The eight reference levels are described in terms of learning outcomes. In the EQF a learning outcome is defined as a statement of what a learner knows, understands and is able to do on completion of a learning process. The EQF therefore emphasises the results of learning rather than focusing on inputs such as length of study. Learning outcomes are specified in three categories – as knowledge, skills and competence. This shows that qualifications – in different combinations – capture a broad scope of learning outcomes, including theoretical knowledge, practical and technical skills, and social competences where the ability to work with others will be crucial, as it is the case for RPO. For RPO, learning outcomes relevant for level 3 to level 6 might apply, depending on the tasks and responsibilities of the RPO (see Appendix 1, Ref. [5].

The European Credit system for Vocational Education and Training (ECVET) [7] aims to give people greater control over their individual learning experiences and make it more attractive to move between different countries and different learning environments. In this sense, it is a valuable tool for building RPO competence. The ECVET system is applicable for all learning outcomes which should in principle be achievable through a variety of education and learning paths at all levels of the European Qualifications Framework for lifelong learning (EQF), and then be transferred and recognised. This system therefore contributes to the wider objectives of promoting lifelong learning and increasing the employability, openness to mobility and social inclusion of workers and learners. It particularly facilitates the development of flexible and individualised pathways and also the recognition of those learning outcomes which are acquired through non-formal and informal learning. With this flexibility, the differing RPO training requirements in European countries can be overcome. At the end of the day, we have to answer the question: what learning outcomes in terms of knowledge, skills and attitudes are expected from an RPO to make him suitable for the job:

- **Knowledge**: aware of the regulatory requirements as far as it affects his specific situation (work), basic understanding of hazards and potential of harm, know how to apply local rules, basic understanding of radiation measurement techniques, etc.;
- **Skills**: ability to communicate in routine and anomalous situations, recognition of situations, where something is going wrong, effective communication with staff and management, keep records, manage documents, use of monitoring instruments and interpret results, etc.;
- **Competences**: Ability to supervise, ability to open and clear reporting, positive attitude towards safety in general, etc.
Even then, competence alone is not enough, having the required competences does not necessarily mean that a person is suitable to do the job. There are suitability considerations such as, for example, “speaking the language of the work floor”, having good and appropriate interpersonal skills and being in a a position to exercise some authority which have to be taken into account as well.

In Appendix 2, Ref. [5], examples of learning outcomes of RPO training are given in terms of knowledge, skills and competence elements for various EQF levels.

3.1 Guidance on building competence of RPO

The RPO is often the relevant point of reference for radiation protection in an undertaking. As such, the RPO is the main contact person for the employer and for the competent authority for radiation protection issues. Therefore, the employer needs to ensure that a person is appropriately trained and competent in radiation protection before appointed as RPO. In some European countries, there exists a regulatory framework specifying educational prerequisites and training contents and durations as well as the necessary experience needed to be appointed as RPO (for example in Germany, Austria and France). This framework provides guidance for the undertakings which training events are mandatory from the regulatory point of view and which other training activities offered by training providers or during conferences could serve to build additional relevant competence or refresh competence of RPO. In other countries, RPO competence requirements are not prescribed in detail, only core competences are defined.

Educational requirements

RPO should have as a minimum a secondary educational level corresponding to a scientific or technical curriculum including 10 to 12 years of schooling. However, the educational level of a radiation protection officer will be dependent on the skills and technical requirements of the job as well as on radiation protection needs. For some facilities, i.e. complex situations with the potential for significant dose, a tertiary educational level should be considered appropriate; for example, in some research establishments or, with respect to the appropriate use of advanced nuclear techniques or in some medical facilities.

Training requirements

The RPO must be provided with sufficient training to enable him to effectively carry out his supervisory duties. However, education and training are only two of a number of attributes that result in a person being both competent and suitable to act as an RPO for a practice. The provision of training covering the core information that is required for all RPO will provide an appropriate level of knowledge, but this will need to be re-enforced with practical experience of the application of this knowledge before the RPO can be said to be competent. The RPO may need to have further practice-specific training and experience before he is considered suitable for a specific practice. For example, an RPO may be considered to be competent and suitable for a straightforward practice, such as industrial gauges, if he has a good understanding of the core requirements of the RPO role, together with experience of applying this knowledge in the field. However, such a person will not be a suitable RPO for industrial radiography without first receiving additional training and experience on the radiation protection issues associated with this area of work. It follows that RPO training will fall into two categories: core training, common to all practices, and supplementary training related to practice-specific radiation protection elements.

The formal training of RPO should involve covering a core syllabus and, as appropriate, any supplementary content pertinent to the practice in question. The content may be covered separately (ie in modular form, core + specific 1 + specific 2 etc) or combined into a single course.

Classroom based training is unlikely to cover all the practical radiation protection and safety aspects and skills associated with specific work tasks; hence additional experience in the workplace and on the job training can be very effective in the overall training programme for
RPO. In this form of training the participant works in the normal place of work either under the direct supervision of, or with indirect input from, an experienced mentor. The participant’s progress and achievements may be recorded on a checklist of topics and tasks. On completion of the training it can be very useful for the trainer and participant to document the participant’s progress, the areas of competence gained and any further training needs.

**Work experience requirements**

Work experience relevant for working as an effective RPO in a specific practice may range between weeks and years, depending on the complexity of the practice, the level of radiation risk involved and the specifics of the working environment. For example:

- A potential RPO in a small facility where only XRF and XRD equipment would only need a few weeks work experience (assuming he was suitably qualified for his “normal” tasks) in order to exercise the RPO role. In this situation the radiation risks are low, the work routine and regulatory compliance straightforward to ensure.

- A potential RPO for industrial radiography employing both x- and gamma techniques would require substantial operational experience before taking on the role. The radiation risk is high, the work (probably) very dynamic in nature and regulatory compliance may be complex.

**Skills and attitudes requirements**

By definition a “competent and effective” RPO will also have specific personal attributes such as good communication skills and the ability to exercise sound judgement i.e. be capable of analysing a situation and coming up with a pragmatic course of action. A complete assessment of the competence of a person to act as RPO will also include an assessment of the person’s ability to apply knowledge effectively using these skills. This could be done, for example, by observing the person’s performance at work or by setting the person a scenario based exercise, designed to assess overall competence and performance to carry out.

3.2 **RPO training in different areas of work**

RPO are working in a variety of many different areas of applications of ionising radiation in the medical sector, in industry and research. In order to cover radiation protection training and work experience for all job categories/practices involving ionising radiation, typical competence groups are provided with course contents and duration, as an example for rather detailed regulatory requirements, partly containing elements of the radiation protection competence requirements of RPO in Germany. It should be noted that other sensible proposals for contents and durations may also serve the purpose.

In Appendix 3, Ref. [5], example tables for RPO training are given, divided into professional categories or competence groups, and including training contents and duration, covering the following areas:

- handling of radioactive materials and practices on installations producing ionising radiation (incl. accelerators and cyclotrons)

The variety of jobs/practices in this field (jobs could be in medicine, industry or research) has been grouped into 8 competence groups with subgroups as bullet points. For each subgroup, radiation protection training courses and work experience are necessary to build competence. For each course the duration is given in hours and the number given in the table indicates the content of the course. There are basic courses for RPO dealing with basic scenarios and basic courses for RPO dealing with complex scenarios. Depending on the practice, there are also special courses for RPO dealing with basic scenarios and less RP responsibilities and special courses for RPO dealing with complex scenarios and more RP responsibilities. Examples for course content and duration are given.

- medicine, dentistry
In the medical sector, there are a number of specialities, and each member of a professional
category could act as RPO. Therefore, each speciality is considered as separate
competence group. There are basic courses and special courses depending on the medical
speciality. Radiation protection training courses, their contents and duration are given.

- operation of x-ray equipment (technical, medical (without patients),
  veterinary medicine)

The variety of jobs/practices in this field (jobs could be in medicine, industry or research) has
been grouped into 6 competence groups with subgroups as bullet points. For each subgroup,
radiation protection training courses and work experience are necessary to build
competence. For each course the duration is given in hours and the number given in the
table indicates the content of the course. There are basic courses for RPO dealing with basic
scenarios and basic courses for RPO dealing with complex scenarios. Depending on the
practice, there are also special courses for RPO dealing with basic scenarios and less RP
responsibilities and special courses for RPO dealing with complex scenarios and more RP
responsibilities. Examples for course content and duration are given.

- RPO in nuclear power plants/research reactors.

Two groups of RPO are considered:

1. RPE working in the installation which have been assigned to act as RPO with full
   responsibility in radiation protection need a university degree, special training in radiation
   protection, practical experience in radiation protection and an in-plant training at the site
   where they will work. For keeping competence up-to-date, participation in refresher courses,
   conferences, etc. is suggested every 2 years.

2. Other professionals working in the installation which have been assigned to act as RPO
   with restricted responsibilities in radiation protection need some minimum educational level,
   special training in radiation protection, practical experience in radiation protection and an in-
   plant training at the site where they will work.

Duration for courses and practical experience are given as well as the content of the special
training in radiation protection.

The focus of training is on radiation protection, but also basic knowledge of nuclear safety is
important, since these issues are related in nuclear installations.

4 CONCLUSIONS

Employees, appointed to act as RPO in hospitals, industrial companies or teaching and
research institutions should have an adequate level of understanding of concepts related to
radiation protection and should also be acquainted with the safe and secure use of radiation
sources as relevant to the application. Depending on the complexity of the radiation
application and the associated radiation protection tasks, RPO need appropriate training in
radiation protection and, in some cases, a certain level of work experience tailored to the
specific needs to fulfil particular radiation protection tasks.

In order to define requirements for RPO competencies, the issue of role and function of RPO
has been considered at the European level. It should be noted that, other than the issues of
general competency and suitability, there is no prescription at the European or international
level of the "specification" of the individual being an RPO. The appropriate route to gaining
the level of competence required to be appointed as RPO will usually be a combination of
training plus relevant experience in the appropriate area of work. The main areas of RPO
work are considered and examples of appropriate elements of building competence of RPO
are given which could serve as European reference standards for RPO training.

The European Qualifications Framework for lifelong learning (EQF) and the European Credit
system for Vocational Education and Training ECVET might be useful tools in building
competence of RPO within Europe. Examples of knowledge, skills and competence elements
for various EQF levels are given which may be further developed to fit existing RPO training
activities.
5 References


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Qualification, accreditation & certification
ABSTRACT

Nuclear Techniques are widely used in different sectors in Morocco (Health, Industry, Agriculture, Research …). The use of ionizing radiation requires radiation protection measures for the workers, the public and the environment. This technological progress has been accompanied by significant involvement on the part of Morocco in international conventions and agreements in compliance with the IAEA recommendations.

Morocco is currently establishing a legislative framework and harmonized regulatory addressing both the radiological and nuclear safety and security. In addition, Morocco is in its final stages of adopting a new law on radiological and nuclear safety and security, and the creation of the agency to ensure control.

To accompany this progress, University of Ibn Tofail, has launched, since September 2010, the first national master on Radiation protection and Nuclear Techniques. This master aims to provide knowledge and know-how directly used in the various sectors using nuclear techniques and requiring radiation protection and nuclear safety and security to protect workers and environment.

The program was established with national and international institutions and Moroccan associations and some stakeholders. The presentation will describe the current state of radiation protection education in Morocco as well as the detailed program of the master. This program over 2 years includes mandatory modules and training graduation for a period of approximately 6 months in a professional environment. Among the students, there are some from francophone Africans countries; this will help to build skills in radiation protection in some African countries.

1. Introduction

After Morocco being one of the first African countries to join the International Atomic Energy Agency (IAEA) in 1957 [1], aware of the socio-economic impact of nuclear power, our country has launched a program of development of nuclear techniques applications in different sectors (education, agriculture, medicine, mining, and geology) and created several Commissions and Institutions since the early sixties:

Interministerial Commission for Atomic Energy (ICAE)

To this end, he proceeded in 1967 to the creation of the Interministerial Commission for Atomic Energy (ICAE) which was charged "to promote the peaceful use of any program of
Atomic Energy Agency to ensure the implementation and coordination in the areas of education, health, agriculture, industry, geological prospecting and scientific research" [2].

**National Centre for Nuclear Energy, Science and technology (CNESTEN)**

As part of its mission, ICAE conducted a prospective reflection on the direction of sectoriel programs and the possibility of the establishment of a “technical implementing agency” endowed, medium or long term, a research reactor to provide the products and services necessary for basic users. Thus germinated the idea of creation of the centre for nuclear studies in Morocco “National Centre for Nuclear Energy, Science and technology” (CNESTEN) founded in 1986 that aims to promote scientific research and nuclear applications in socio-economic sectors, to prepare the technological basis necessary for introduction of nuclear energy and to provide the State with technical support in the field of radiological safety and security. CNESTEN has a research nuclear reactor (2 MW Triga Mark II) and several specialized laboratories such as radiopharmaceuticals production, radioactivity analyses, Isotopic analyses, Electronic and Nuclear Instrumentation, Radiation protection and others laboratories.

**National Nuclear Energy Council (CNEN)**

The council was set up under the Prime Minister on May 1993, and is responsible for proposing to the government the orientations and objectives of national policy on the peaceful use of nuclear energy for economic, scientific and technological development purposes and for proposing measures to coordinate the implementation.

Various commissions have been set up under the council, including the Commission for the Coordination of Nuclear Activities, a Nuclear Regulation Commission and a Commission responsible for International Cooperation Programmes.

**National Nuclear Safety Commission (CNSN)**

This Commission was set up on December 1993 and is composed of scientific experts, the General Director of CNESTEN and representatives of the Ministers for the Interior, Health, Higher Education, Public Works, Transport, Agriculture, Employment, Energy, Environmental Protection and National Defense. The Commission gives its opinion on licensing applications and on the conditions attaching thereto as well as on any modification affecting the safety of a nuclear installation.

**National Centre for Radiation Protection (CNRP)**

This National Centre created in 1979 is under the Ministry of Health. The Centre controls the import, export, transport, storage and use of ionizing radiation’s sources. It centralizes all statistical data relating to protection against ionizing radiation and ensures application of radiation protection regulations.

**Association of Moroccan Nuclear Engineers (AIGAM)**

This cultural association created in 1985 is very active in Morocco. It includes engineers, professors, doctors, researchers in nuclear field. With its human capital and competence, AIGAM is strength of reflection and proposals in the nuclear field and accompanied during the past twenty seven years the development of nuclear applications especially in the field of health, industry, agriculture, environment, research and others.
Each year, AIGAM organizes an international event in cooperation with IAEA (International Atomic Energy Agency), CEA (Atomic Energy Commission, France) and others national and international organisms.

**Moroccan Radiation Protection Association (AMR)**

Created on 2002 and affiliated to IRPA (International Radiation Protection Association) since 2004, AMR has an important role to promote and to strengthen radiation protection at different levels (operators, regulators, education and research) through the organization of seminars, conferences, workshops,....Fifteen national and international events were organized by AMR with collaboration of others national and international associations and organizations.

**Moroccan Association of Medical Physics (AMPM)**

Created on 1996 and affiliated to IOMP (International Organization of Medical Physics) since 1997. The main aim of AMPM is to promote Medical Physics in its all aspects. AMPM succeeded in the organization of 2 important international events (1997 & 2008) and many national meetings. For Continuing Education Programme purposes, AMPM is organizing seminars and workshops periodically on different themes to update the knowledge of the local community of Medical Physicists.

AMPM militates for the recognition of the profession of Medical Physicist in Morocco with the collaboration of other associations and organizations like IAEA.

2. National regulation and legislation in radiation protection

The import, export, use, acquisition, storage, sale, transportation, transfer, transit, production of ionizing radiation sources are activities regulated by the national regulations [3].

National regulations based on law No. 005-71 of 12 October 1971 on protection against ionizing radiation:
- Lays down the fundamental principles intended to govern any activity involving radiological risks;
- Prescribes the establishment of a authorization system or declaration,
- Establishes exemption case, prohibition and sanctions.

In nuclear safety, Decree No. 2-94-666 7 December 1994 on the authorization and control of nuclear facilities designates the Ministry of Energy and Mines as the competent authority for nuclear safety.

Concerning radiation protection, there are two decrees of 28 October 1971 establishing the principles of radiation protection and general conditions governing activities involving radiation exposure on the one hand and designate the Ministry of Health as competent authority in radiological safety on the other.

The National Centre for Radiation Protection is the regulatory authority body in terms of radiological safety, has been operational since 1979 and is responsible for:
- Ensure the application of national legislation on radiation protection;
- Control all activities related to the use of ionizing radiation;
- Centralize the statistics and studies related to protection against ionizing radiation;
- Conduct radiological monitoring of workers assigned to work with ionizing radiation;
- Intervene in case of a radiological emergency;
- Contribute to the monitoring programs vocation radiological or nuclear
- Participate in information and training in radiation protection
Morocco is currently upgrading its legislative and regulatory nuclear device in accordance with international conventions and standards in the field. In addition, Morocco is in its final stages of adopting a new law on nuclear safety and security and radiological, and the creation of the agency to ensure control [4]. This authority will be fully resourced and will responsible for:

- Ensure compliance with legislative and regulatory requirements;
- Develop a consistent approach to authorization applications;
- Conduct inspections relating to the safety and security.

National regulation in terms of training requires that all workers who may be exposed to ionizing radiation must receive appropriate training to the nature of the risk. The nature and frequency of training for different types of operations must be approved by the Minister of Health.

3. Education and Training in Radiation Protection in Morocco

On behalf of Article 28 of Decree No. 2-97-30 October 28, 1997, the regulatory requirements for radiation safety training that "Any worker may be exposed to ionizing radiation must receive training appropriate to the nature of the risk. The nature and frequency of training for different types of operations must be approved by the Minister of Health.

Also, any institution using ionizing radiation must:

- Prepare an appropriate Radiation Protection Program (RPP);
- Establish a practice Program Quality Assurance Program (QA);
- Ensuring appropriate human resources to ensure the implementation and maintenance of the RPP;
- Provide ongoing training and adequate practical exercises to workers;
- Appoint a competent person in radiation protection.

Regarding the Medical Radiophysics and according to Article 12 of Decree No. 2-97-132 October 28, 1997 "All nuclear medicine center or radiotherapy must have a medical physicist in charge of monitoring problems of medical physics and radiation protection in this service."

3.1. Current state of training in radiation protection in Morocco

The National Center of Energy, Sciences and Nuclear Technologies (CNESTEN) organizes regularly events:

- National workshops
- Regional workshops under the auspices of the IAEA
- Post-Graduate Education Course in radiation protection and safety of radiation sources (PGEC)
- Practical training for national and regional students.

The National Centre for Radiation Protection (CNRP) provides also:

- National workshops under the auspices of the World Health Organization (WHO)
- Regional workshops under the auspices of the IAEA
- Training Internships

These two state organizations benefit the greatest number of users in different sectors of activity and thus ensure better prevention and protection against the dangers of ionizing radiation.
3.2. Current state of education in radiation protection in Morocco

In recent years, we have noticed a decline in the nuclear science and engineering education at Moroccan universities. This study was conducted by the association in nuclear engineering (AIGAM) in collaboration with relevant bodies. This study has culminated in the organization of an international event in 2010 in Rabat in partnership with the International Atomic Energy Agency (IAEA), the Atomic Energy Commissariat (CEA-France) and other national and international institutions [5].

However, Moroccan universities offer some modules in radiation protection depending on the university curriculum. Faculty of Medicine provides training in radiation protection integrated into the curriculum of medical education and curriculum specialties of radiology, radiotherapy and nuclear medicine. As well medicine of work provides education on professional risks of ionizing radiation, regulation, prevention and medical surveillance of personnel exposed to such radiation. This can promote good attitudes to radiation protection and safe use of ionizing radiation.

Some faculties of science offer also modules in radiation protection for post-graduate students to give basic knowledge directly usable in professional activities within the nuclear science and engineering.

4. National Master Program in radiation protection at University of Ibn Tofail

4.1. Objectives

Following the development of the uses of ionizing radiation in the different sectors in our country and due to the growing demand for education in radiation protection, we have launched in September 2010 at University of Ibn Tofail a national master in radiation protection and nuclear techniques. This master aims to provide solid knowledge in the fundamental and complementary areas related to the principles and practice of ionizing radiations, nuclear instrumentation, and radiation protection measures required for workers, public and environment. It also aims to prepare students for research in related fields.

The structure and content of this Master's program has been designed in collaboration with relevant international and national institutions and associations. The international institutions are: National Institute of Nuclear Science and Technology (INSTN-Saclay, INSTN-Grenoble), Laboratory of Climat and Environment (CEA-CNRS, France) and Biophysics Unit at the University of Sousse (Tunisia). On the other hand, the national organisms are: CNESTEN, CNRP and the associations: AIGAM, AMR and AMPM.

The master is accredited at 3 successive levels respecting local recommendations and national standards: Institution, University and National Commission (CNACES) charged of accreditation. The master is open for graduates' students at national and regional levels where in each promotion we have 2 students from sub-Saharien countries.

4.2. Course contents

4.2.1. First phase

The program of the master is over 2 years and the first phase consists of 12 required modules. Each module is in the form of lecturers, seminars, supervised work, practical work and technical visits taking a volume hour of 80h. Every 2 weeks, the students present seminars on a topic of their choice related to the master's program. They attend also national events such as conferences, workshops where they are requested to present a detailed report, it contributes to their education. The modules required for the 3 semesters and internship are regrouped in the table 1.
Table 1: Program Design

<table>
<thead>
<tr>
<th>M1</th>
<th>S1</th>
<th>Mod1: Complements of de Mathematics and Statistics and English</th>
<th>Mod2: Interaction Radiation-matter and Nuclear Detection</th>
<th>Mod3: Nuclear Physics and particle accelerators</th>
<th>Mod4: Thermohydraulic and Molecular Spectroscopy</th>
</tr>
</thead>
<tbody>
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<td></td>
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</tr>
<tr>
<td>M2</td>
<td>S2</td>
<td>Mod5: Programming codes and Project Management</td>
<td>Mod6: Exposition, Dosimetry and Biological effects of ionizing radiation</td>
<td>Mod7: Radiochemistry, Behavior of radionuclides in the environment and applications</td>
<td>Mod8: Nuclear analytical techniques</td>
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<tr>
<td></td>
<td>S3</td>
<td>Mod9: Reactor Physics and Nuclear Safety</td>
<td>Mod10: Regulation, radioactive waste management and intervention in emergency situations</td>
<td>Mod11: Radiation protection</td>
<td>Mod12: Applications of nuclear techniques in (medicine, industry, agriculture and materials science)</td>
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<tr>
<td></td>
<td>S4</td>
<td>Internship in a professional organism and presentation of memory</td>
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</tbody>
</table>

M1: Master 1, M2: Master 2, Si: Semester i, Mod: Module

4.2.2. Second phase

For the semester 4, the students in this second phase have an internship of about 5 months in a professional environment followed by an oral presentation of memory. The internship organizations’ are CNESTEN, CNRP, Hospitals, OCP (Office Cherifien des Phosphates) and research Laboratories at Faculty of Sciences-Kenitra (FSK). Table 2 shows the fields of activities of the practice-integrated study phase.

Table 2: Overview of internship subjects

<table>
<thead>
<tr>
<th>Subject of Study</th>
<th>Organism of internship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation protection of the public and a family patient following a therapy with iodine-131</td>
<td>CNRP</td>
</tr>
<tr>
<td>Calibration of OSL dosimeter reader (Optically Stimulated Luminescence)</td>
<td>CNRP</td>
</tr>
<tr>
<td>Calibration of the Harshaw TLD 6600 dosimeter reader</td>
<td>CNRP</td>
</tr>
<tr>
<td>Calibration of dosimetry measuring instruments for radiation protection</td>
<td>CNRP</td>
</tr>
<tr>
<td>Radiation protection requirements’ optimization for the Gamma-ray Scanning Technique</td>
<td>CNESTEN</td>
</tr>
<tr>
<td>Dosimetric evaluation of industrial radiography operations in Morocco</td>
<td>CNESTEN</td>
</tr>
<tr>
<td>Design of a new device for removing an irradiated target dedicated to the production of iodine- 131from the reactor TRIGA Mark II</td>
<td>CNESTEN</td>
</tr>
<tr>
<td>Contribution of trace elements in the study of Basin Sebou systems Aquifer</td>
<td>CNESTEN</td>
</tr>
<tr>
<td>Qualitative and quantitative study of a Helium-3 Neutron Detector Gas</td>
<td>CNESTEN</td>
</tr>
<tr>
<td>Design a mounting for the study of luminescent materials at low temperatures</td>
<td>CNESTEN</td>
</tr>
</tbody>
</table>
Radiation protection study relatively to the project of iodine-131 production in the laboratories of CNESTEN

Validation test’s method and determination of the uncertainties in thermoluminescent dosimetry

Contribution to the validation of the Neutron Activation Analysis Technique (NAA) and realization of a management protocol database for sample analysis

Application of gamma spectrometry and counting alpha / beta total to the environment radiological monitoring study

Post service study of nuclear cardiology using thallium myocardial scintigraphy

Dosimetric monitoring by Positron Emission Tomography coupled with tomography (PET / CT)

Behavior of uranium issued from phosphogypsum in seawater

Study of uranium transfert issued from phosphogypsum in seawater

The Rutherford backscattering spectrometry, Applications to characterization thin films of ITO and ZrO2

Characterization of thin films by Rutherford backscattering spectroscopy (RBS)

| Radiation protection study relatively to the project of iodine-131 production in the laboratories of CNESTEN | CNESTEN |
| Validation test’s method and determination of the uncertainties in thermoluminescent dosimetry | CNESTEN |
| Contribution to the validation of the Neutron Activation Analysis Technique (NAA) and realization of a management protocol database for sample analysis | CNESTEN |
| Application of gamma spectrometry and counting alpha / beta total to the environment radiological monitoring study | CNESTEN |
| Post service study of nuclear cardiology using thallium myocardial scintigraphy | Department of Nuclear Medicine (CHU-Rabat) |
| Dosimetric monitoring by Positron Emission Tomography coupled with tomography (PET / CT) | Department of Nuclear Medicine (Private clinic-Rabat) |
| Behavior of uranium issued from phosphogypsum in seawater | OCP |
| Study of uranium transfert issued from phosphogypsum in seawater | OCP |
| The Rutherford backscattering spectrometry, Applications to characterization thin films of ITO and ZrO2 | Research Lab. (FSK) |
| Characterization of thin films by Rutherford backscattering spectroscopy (RBS) | Research Lab. (FSK) |

### 4.3. Opportunities

The master provides students with a board and complete vision of nuclear science and engineering. It opens up a wide range of jobs in various socio-economic sectors using nuclear techniques and requiring radiation protection. The master also prepare for careers in research in the case of continuing study thesis.

### 5. Perspectives and conclusion

We hope, through this master’s program joining training in nuclear techniques and applications of radiation protection, to meet the Moroccan medical and industrial professional needs.

We wish to extend our partnership with international organizations and the support of IAEA to improve the curriculum content of our Master and implement practical activities to achieve excellence and scalability needed in this profession in constant progress. We would like also to establish a school site and a library dedicated to radiation protection.

This master would provide and expand geographically an employment opportunities, not only in Morocco but also in African countries speaking French. It could also accelerate the formal establishment of a law recognizing such specialties locally and regionally.

We are also engaged with IAEA and PNS (Partnership for Nuclear Security) to introduce a module on Nuclear Security in the curricula of this master in October 2013 [6].

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IMPLEMENTATION OF THE UK SCHEME FOR RADIOACTIVE WASTE ADVISERS

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ABSTRACT

Council Directive 96/29/Euratom laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (the Basic Safety Standards) requires qualified experts to advise on radiation protection. In the UK a qualified expert for radioactive waste management and environmental radiation protection is known as a Radioactive Waste Adviser and a scheme has been implemented by the UK environmental regulators to recognise the competence of Radioactive Waste Advisers.

The three UK environmental regulators have worked together with the radiation protection profession to develop a Statement on Radioactive Waste Advisers. The Statement sets out how we will comply with our legal responsibilities relating to qualified experts as required by the Basic Safety Standards and provides information on how the scheme will be implemented. The Statement is accompanied by a Syllabus that sets out the required competences that an individual needs to achieve to be recognised as a Radioactive Waste Adviser.

The environmental regulators have set up an Approval Board to oversee the operation of the scheme for the recognition of Radioactive Waste Advisers. The Approval Board has members from the environmental regulators and the nuclear and non-nuclear industries. The involvement of industry members helps to ensure that the work of the Approval Board is well-informed, balanced and transparent.

The competence of Radioactive Waste Advisers will be assessed by an Assessing Body that has been approved by the Approval Board. The Assessing Body is independent from the environmental regulators and run by the radiation protection profession.

This paper will describe the Radioactive Waste Adviser scheme, the expectations the environmental regulators have of Radioactive Waste Advisers and the permit holders they advise and how we have involved the radiation protection profession in the development of the scheme.

1. Introduction

Council Directive 96/29/Euratom laying down the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (Ref. 1) (the Basic Safety Standards Directive) requires employers to appoint “qualified experts” to advise them about work with radioactivity that may affect people and the environment.
The Basic Safety Standards Directive has a very broad definition of what a qualified expert needs to be able to do; it describes qualified experts as:

“Persons having the knowledge and training needed to carry out physical, technical or radiochemical tests enabling doses to be assessed, and to give advice in order to ensure effective protection of individuals and the correct operation of protective equipment, whose capacity to act as a qualified expert is recognized by the competent authorities. A qualified expert may be assigned the technical responsibility for the tasks of radiation protection of workers and members of the public”.

In the United Kingdom the role of the qualified expert as defined in the Basic Safety Standards is undertaken by different roles specified in different legislation and regulated by different organisations. These include experts who can advise employers about personnel safety (Radiation Protection Advisers), patient safety, instrument calibration and maintenance, radioactive waste management and transport of radioactive materials.

This paper describes how a scheme has been implemented by the UK environmental regulators (the Scottish Environment Protection Agency, the Environment Agency and the Northern Ireland Environment Agency) to recognise the competence of qualified experts for radioactive waste management and environmental radiation protection. These qualified experts are known as Radioactive Waste Advisers.

2. Legislative requirements

The requirement for Radioactive Waste Advisers comes from the Basic Safety Standards Directive which requires employers to appoint qualified experts to advise them about work with radioactivity that may affect people and the environment.

The environmental regulators have a legal duty to ensure these requirements on permit holders are fulfilled as a result of the Basic Safety Standards Directions (Ref. 2, 3) issued to the Environment Agency and Scottish Environment Protection Agency by Government in 2000 and the Radioactive Substances (Basic Safety Standards) (Basic Safety Standards) (Northern Ireland) Regulations 2003 (Ref. 4). Article 38 of the Basic Safety Standards Direction requires that the necessary arrangements to recognise the capacity of qualified experts are put in place.

The environmental regulators implemented these requirements by appropriate conditions in permits issued to those wanting to accumulate or dispose of radioactive waste under the relevant Radioactive Waste Legislation (Ref. 5, 6) for the part of the UK they are operating in.

3. Why we needed a scheme for the recognition of Radioactive Waste Advisers

Each environmental regulator was using different internal procedures implemented by site inspectors for the recognition of Radioactive Waste Advisers and little information had been made available to those acting as Radioactive Waste Advisers or wanting to become Radioactive Waste Advisers on the regulators’ expectations. Each Radioactive Waste Adviser was recognised for an individual permit with no process for the general recognition for an individual to act as a Radioactive Waste Adviser across several permits. This led to potential inconsistencies in the recognition of Radioactive Waste Advisers and unnecessary repetition of submission and assessment of information for those wanting to be Radioactive Waste Advisers for more than one permit.

The environmental regulators believed that the system could be improved by implementing an independent UK-wide scheme for the recognition of Radioactive Waste Advisers that would:
• improve regulatory consistency;
• improve regulatory independence;
• provide clarity of requirements;
• provide transparency;
• make it easier for an individual to become a Radioactive Waste Adviser;
• reduce the regulatory burden on industry; and
• improve the ability of permit holders to comply with the requirements put on them by the environmental regulators.

4. How we developed the scheme: stakeholder engagement

Prior to developing the proposed scheme, the environmental regulators carried out extensive liaison with the radiological protection profession, the nuclear and non-nuclear industry and other interested stakeholders. This enabled us to draft proposals for the Radioactive Waste Adviser scheme on which we held a three-month formal public consultation (Ref. 7). Over fifty responses were received from a wide range of stakeholders across the nuclear and non-nuclear industries and these responses were analysed and published in a Consultation Response Document (Ref. 8).

Before the Consultation Response Document was published, we held a post-consultation workshop for stakeholders. The purpose of the workshop was for the environmental regulators to present a summary of the responses to the consultation on Radioactive Waste Advisers, share with delegates how we intended to respond to the issues raised during consultation and facilitate discussion of our proposals to seek delegates’ views on them so that we could formulate a robust and acceptable final statement on Radioactive Waste Advisers.

5. Statement on Radioactive Waste Advisers

In May 2011 the environmental regulators published a joint Statement on Radioactive Waste Advisers (Ref. 9) which set out how we would comply with our legal responsibilities relating to qualified experts as required by the Basic Safety Standards Directive, our expectations of Radioactive Waste Advisers and how a UK-wide scheme would be implemented for the recognition of Radioactive Waste Advisers.

The Statement gives our expectations of permit holders with respect to Radioactive Waste Advisers and makes it clear that the responsibility for ensuring that a Radioactive Waste Adviser is suitable for advising on a particular permit lies with the permit holder whilst responsibility for assessing competence as a Radioactive Waste Adviser lies with an independent Assessing Body approved by the environmental regulators.

A scheme is set out for the assessment of individual Radioactive Waste Advisers by an independent Assessing Body that has been approved by the environmental regulators. Individuals will need to demonstrate their competence to the Assessing Body and on doing so will be accepted by the environmental regulators as competent for providing advice on radioactive waste management and environmental radiation protection.

During the development of the Radioactive Waste Adviser scheme it was apparent that the nuclear industry was very keen to use Corporate Radioactive Waste Advisers where a group of individuals collectively provide the Radioactive Waste Adviser function for a site. The Statement sets up the framework for Corporate Radioactive Waste Advisers and sets out the administrative arrangements for the approval of Corporate Radioactive Waste Advisers.
The Statement put in place administrative arrangements for setting up the Radioactive Waste Adviser Approval Board to oversee the operation of the scheme, appoint one or more Assessing Bodies for assessment of the competence of individual Radioactive Waste Advisers and approve Corporate Arrangements for Corporate Radioactive Waste Advisers.

Transitional arrangements were also put in place to allow those individuals providing Radioactive Waste Adviser advice to be awarded grandfather rights until June 2016 by which time they will need to apply to an approved Assessing Body for recognition of their competence to act as a Radioactive Waste Adviser.

At the same time we also published a Radioactive Waste Adviser Syllabus (Ref. 10) and associated guidance documents that will be discussed further in the following sections of this paper.

6. Radioactive Waste Adviser Syllabus

The Radioactive Waste Adviser Syllabus is based on the basic syllabus for the qualified expert in radiation protection with a few additional items from the “additional material” list as published in EC Communication 98/C133/03 (Ref. 11). We added “Security of radioactive materials” to the syllabus which we felt should be included as this is a new topic since the EC syllabus was proposed. This was driven by the existence of significant effort in the field of radioactive source security in the UK since 2002 and the creation of a rigorous statutory regime implemented through the environmental regulators’ permit conditions since January 2006.

The competence required for each topic is based on three levels: General Awareness (GA), Basic Understanding (BU) and Detailed Understanding (DU). These levels are defined as:

**General Awareness:** knows that the topic exists and is aware of its significance to work activities in context. Also knows how and where to obtain help on the topic if needed.

**Basic Understanding:** has a basic understanding of the topic with a level of detail that allows the Radioactive Waste Adviser to apply it to familiar work activities in context. If necessary, the Radioactive Waste Adviser can research further knowledge using readily available sources and apply it in less familiar circumstances.

**Detailed Understanding:** has a good understanding of the topic and the underlying principles and can apply the knowledge in appropriate contexts. The Radioactive Waste Adviser can apply the knowledge working from basic principles to deal with situations in new or unfamiliar areas.

7. Guidance documents

The Statement provided a framework for the Radioactive Waste Adviser scheme and further information is provided in guidance to support the Statement. Guidance has been published on:

**Roles and Responsibilities of permit holders and Radioactive Waste Advisers** (Ref. 12) Explains that the environmental regulators fulfil their responsibilities in relation to qualified experts by requiring permit holders to appoint Radioactive Waste Advisers. It specifies what we mean by the term Radioactive Waste Adviser, what tasks we expect the Radioactive Waste Adviser to perform and the associated responsibilities of the permit holder.

**Suitability of Radioactive Waste Advisers** (Ref. 13)
Explains that a Radioactive Waste Adviser must be suitable for the particular permit holder that points them and that it is the permit holder's responsibility to determine suitability. It gives some guidance on how a permit holder might determine the suitability of a Radioactive Waste Adviser.

**Corporate Radioactive Waste Advisers** (Ref. 14)
Explains the environmental regulators' scheme for the recognition of Corporate Radioactive Waste Advisers for nuclear sites and how we expect permit holders to demonstrate that they have adequate Corporate Arrangements for Radioactive Waste Advisers.

**Requirements for Assessing Bodies applying to be approved for the assessment of Radioactive Waste Advisers** (Ref. 15)
Provides information on what needs to be submitted to the Radioactive Waste Adviser Approval Board by Assessing Bodies wanting to be approved for the assessment of competence of Radioactive Waste Advisers.

8. **Radioactive Waste Adviser Approval Board**

The Radioactive Waste Adviser Approval Board is composed of representatives from each of the environmental regulators and members of the nuclear and non-nuclear industries who have knowledge and experience of the requirements of a Radioactive Waste Adviser and the type of work they might be involved in. The inclusion of industry representatives is considered important to ensure a balance of views rather than just those of the regulators and to ensure that we operate in a transparent and fair manner.

9. **Assessing Body**

In June 2012, the Radioactive Waste Adviser Approval Board formally approved RPA 2000 as an Assessing Body for Radioactive Waste Advisers. Approval followed formal application which had been preceded by informal discussions with representatives of RPA 2000. RPA 2000 is a non profit making company, set up for the purpose of certifying competence in ionising and non-ionising radiation protection practice. It was established by four professional societies representing radiation protection professionals and is governed, operated and its functions fulfilled by members of the radiation protection profession.

RPA 2000 has published information for potential Radioactive Waste Advisers on its website (Ref. 16) and was ready to accept applications on 1 January 2013.

10. **Stakeholder engagement**

Throughout the development of the Radioactive Waste Adviser scheme stakeholder engagement has been essential to ensure that we implement a scheme that fulfils our regulatory requirements but also meets the needs of permit holders and the radiation protection profession. We have engaged with stakeholders at all stages of the development process and continue to do so through wherever possible through engagement with professional societies, industry groups and publication of information on dedicated RWA web pages and publication of RWA Update, an electronic information sheet distributed to over 700 stakeholders who have an interest in the topic.

11. **Conclusions**

The UK environmental regulators have found that extensive stakeholder engagement with the UK radiation protection profession has resulted in a high level of consensus on the
necessary competencies of a Radioactive Waste Adviser. In addition, this approach has created a high level of ownership of the arrangements by the UK radiation protection profession. The use of generous grandfather rights means that no existing practitioners in the field of radioactive waste management have been excluded. The appointment of an independent Assessing Body overseen by an Approval Board operated by the environmental regulators and including representatives from industry has resulted in a system that is based on peer review and is therefore very well-informed by practitioners and best practice.

12. References

3. The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 2000
4. The Radioactive Substances (Basic Safety Standards) Regulations (Northern Ireland 2003)
5. The Environmental Permitting Regulations 2010
6. The Radioactive Substances Act 1993
7. Qualified Experts for Radioactive Waste Management: A Consultation by the UK environment agencies
8. Qualified Experts for Radioactive Waste Management: Consultation Response Document
10. Radioactive Waste Adviser Syllabus (RWA-S-2)
11. Communication from the Commission concerning the implementation of Council Directive 96/29/Euratom laying down basic safety standards for the protection of the health of the workers and the general public against the dangers arising from ionising radiation (98/C 133/03)
15. Environment Agencies’ Guidance on Requirements for Assessing Bodies applying to be approved for the assessment of Radioactive Waste Advisers (RWA-G-4)
LEVEL OF EDUCATION AND TRAINING IN RADIATION PROTECTION IN THE CURRICULUM OF HEALTH PROFESSIONALS IN NORWAY

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Abstract

Introduction: Today, medical exposure is widely used outside radiological departments, and new technology allows for more advanced diagnostic and interventional procedures. During 2008 and 2009 the Norwegian Radiation Protection Authority (NRPA) carried out inspections at 52% of all Hospital Trusts (HT) in Norway. The inspections revealed lack of skills in radiation protection at 91% of the inspected HTs. Insufficient knowledge in radiation protection were mostly associated to medical exposure outside radiological departments. The purpose of this survey was to get an overview of the amount and level of education and training in radiation protection (RP) in the curriculum of health professionals who is involved with medical exposures. In Norway all educational institutions have to implement the European Qualifications Framework for lifelong learning, based on learning outcomes defined in Knowledge, Skills and Competence (KSC).

Materials and Methods: Information about education and training in RP was collected from 49 educational institutions for 13 different health professionals. A questionnaire were developed to collect information about the provided theoretical topics within RP, practical training, number of educational hours, defined learning outcomes and information about any exams to evaluate the obtained KSC in RP. We also collected information from professional societies and 15 HTs about the expectations to health professional’s knowledge about RP. The results were analyzed and compared with the recommended radiological protection training requirements given by ICRP publication 113.

Results: For the physicians we found that all groups except the nuclear medicine specialists have less training hours and KSC about RP in their curriculum than recommended by ICRP. Only nuclear medicine specialist of the physicians has learning outcomes and exams in RP in their education. For dental care most of the groups has more RP in their curriculum than recommended by ICRP. All educational institutions for surgical nurse have less education and training in RP than recommended. Most of the training topics in the education of radiographers has the same level and knowledge as ICRP recommend. Further, some results show a significant variation in skill, level and training hours between educational institutions. The result also shows that employers of HT expect that medical staff have more RP in their education.

Conclusion: It was found a substantial lack of learning outcomes in RP in the curriculum for surgical nurse and physicians except for nuclear medicine specialists. For some medical professionals it was significant variations between educational institutions. A challenge for the future work is to implement learning outcomes in RP in the curriculum for all medical professionals involved with medical exposures.

1. Introduction

Radiological examinations are the largest man-made source to collective effective dose (CED) in Norway, and contributed to 1.1 mSv per inhabitant in 2008 [1]. From 2002 the CED haven’t increased, but a change in the use of general modalities to a more frequent use of CT have been identified. Fluoroscopy is becoming more frequently used outside the radiological departments, and new technology allows for more advanced diagnostic and interventional procedures, which can results in higher patient and staff doses [2-3]. Furthermore, lack of radiation protection (RP) knowledge can increase the radiation risk to both patients and staff. Cardiologist has the highest personnel doses for medical staff and they have increased significantly the last decade [4]. During 2008 and 2009 the Norwegian Radiation Protection Authority (NRPA) carried out inspections at 52% of all Hospital Trusts (HT). The inspections revealed lack of knowledge in RP at almost all of the inspected HTs, mostly associated to medical exposure outside radiological departments [5]. Typical examples were:

- Staff were unable to identify the X-ray tube from the image intensifier of the C-arm
- Inadequate knowledge of the operating console
- Unknown with the three cardinal principles for staff protection
- No deliberate use of collimation and pulsed fluoroscopy

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The results from the inspections indicate a lack of education and training in radiation protection for healthcare professionals. The aim of this study was therefore to get an overview of the amount and level of education and training in RP in the curriculum of professionals who is involved in medical exposures.

EU recommends to establishment the European Qualifications Framework (EQF) for lifelong learning. The EQF aims to relate different countries' national qualifications systems to a common European reference framework. Individuals and employers will be able to use the EQF to better understand and compare the qualifications levels of different countries and different education and training systems [6]. In Norway, all educational institutions have to implement the EQF for lifelong learning based on learning outcomes defined in Knowledge, Skills and Competence (KSC) [6]. Focusing on KSC in RP in the education of health professionals who is involved with medical exposures, will hopefully also help to justification and optimization of medical exposure.

2. Materials and methods
Information about education and training in RP from 56 educational institutions for 13 health professionals was collected. Health professionals included in this study are all involved in use of ionizing radiation, but to a different degree. Table 1 shows the included health professionals and the number of educational institutions for each professional. All educational institutions in Norway which offer the study program for the professionals, was invited to participate in the survey.

<table>
<thead>
<tr>
<th>Health profession</th>
<th>No. of educational institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear Medicine Spesialists</td>
<td>1</td>
</tr>
<tr>
<td>Radiology Specialists</td>
<td>1</td>
</tr>
<tr>
<td>Interventional Cardiologists</td>
<td>1</td>
</tr>
<tr>
<td>Gastroenterologist</td>
<td>1</td>
</tr>
<tr>
<td>Orthopaedist</td>
<td>1</td>
</tr>
<tr>
<td>Medical Doctor</td>
<td>4</td>
</tr>
<tr>
<td>Radiographer</td>
<td>6</td>
</tr>
<tr>
<td>Surgical Nurse</td>
<td>11</td>
</tr>
<tr>
<td>Clinical Laboratory Technologist</td>
<td>8</td>
</tr>
<tr>
<td>Maxillofacial Radiologist</td>
<td>2</td>
</tr>
<tr>
<td>Dentists</td>
<td>3</td>
</tr>
<tr>
<td>Dental Hygienist</td>
<td>4</td>
</tr>
<tr>
<td>Dental Assistant</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56</strong></td>
</tr>
</tbody>
</table>

A questionnaire were developed and sent to the educational institutions to collect information about:

a) Topics and level in RP in the curriculum
b) Practical training
c) Number of training hours
d) Defined learning outcomes and information about any exams to evaluate the obtained KSC in RP

A separate survey among 21 Hospital Trusts (HT) collected information about the employer’s expectations for health professional’s knowledge in RP.
For all questionnaires we analyzed the answers and found the mean value and variation in results. Furthermore, the level of knowledge and the amount of training hours were compared with the recommended radiological protection training requirements given in ICRP publication 113. In case of uncertainty on how to interpret the answers, the actual educational institution or HT were contacted to clarify any misunderstandings.

3. Results
A total of 47 educational institutions responded to the survey. The mean response rate was 94% and varied from 61% to 100% for the different study programs. An overview of the amount of training hours for dental care professionals, surgical nurses and radiographers compared with ICRP recommendations are shown in figure 1. Within dental care most of the groups have more RP in their curriculum than recommended by ICRP, except dental assistants who have less training hours and knowledge in RP than recommended. All the 8 educational institutions for surgical nurses have less education and training in RP than suggested. For most of the training topics in RP, the education of radiographers has the same level and knowledge as ICRP recommends.

A significant variation from this study in skill, level and training hours between educational institutions are observed for some professions. Educational institutions for surgical nurses show a substantial variation in the amount of training hours in RP, varying from 1 to 6 hours (figure 2).

Figure 1: The mean number of training hours for dental assistants, dental hygienists, dentists, surgical nurses and radiographers compared with the recommended amount of training hours by ICRP.

Figure 2: The amount numbers of training hours in RP for surgical nurses from nine educational institutions (A-G).
For the physicians, all groups except the nuclear medicine specialists have less training hours and KSC for RP in their curriculum than recommended by ICRP. Interventional cardiologists and gastroenterologists don’t have any training in RP at all (figure 3).

Figure 3: The mean number of training hours for physicians compared with the recommended amount of training hours by ICRP.

Table 2 shows an overview of the training areas in RP and the revealed level of knowledge for radiology and nuclear medicine specialists in this study, compared with the suggested level from ICRP.

Table 2: Overview of the ICRP recommended RP training requirements for Diagnostic Radiology specialists (DR) and Nuclear Medicine specialists (NM) and the results from this study.
Level of knowledge is indicated with: l = low, m = medium and h = high.

<table>
<thead>
<tr>
<th>Training Area</th>
<th>ICRP DR</th>
<th>Study DR</th>
<th>ICRP NM</th>
<th>Study NM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic structure, x-ray production and interaction of radiation</td>
<td>m</td>
<td>l</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Nuclear structure and radioactivity</td>
<td>m</td>
<td>l</td>
<td>h</td>
<td>h/m</td>
</tr>
<tr>
<td>Radiological quantities and units</td>
<td>m</td>
<td>l</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Physical characteristics of the x-ray machines</td>
<td>m</td>
<td>l</td>
<td>l</td>
<td>l</td>
</tr>
<tr>
<td>Fundamentals of radiation detection</td>
<td>m</td>
<td>l</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Principle and process of justification</td>
<td>h</td>
<td>m/l</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Fundamentals of radiobiology, biological effects of radiation</td>
<td>h</td>
<td>m</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Risks of cancer and hereditary disease</td>
<td>h</td>
<td>m</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Risk of deterministic effects</td>
<td>h</td>
<td>m</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>General principles of RP including optimisation</td>
<td>h</td>
<td>m</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Operational RP</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Particular patient RP aspects</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Particular staff RP aspects</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Typical doses from diagnostic procedures</td>
<td>h</td>
<td>m</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Risks from fetal exposure</td>
<td>h</td>
<td>m</td>
<td>h</td>
<td>h</td>
</tr>
<tr>
<td>Quality control and quality assurance</td>
<td>m</td>
<td>m</td>
<td>h</td>
<td>m</td>
</tr>
<tr>
<td>National regulations and international standards</td>
<td>m</td>
<td>m</td>
<td>m</td>
<td>m</td>
</tr>
<tr>
<td>Suggested number of training hours</td>
<td>30-50</td>
<td>14</td>
<td>30-50</td>
<td>60+</td>
</tr>
</tbody>
</table>

A summary of the professions which have learning outcomes and exam in RP in their education is shown in table 3. Of the physicians, only nuclear medicine specialist has learning outcomes and exam in RP in their education.
Table 3: Overview of the health professions, showing professions that have learning outcome in RP in their syllabus and exam in the field RP.

<table>
<thead>
<tr>
<th>Health professional</th>
<th>Learning outcome</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear Medicine Specialists</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Radiology Specialists</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Interventional Cardiologists</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Gastroenterologist</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Orthopaedist</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Medical Doctor</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Radiographer</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Surgical Nurse</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Clinical Laboratory Technologist</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Maxillofacial Radiologist</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dentists</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dental Hygienist</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Dental Assistant</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Of the 21 HT, 15 answered to the questionnaire (response rate 71 %). The result shows that employers of HT expects that medical staff in general have more RP implemented in their education and to be better skilled to work with radiation.

4. Discussion
Training in RP is considered to be one of the most important factors in optimising medical use of radiation. International organizations (ICRP, IAEA, WHO and EC) have identified the significance importance of education and training in RP [2-7 8-9-10-11-12]. In the revised draft of the EURATOM Basic Safety Standard the requirements for education and training have been strengthen [11]. In addition have EC seen the need for updating their guidelines in RP for medical exposure [13]. ICRP have already published updated recommendations for education and training in their publication nr. 113, however they don’t include any recommendations for learning outcomes.

The overall response rate from the educational institutions was high (94 %) and comparable with similar study from Finland [14].The vocational education for dental assistants had the lowest response rate (61 %). One possible explanation for this could be that some of the educational institutions don’t offer the education each year.

Professions in dental care have an adequate level of knowledge in RP, compared with ICRP recommendations. All of them have also exams in the field of RP and learning outcomes in their syllabus. Doses from dental X-ray are however very low, nevertheless the number of examination is very high and they also perform a lot of examinations of children. Therefore is it important with good KSC in RP for dental care staff.

Surgical nurses are often involved in the use of C-arms during operations, and it is therefore important that they have KSC in RP. ICRP recommends that nurses who are assisting in X-ray procedures have between 8-12 training hours in RP. Result from the study shows that the mean number of training hours in the education for surgical nurses was only 4. For the 9 educational institutions the number of training hours varied with a factor 6. The low level of education in RP shown in this study can explain the lack of SKC in RP NRPA have revealed during previous inspections [5]. In Finland they also found that some educational institutions
didn't have any education and training in RP at all [14]. For those groups is it important to improve the RP in their syllabus in order to reach the recommended level of knowledge in RP, and to minimize the risk related to incorrect use of ionizing.

Radiographers have many tasks in medical imaging and need a high level of detailed knowledge and understanding of RP [2]. The mean reported number of training hours for radiographers were 112 and are within the recommended range defined by ICRP. All educational institutions reported that it was difficult to give an exact value for training hours, since RP is included in many fields and also included in the practice of the education. That may be the reason why radiographers in the Finish study had much higher (513) amount of training hours in RP in their education. Nevertheless, the level of KSC in the syllabus for radiographers is satisfying, compared with the ICRP recommendations. However, it could have been a requirement about recertification and Continuous Professionals Development (CPD), because of the rapid development in medical technology and for optimization purposes.

Results for general physicians show that they have very little RP in their education. In the syllabus for medical doctors they don’t have any learning outcome and only 2 hours RP in their education. That’s a lesser amount than ICRP recommend, but nearly the same as found in the study to Kourdioukova (2010) who analyzed the radiology education for medical doctors in Europe [15]. This result may explain why only few physicians have good knowledge about radiation doses and associated health risks [16]. Another study found limited radiation knowledge and use of guidelines for referring clinicians [17]. A challenge is how to increase KSC in RP for physicians.

Orthopaedists have only one hour training in RP in their education and gastroenterologists don’t have any training in RP at all in their education. ICRP recommends that medical specialists using X-ray systems have between 15-20 training hours in RP. These groups may have got their training in hospitals, after finish their education. Implementation of guidelines can be a good tool to develop KSC in RP. The European Society of Digestive Endoscopy promotes a RP guideline for endoscopic procedures, developed by a group of endoscopists and medical physicists [18].

Interventional cardiologist is not an own discipline in Norway, and that’s may be the reason why they don’t have any training in RP at all in their education. That’s a great distinction to the amount (20-30 training hours) ICRP recommends for interventional cardiologist. Interventional procedures can be complex and involve high doses of radiation for patient and staff. As mentioned earlier this is the profession that gets the highest personnel doses, which can gives, rise to concern. The question is if more KSC in RP in their education can optimize the fluoroscopic procedures and decrease the personnel dose?

The radiology specialists in this study have less than half of the amount of RP training hours in their education than the ICRP recommendations. Also half of the amount of training hours compared with the results from the Finish study [14]. Furthermore the level of knowledge for the different training areas in RP is also lower than recommended by ICRP. In addition an earlier survey in Norway has revealed large dose variations (in local Diagnostic Reference Levels, DRL) between HT which indicate an enormous optimization potential of radiological examination protocols [19]. It could be that more education and training in RP as key components of optimization of exposure can decrease the large dose variation in local DRLs. More focus on education and training in RP may be beneficial in the optimization process and may also decrease the large dose variations in local DRL.

The result also shows that employers of HT expected that medical staff had more RP in their education. However RP is practically absent in the syllabus for physicians and Norway as a non-member of EU is not obligated to implement the mandatory education program in RP given by the European Directive. Nevertheless, an RP regulation sets requirements to the
staff KSC in RP. Today many physicists at the HT have to give the education and training in RP to the users involved in medical exposure.

The use of learning outcomes KSC in RP is most likely a good help for students and for employers to comprehend the qualification of the professions. In addition it can be a tool to ensure that all workers in the same profession get the same level of KSC in Can KSC in RP improve the justification of medical imaging? The IAEA is promoting the triple A-concept [20]:

- **Awareness** about radiation risks
- **Appropriateness** to ensure that those referred for radiological examinations really need them
- **Audit** to check the effectiveness of the referral and related processes.

IAEA hope this will improve the understanding of justification, and if that’s correct it’s very important to improve the RP in the syllabus for physicians. The “triple A” concept are also adopted by Nordic radiation protection authorities in a statement concerning the increased use of CT in the Nordic countries [21].

### 5. Conclusion

This study has revealed large variations and lack of RP for some health care professions who are involved in medical exposures. Particularly for physicians, except nuclear medicine specialists, a substantial lack of RP in the syllabus was observed. One way to overcome this is to introduce mandatory RP in the education for physicians and specialists, as BSS require. For some medical professions it was a significant variation in the number of training hours in RP between educational institutions. This can be solved by using the ICRP recommendations.

A challenge for the future is to implement learning outcomes in RP in the curriculum for all medical professions involved with medical exposures.

### References


THE DEVELOPMENT OF A RECOGNITION SYSTEM FOR RADIOACTIVE WASTE ADVISERS

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ABSTRACT

In May 2011, the UK Environment Agencies published a statement on Radioactive Waste Advisers. The Radioactive Waste Adviser (RWA) is the term used to describe a specialist in radioactive waste management and environmental radiation protection. The RWA fulfils some of the functions of a qualified expert as described in the European Basic Safety Standards Directive, the other functions being carried out by other specialists in radiation protection required by legislation overseen by other regulators. The Statement requires employers who hold a permit for the accumulation or disposal of radioactive waste to appoint suitable RWAs for the provision of expert advice, and describes the required arrangements for the recognition of RWAs. The Environment Agencies also issued a detailed syllabus specifying the required knowledge and competencies of a RWA.

RPA 2000, a non profit making company, set up in the year 2000 for the purpose of certifying competence in ionising and non-ionising radiation protection practice has developed a certification scheme to fulfil the recognition requirements for RWAs. This scheme has been trialled over the past year and has been approved by the Environmental Agencies. The scheme was launched on 1 January 2013.

Attendance of training courses that cover the knowledge requirements of the RWA syllabus (and the passing of any associated examination) will be the primary method of demonstrating a satisfactory level of knowledge. A percentage of the evidence of competency provided by an applicant can be based on simulations rather than actual work for an employer, in circumstances where the applicant has had no direct experience of the specific topic e.g. a risk assessment for an airborne discharge of radioactive material. Training courses will also provide a useful way of developing this simulated evidence.

This paper will describe the RPA 2000 RWA certification scheme, and discuss the knowledge and range of competencies required of applicants.

1. Introduction

The European Basic Safety Standards Directive (Ref. 1) requires employers to consult qualified experts on a range of radiation protection issues. In the UK, the role of the qualified expert is implemented in part by the requirement for employers to consult a certificated Radiation Protection Adviser (RPA). However, due to the fact that the function of the RPA is specified in regulations made under health and safety at work legislation, the role of the RPA is limited to occupational exposure issues. The RPA duties do not cover general waste disposal or environmental issues. Radioactive waste management is controlled by environmental legislation regulated by the UK environment agencies, and although this legislation also requires expert advice to be obtained from a suitably competent person, no recognition or certification system had previously been created for this role.
In May 2011, the UK environment agencies published a statement on Radioactive Waste Advisers. The Radioactive Waste Adviser (RWA) is the term used to describe a specialist in radioactive waste management and environmental radiation protection. The Statement specified the requirements for a recognition system for RWAs. It also invited interested assessing bodies to develop a suitable recognition system and apply for approval. The assessing body RPA 2000 responded by developing and testing a scheme, making use of the experience gained in the development and operation of the RPA recognition system.

2. Background to RPA 2000

RPA 2000 was set up in 2000 as a non profit making company for certifying competence in radiation protection practice. It was established by four Professional Societies, namely the Association of University Radiation Protection Officers (AURPO), the Institute of Physics and Engineering in Medicine (IPEM), the Society for Radiological Protection (SRP) and the Institute of Radiation Protection (IRP), which has since been incorporated into SRP. The driver behind its creation was the implementation into national legislation of the 1996 Euratom Basic Safety Standards Directive (BSS) and the requirement for the recognition of qualified experts. This role was incorporated into the new Ionising Radiations Regulations 1999 (IRR99) as the Radiation Protection Adviser (RPA). The UK regulator, the Health and Safety Executive (HSE) published criteria of competence for RPAs, addressing both knowledge and practical competency, and IRR99 defined an RPA as “an individual who, or a body which, meets such criteria of competence as may from time to time be specified in writing by the Executive”. The RPA certification scheme developed by RPA 2000 was designed to assess both the adequacy of the knowledge of the individual and his level of competence, taking into account the HSE criteria. RPA 2000 is formally recognised by the UK Health and Safety Executive (HSE) as an assessing body.

The RPA certification scheme has now been running for 13 years, with over 700 RPAs obtaining certification. In that period the scheme has been reviewed and amended to reflect the experienced gained in its operation and is the only RPA certification scheme currently operating in the UK. At the request of the members of the professional societies associated with RPA 2000, it has also developed and launched competence certification schemes to assess the competence of:

- Persons wishing to act as a Laser Protection Adviser (LPA) under the Care Standards Act, and
- Persons wishing to act as an Ionising Radiations Instrumentation Specialist (IRIS).

Successful applicants in each of the three schemes are awarded the appropriate Certificate of Competence, which is valid for a period of five years and which can be renewed via points based renewal schemes.

3. The requirements of the Radioactive Waste Adviser

The current revision process for the BSS coincided with a review by the UK regulatory authorities of the implementation of the qualified expert requirements in the UK. This review concluded that a further qualified expert function was needed to cover the management and disposal of radioactive waste. The UK environment agencies (the Environment Agency (EA), the Northern Ireland Environment Agency (NIEA) and the Scottish Environment Protection Agency (SEPA)) carried out a comprehensive stakeholder consultation and subsequently issued a statement and associated guidance on the recognition of RWAs. This statement was published in May 2011 (ref 2). The Statement required employers who hold a permit for the accumulation or disposal of radioactive waste to appoint suitable RWAs for the provision of expert advice, and described the required arrangements for the recognition of RWAs.
Recognition was to involve the assessment of the competence of an individual to act as RWA, with competence being defined as:

“The combination of knowledge and experience that equips an individual or group of individuals to provide expert advice on radioactive waste management and environmental radiation protection.”

The environment agencies also issued a detailed syllabus that specified the topics that RWAs were expected to have knowledge and understanding on, and those where demonstration of experience was required. The topics were obtained from the syllabus for qualified experts given in EC Communication (ref 3) with further detail added to clarify the areas of knowledge and understanding expected of an RWA. The topics were also categorised at three different levels to reflect the extent of competence required. These levels were defined as:

- **General Awareness**: knows that the topic exists and is aware of its significance to work activities in context. Also knows how and where to obtain help on the topic if needed.
- **Basic Understanding**: has a basic understanding of the topic with a level of detail that allows the RWA to apply it to familiar work activities in context. If necessary, the RWA can research further knowledge using readily available sources and apply it in less familiar circumstances.
- **Detailed Understanding**: has a good understanding of the topic and the underlying principles and can apply the knowledge in appropriate contexts. The RWA can apply the knowledge working from basic principles to deal with situations in new or unfamiliar areas.

An extract of the syllabus is given in Appendix 1. The Statement and full syllabus can be found on the following website:  

The Statement also invited suitable organisations to apply as Assessing Bodies for the recognition scheme, and described the approval process that would be followed in determining the suitability of the applicant bodies.

4. **The creation of the RPA 2000 RWA certification system**

The experience gained in the operation of the three existing certification schemes placed RPA 2000 in a good position to develop and run a RWA certification scheme. This was helped by the fact that RWA recognition was to follow the established model of the assessment of knowledge and experience with a view to recognition of core competency. As with the RPA recognition system, the judgement of the suitability of a recognised RWA for a specific area of work would be the responsibility of the employer.

The policy of RPA 2000 is to support the introduction of new specialist certificates provided that:

- There is justifiable and demonstrable demand from the membership of the Constituent Societies for any proposed certificate.
- Interested and suitably experienced members, from the Constituent Societies, are prepared to form and maintain a Working Group (WG) to:
  - undertake the development of appropriate standards and to identify a sufficient number of potential assessors to make the introduction of the certificate a viable option; and
  - provide the Board of RPA 2000, for the lifetime of the associated Specialist Certificate, with ongoing support and effort in respect of the necessary scientific and
technical competence and manpower associated with maintenance of the Specialist Certificate.

Accordingly, a working group consisting of members of each of the constituent societies of RPA 2000 was set up to review the RWA Statement and draw up knowledge and practical competency requirements, using the existing RPA documentation as a template. The members came from all the sectors that would require RWA advice (nuclear, medical, education, industry) and hence were able to provide input on the specific RWA requirements of each sector.

The fact that both the RWA syllabus and that followed for the recognition of RPAs were based on the EC qualified expert syllabus (3) was a major benefit in the development of RWA knowledge and experience requirements. As with RPA recognition, the working group decided to develop a system where recognition would be based on the assessment of knowledge based evidence and experience based evidence, each being derived from the specifications given in the RWA syllabus. This approach requires the applicant to assemble a portfolio that is divided into 2 parts. In the first part the applicant provides evidence to demonstrate that they have the necessary knowledge at the appropriate level for each of the topics and sub-topics listed on the application form. This evidence may take the form of details of training courses attended and course assessments passed, or in-house training on specific subjects. The second part of the portfolio covers practical competence and workplace experience, and requires the applicant to submit evidence of practical competence for a range of topics and sub-topics for which experience is required.

A significant component of the knowledge and practical competency requirements specified in the RWA Statement duplicated knowledge and practical competency requirements in the RPA certification scheme. In view of this, the working group decided to separate out those topics that were common to both qualifications and those that were additional to the RPA requirements. Applicants who held RPA recognition would only be asked to provide evidence of knowledge and experience on those topics that were additional to the RPA recognition requirements.

The development of the RWA recognition requirements was completed by the autumn of 2012. The working group members then tested the process by assembling RWA portfolios themselves and circulating them around the group for assessment.

This testing process raised several minor points that could readily be addressed by minor amendments to the process. Demonstration of the knowledge requirements proved to be relatively straightforward, since training courses already existed covering the topics required. Provision of training course programmes and certificates of attendance generally provided sufficient evidence. The demonstration of practical competence proved more difficult and raised the concern that many applicants would not have the breadth of experience to provide evidence of experience on all the topics covered. This concern is illustrated by the Practical Competence requirements under the topic: Operational Radiation Protection, Hazard and Risk Assessment (including environmental impact). Under this topic, applicants were required to provide evidence of workplace experience for each of the following sub-topics:

- Radiological impact assessment methods
- Pathways by which radioactive discharges may lead to a public dose:
  - External
  - Airborne – direct ingestion
  - Airborne – deposition, followed by ingestion via food pathway
  - Airborne – inhalation
  - Liquid –direct ingestion (drinking water)
  - Liquid – ingestion via food pathway
  - Contact
• Bio-accumulation effects

Not surprisingly, some of the WG members had difficulty in providing evidence of experience for each of these topics, the range of the evidence available to each person being very dependant in the sector in which they worked. In view of this, and following discussion with a representative from the environment agencies (the required topics come directly from the syllabus for RWAs) the scheme recognition requirements were reviewed and amended so that evidence of experience need only be provided for about 60% of the sub-topics in each Topic (evidence from 5 of the 9 topics is now required for the example above). Further guidance was also drawn up to provide information on the type of evidence that would suffice for each topic. The environmental agencies reviewed the syllabus and made several changes, including the removal of the requirement for practical experience from the topics Critical group concept and Environmental monitoring.

The RWA Statement permitted simulation to be used for the generation of some of the evidence of practical experience. This would allow applicants to submit exercises and simulations carried out in workshops and training courses as part of their evidence of practical experience and competence. This route was not widely used in the trial, but may form an important component in the assembly of evidence of experience for applicants in the live scheme. This may be dependant on trainers providing training events that are tailored to provide this evidence.

The changes made significantly simplified the process of collating and submitting evidence of practical competence, while still retaining a high standard of assessment. The scheme was submitted for approval to the environment agencies in late 2012 and was approved with a launch date of 1 January 2013.

The scheme is now fully operational, and guidance for persons wishing to obtain RWA certification can be found on the RPA 2000 website (http://www.rpa2000.org.uk/). The members of the working group are currently acting as RWA assessors for new submissions and suitably experienced persons are also being invited to act as assessors. The environmental agencies’ Statement put transitional arrangements in place in the later half of 2012, which allowed persons who had been providing formal advice over the previous 5 years with regard to the disposal of radioactive waste to apply for grandfather rights to act as RWA. Over 400 persons have subsequently been issued with grandfather rights, which will remain valid until 30 June 2016, at which point full RWA certification will be required. It follows that there are only likely to be a limited number of applications for certification in the first few years of the scheme, but the number of applicants is likely to increase significantly as the 2016 deadline approaches. In view of this, RPA 2000 are currently looking for an incentive to encourage holders of grandfather rights to apply for full certification within next 4 years to avoid a surge in applications in 2016. A person’s RWA certification will have a period of validity of 5 years before renewal is required. RPA 2000 is currently developing a points-based certification renewal scheme by which applicants will be able to demonstrate that they have maintained and developed their knowledge and experience through continuing professional development.

5. Conclusions

The scheme that has been created is reasonably demanding, and will be a good test of an applicant’s competency in radioactive waste management and environmental radiation protection. It is also a pragmatic approach that avoids undue focus on academic attainment and qualification, which are not necessarily an accurate measure of competence. Only after several years have passed will it become apparent whether the scheme is pitched at the right level or whether it is too rigorous in term of the evidence required for practical competency. Even though RPA 2000 has provided a degree of flexibility over the evidence required for each topic, it may be that many advisers find it difficult to obtain recertification when their
grandfather rights expire. It should be noted, however, that the Environment agencies and RPA 2000 do permit simulation to demonstrate competence if it is not possible for an individual to gain real experience of some of the syllabus requirements. There is perhaps a role here for training providers to provide workshops where simulations can be carried out for the purpose of obtaining certification. Training providers in the UK have already reviewed and revised their training courses on radioactive waste management to ensure that their course syllabi cover all the required knowledge elements for RWA recognition, and simulation exercises could also be included in these courses.

The commonality between the RWA and RPA certification processes has major benefits. It permits common areas of competency to only be assessed once for both schemes and strengthens the knowledge and experience assessment approach to certification. The existence of both schemes ensures that the UK has a robust recognition process that fully satisfies the existing Euratom requirement for the qualified expert and the forthcoming requirement for the radiation protection expert.

6. References


## Appendix 1 Extract from the Radioactive Waste Adviser Syllabus

<table>
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<tr>
<th>Topic number</th>
<th>Topic</th>
<th>Content</th>
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<tbody>
<tr>
<td>13</td>
<td>Waste management</td>
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</table>
| 13a          | Radioactive waste    | - Sources of radioactive waste, waste types, waste classification and waste characterisation.  
- Principles of radioactive waste management: dilute and disperse, concentrate and contain, storage for decay and clearance from control.  
- The waste hierarchy:  
  - Avoidance  
  - Minimisation  
  - Reuse  
  - Recycle  
  - Disposal  
- Storage options for radioactive waste.  
- Treatment options for radioactive waste.  
- Management of disused sealed sources: technical options and safety aspects.  
- Disposal options for radioactive waste. | Yes                             |
| 13b          | Radioactive waste    | - Sampling methodologies and minimisation of secondary waste.  
- Assay methodologies:  
  - Uncertainties and limits in assay data  
  - Assay recording methods | Basic Understanding           |
| 13c          | Radioactive waste    | - Disposal options for radioactive waste.                                                                                     | Detailed Understanding         |
| 14           | Transport            | - Transport of radioactive materials:  
  - Packaging of radioactive materials and waste for transport  
  - Security of radioactive materials during transport  
  - Transport documentation – dispatch and receipt. | General Awareness              |

159 of 434  
20/03/2013
ESTABLISHING A NATIONAL STRATEGY FOR E&T IN RADIATION PROTECTION

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ABSTRACT

The establishment of a national effective and sustainable Radiation Protection (RP) system, demands an adequate number of trained personnel which in turn can be achieved with the implementation of a national strategy on Education and Training (E&T). The strategy contributes to the growth of national expertise through the development of national E&T programmes, taking into account the existing and future needs, having regard to the national capabilities and resources.

In Greece, a national strategy on E&T for building competence in radiation protection has been recently elaborated by the Greek Atomic Energy Commission (GAEC), which is the competent regulatory authority for radiation protection and nuclear safety, based on the relevant International Atomic Energy Agency’s document. The first step for its implementation is the collection of the national data concerning the E&T of all the occupationally exposed workers. The source for this input is GAEC’s national radiation protection database which includes among others, (facilities, inventory of sources, dose registry etc.), the educational level of the exposed workers in Greece. In the assessment of the E&T needs, the future needs, the national capabilities and resources were also taken into account.

A training programme tailored to meet national needs has been designed, and its implementation is under development. For that reason, curricula have been developed for various personnel categories such as, medical technologists, interventional cardiologists and industrial radiographers. According to the national strategy, three types of training courses are provided by GAEC.

- Planned short-term national training courses (usually on yearly basis).
- Ad-hoc additional training to specific groups due to emerging needs.
- Upon request by specific groups or companies (e.g. fire brigade, FLOs).

Finally, the effectiveness of the national strategy is monitored regularly in the framework of a QMS, implemented by GAEC, based upon the ISO 29990:2010. This includes, among others, self-assessment mechanisms and external appraisal.

In the present paper, GAEC’s initiatives concerning the establishment of a national strategy for E&T in RP are discussed.

1. Introduction

The International Basic Safety Standards [1] require as one of the main points of safety culture that the responsibilities of each individual for protection and safety shall be clearly identified and each individual be suitably trained and qualified. To this end, the government shall ensure that requirements are established for the education, training, qualification and competence of all persons engaged in activities relevant to protection and safety and that arrangements are in place for the provision of the education and training services required for building and maintaining the competence of persons and organizations.

As far as the regulatory body is concerned, the application of the requirements for education, training, qualification and competence in protection and safety, such that the application of regulatory requirements is commensurate with the radiation risks associated with the exposure situation, should be ensured. Responsibilities in relation to protection and safety are extended to relevant parties (persons or organizations responsible for facilities that give rise to radiation). In the frame of these responsibilities, they shall ensure that all
personnel engaged in activities relevant to protection and safety has appropriate education, training and qualification. Guidelines on how to meet requirements for education and training in radiation safety and in radiation protection aspects of nuclear, radiation, transport and radioactive waste are provided in the safety guide [2]. In any case, the establishment of a sustainable education and training programme based on the analysis of existing and foreseeable training needs and with an effective use of available human and physical resources at national and international level is required. In other words, it is required the establishment of a national strategy which will contribute to strengthen radiation safety by developing national expertise in a sustainable and effective way. The IAEA’s strategic approach to education and training recognizes the importance of Member States taking ownership of the tasks through developing and implementing national strategies to strengthen education and training in radiation, transport and waste safety to achieve the desired level of competence [3]. Moreover, according to [4] the government shall establish a national policy and strategy for safety, the implementation of which shall be subject to a graded approach in accordance with national circumstances and with the radiation risks associated with facilities and activities, to achieve the fundamental safety objective and to apply the fundamental safety principles established in the Safety Fundamentals.

In this work the initiatives received by the department of education and training of the GAEC, which is the competent regulatory authority for radiation protection and nuclear safety, for establishing a national strategy are described. GAEC acts as the IAEA’s Regional Training Centre (RTC) for radiation, transport and waste safety in Europe in the English language. Following the successful completion of an EduTA mission (2008), a long term agreement was signed, in 2011, between the government of Greece and the IAEA, to support GAEC as RTC in Europe. The agreement was ratified by Law (No. 4085, Official Gazette Folio No. 194, First issue) in October 2012. As an IAEA RTC, GAEC is expected to be leading country, providing its expertise and advice to other Member States in the region, on how to establish a national strategy. Taking that into account, the establishment of a national strategy for a country that hosts a RTC is of a great priority [5]. This priority is even higher for GAEC that at the same time is the national regulatory authority.

The process described in this work includes a number of linked phases that provide the answers to key questions [6]:

- **Assessment of education and training needs**, answering the question: “What is needed?”
- **Design of education and training programme**, answering the question “What is the education and training programme that will meet the need?”
- **Development and implementation of education and training programme**, answering the question “How is the education and training programme to be established?”
- **Evaluation of the effectiveness of the education and training programme** answering the question “Is the established education and training programme of value?”

It should be mentioned that the regulatory framework for education and training in Greece is based on:

- The Radiation Protection Regulations according to which GAEC is the competent authority to recommend the introduction of radiation protection courses to the corresponding universities at underground level. GAEC is also authorised to issue certificates of competency and training to radiation protection workers or to recognize corresponding diplomas or certificates awarded on the authorized curricula.
- GAEC’s establishment and organizational laws. According to its statutory law, GAEC cares for the postgraduate training scientists and experts in or out, on issues related to GAEC objectives.

GAEC provides education and training courses to radiation workers in the fields of medical, industrial and research applications of ionizing radiation to people involved in emergency response plans, to customs offices and airport workers, where audits for illicit trafficking of radioactive sources are performed, as well as to workers involved in radioactive material transport. Recently, GAEC implemented an extensive programme of training in radiation
protection for the non-medical staff of ionizing radiation laboratories. GAEC defines the following personnel categories possibly involved in radiation facilities and activities:

- Specialist radiation protection adviser
- Radiation protection programme officer
- Approved medical practitioner
- Radiation protection officer (non-medical applications)
- Safety source officer
- Radiologist, radiotherapist, practitioner of nuclear medicine and dentist
- Technical safety officer, radiographer, technologist-radiologist, operator-developer, operator-assistant and radiography assistant
- Qualified experts

For simplicity purposes the above categories have been classified to the more general categories: qualified experts, radiation protection officers / radiation source officers, operators / workers, radiation health professionals according to their educational level.

2. Analysis of education and training needs

The first phase of the procedure for developing and implementing a national strategy for education and training in radiation protection is to evaluate the education and training needs. For assessing the training needs the national regulations and legislations have been taken into account. In addition, feedback from the GAEC’s division of licensing and inspections concerning the application of safety culture in different working environments and the requirement of different categories of personnel for additional education and training has been taken into consideration.

GAEC in order to assess the training needs takes advantage of the information and the data included in the National Radiation Protection Database (NRPD). The Database includes information about the individual dose monitoring of the occupationally exposed workers, as well as information about the radiation facilities and activities operating in Greece which are systematically updated by the Licensing and Inspections Division. An important aspect, crucial for the estimation of the education and training needs, is the fact that data concerning the educational level of the occupationally exposed workers are maintained in the NRPD. The existence and the quality of the NRDB was characterized, in the IRRS (Integrated Regulatory Review Service) report to the government of Greece, as a good practice.

The data derived from the assessment of the needs analysis performed by the GAEC are quoted in Table 1. In this table the number of existing facilities and the foreseen facilities to be developed during the next five years are referred. Data on the number of the occupationally exposed workers in each category are also given. Taking all these into account, education and training needs are detected in case of operators in industrial applications, as well as in case of radiology operators including dental radiology and veterinary radiology and in the field of diagnostic and interventional radiology with refer to both the medical and the non medical staff. As far as categories such as the interventional radiology and the veterinary radiology are concerned, the training needs are referred to all the corresponding personnel, due to the fact that the education that these categories have received on the specific issue of radiation protection is not based on syllabi approved by the GAEC’s Board. That is the reason why in these categories, the training needs are not limited only to the foreseen personnel.

It is estimated that the number of facilities/activities is not going to increase during the next years mainly due to the monetary crisis in Greece. This trend is illustrated in Table 1, mainly in the industrial and research sector.

The whole need analysis procedure is fully described and documented in the quality system based on the ISO 29990:2010 international standard recently developed by the GAEC Division of Research, Development and Education.
Tab. 1: Assessment form on the national educational and training needs

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<th>Number of facilities/activities</th>
<th>Existing</th>
<th>Foreseen (&lt;5yrs)</th>
<th>Total</th>
<th>Qualified Expert / Medical Physics Experts</th>
<th>Radiation Protection Officer / Safety Source</th>
<th>Operators/Workers</th>
<th>Radiation Health Professionals</th>
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<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Veterinary Radiology</td>
<td>180</td>
<td>20</td>
<td>200</td>
<td>180</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>5</td>
<td>-</td>
<td>5</td>
<td>5</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security equipment (e.g. baggage X-ray, container inspection, etc)</td>
<td>45</td>
<td>-</td>
<td>45</td>
<td>45</td>
<td>300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*total = 2224, hemodynamic = 660, gastroenterology = 155, surgery = 225, orthopedic = 287
3. Design of a national education and training programme

The national education and training programme developed by the GAEC is based on the training needs assessments. Except for the programmed educational activities, the programme allows for ad-hoc decisions for additional training to specific groups while GAEC, via its quality system, has established procedures for accepting requests for education and training from third parties (e.g. civil protection, first responders, army, fire brigade, private industries).

For designing and establishing the programme GAEC has taken into account the existing national capability (human resources, facilities, financial circumstances) as well as the international context (e.g. support provided by the IAEA). More specifically, the education and training activities are introduced by the GAEC’s Division of Research, Development and Education. GAEC bears the financial cost of organizing training courses for workers, while training material is provided to them without any cost. All GAEC’s infrastructure including classrooms, laboratories and its technical equipment is available for the national education and training programme. Moreover in the frame of the national strategy through training-the-trainers courses a pool of highly qualified and experienced lecturers has been created. Cooperation with universities, research centres and other public bodies is also possible.

In order to perform an effective design of the national programme it was important to collect data concerning the education and training provided in Greece in the field of radiation protection. The majority of this education is provided by GAEC [7], [8] through the following actions:

- Provision of education and training courses to radiation workers in the fields of medical, industrial and research applications of ionising radiation, to people involved in emergency response plans, to customs offices and airports workers, where audits for illicit trafficking of radioactive sources are performed, as well as to workers in radioactive material transport.

- Participation in the Inter-University Postgraduate Course in Medical-Radiation aiming at the creation of a sustainable mechanism ensuring the appropriate training of persons responsible for radiation protection of public, workers and patients during medical exposures. Its principal goal is to provide a number of highly qualified Medical Physicists according to the national needs. These Medical Physicists should be capable of acting both as Medical Physics Experts according to MED 97/43 Euratom Directive [9] and as Radiation Protection Experts according to the BSS 96/29 Euratom Directive [10]. Nowadays, the course functions with the enacted collaboration of the Athens University (Medical Faculty, Physics Department, Department of Biology) and Medical Departments of Aristotelian University of Thessalonica, University of Ioannina, Democriton University of Thrace and University Crete as well as in collaboration with GAEC and NCSR “Demokritos”. Details on this course can be found in [11].

- Provision of education and training to people involved in the national emergency response plan against nuclear and radiological threats organising frequently seminars addressed to this personnel in order to establish the sustainability of national operational capability on preparedness and response.

- As the IAEA European RTC in the field of radiation protection and safety of radiation sources, GAEC hosts the Postgraduate Educational Course on Radiation Protection and the Safety of Radiation Sources, co-organized and co-funded by IAEA. The Course provides education and training to young scientists pursuing to acquire a sound basis in radiation protection and knowledge of related safety fundamentals in order to become, in the course of time, qualified experts in their countries. In addition, organises international seminars in specialized fields of radiation protection, as well as in radiation sources safety and nuclear security, while offers on the job training to scientists chosen by IAEA, in the fields of radiation protection, regulations, personal dosimetry, ionising radiation calibration and environmental radioactivity control. In these courses there is always the possibility for Greek participants.

For providing a high quality education, GAEC ensures that is recruited by experienced trainers to whom as well provides several opportunities to maintain their competencies by
encouraging their participation in training courses, conferences, international networks and by facilitating their participation in research and development programmes.

In designing the national programme an overview of the education and training possibilities offered by the Greek Universities was necessary as they have state of the art infrastructure and apply a variety of nuclear and nuclear related analytical techniques in their laboratories involving natural and atomic radiations. These installations and laboratories provide the means for a high-level education and training in the field of nuclear sciences, including nuclear physics, nuclear applications and nuclear engineering.

Taking all these into consideration and matching the needs with the resources, GAEC identified which courses need to be organized during the next 5 years. The maximum number of participants in each course depends on the facilities required. Table 2 summarizes the type and number of courses planned to be delivered during the next five years. It should be noted that these courses will be included to the courses provided in the frame of the Inter-University Postgraduate Course in Medical-Radiation, mentioned above, and the GAEC conventional duties as an IAEA Regional Training Centre. Courses are programmed to be performed in different cities of Greece for covering needs all around the country.

<table>
<thead>
<tr>
<th>Practices / Activities</th>
<th>Category of personnel</th>
<th>Training course</th>
<th>Number of training courses</th>
<th>Leading to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinary Radiology</td>
<td>Health Professionals</td>
<td>Radiation protection in Veterinary Radiology</td>
<td>3</td>
<td>certificate of competence</td>
</tr>
<tr>
<td>Diagnostic and Interventional Radiology</td>
<td>Radiation Health Professionals</td>
<td>Radiation protection in Interventional Cardiology</td>
<td>4</td>
<td>certificate of participation</td>
</tr>
<tr>
<td>Diagnostic and Interventional Radiology</td>
<td>Technologists</td>
<td>Radiation protection in Interventional Radiology</td>
<td>4</td>
<td>certificate of participation</td>
</tr>
<tr>
<td>Scrap Metal Industries</td>
<td>Portal Operators</td>
<td>Principles of Radiation Detection (on-the-job-training)</td>
<td>3</td>
<td>certificate of participation</td>
</tr>
<tr>
<td>Mineral extraction and processing companies (NORM)</td>
<td>Operators</td>
<td></td>
<td>2</td>
<td>certificate of participation</td>
</tr>
<tr>
<td>Research activities: use of sealed and unsealed sources</td>
<td>Operators</td>
<td></td>
<td></td>
<td>certificate of participation</td>
</tr>
<tr>
<td>Security Equipment</td>
<td>Operators</td>
<td>Principles of Radiation Detection (on-the-job-training)</td>
<td></td>
<td>certificate of participation</td>
</tr>
</tbody>
</table>

Tab 2: Outline of the national education and training programme for the next 5 years.

4. Development and implementation of education and training programme

For the purposes of the national education and training programme described, appropriate educational material has been developed. Depending on the seminar, presentations, text books and/or laboratory exercises, on the job training activities, procedures for the assessment of the participants’ competence have been developed. The curricula of the courses are based on the recommendations of international organizations (IAEA, EC, ICRP) [12], [13], [14] and [15] and are approved by the GAEC’s board.

The successful implementation of the national programme requires the support of other national organizations as well. Thus, in line with its organizational values, GAEC identified the need to form a national network of collaborating institutions in order to provide high quality services in the field of radiation safety education and training. This network is constituted by:

- the National Center of Scientific Research "Demokritos", including research reactor, TANDEM accelerator, non-destructive testing facility, interim waste storage facility, production of isotopes, biodosimetry laboratory;
• the Faculties of Medicine and Physics of the University of Athens;
• the National Technical University of Athens, Nuclear Engineering Department of the School of Mechanical Engineering;
• the Faculty of Medicine of the University Ioannina;

As it is understandable GAEC has established specific requirements for its trainers that correspond to specific educational background and experience level.

Crucial parameter for the development and implementation of the programme is the fact that the GAEC division of development, research and education has recently established a quality management system based upon the ISO 29990:2010, which specifies basic requirements for providers of learning services in non-formal education and training. With this system procedures for developing educational services, for communicating them to the involved parties and for their provision have been established. According to the system specific responsibilities are defined ensuring the quality of the educational services.

5. Evaluation of the National Strategy

GAEC, as Training Centre of the International Atomic Energy Agency, was evaluated in November 2008 by an expert team of IAEA regarding issues of provision of education and training in radiation protection (Education and Training Appraisal Mission of IAEA, November 17-21, 2008, EduTA). Among the parameters evaluated was the legislative framework concerning matters of education and training in radiation protection, the national training program in radiation protection, the accredited training courses, the facilities used for educational and training programmes, the available human resources and the national lecturers. The report of the appraisal team was positive, which underlines the high level of scientific sufficiency and the experience of GAEC in the rendering of educational and training services in the field of radiation protection.

Regarding the educational services provided by GAEC, in the frame of the national strategy, it should be noted that there exist mechanisms for evaluating both their effectiveness and their adequacy, the most important of which is the use of properly designed questionnaires. The questionnaires are addressed to both the trainers and the trainees. The answers collected indicate whether or not the services provided have fulfilled the aims for which they were developed. Another indicator is the inspection reports received by the GAEC division of licensing and inspections in which the safety culture of the individuals during their work is evaluated. In this case, the evaluations before and after the personnel attendance in the seminars, should be taken into respect. In the same direction, the systematic study of the NRDB (e.g. data concerning the individual and collective doses) may indicate the adoption of the correct practices.

6. Conclusions

In this work the procedures for establishing a national strategy for education and training in radiation protection were described. Its development consists of four stages including the analysis of training needs, the design of a national training programme, its development and implementation, as well as its evaluation. Important factor for establishing a national strategy was the maintenance and use of the National Radiation Protection Database. The procedures described for the establishment of the national strategy are supported by the recently established quality management system based upon the ISO 29990:2010.

It was found that there exist a need for education and training in different personnel categories and a series of appropriate educational seminars were developed and are going to be performed during the next 5 years.

The unique combination of being simultaneously a regulatory authority and an IAEA RTC, renders GAEC a reference point in terms of education and training at both national and regional level. An effective strategy implemented by an IAEA RTC enhances the safety
culture at both national and international level and promotes echange of expertise among the Member States.

7. References

5. Steering Committee on education and training in radiation protection and Waste Safety, Report No.11.
12. IAEA Safety Report Series No. 20, Training in Radiation Protection and the Safe Use of Radiation Sources.
ABSTRACT

The present work serves as an introduction to the curriculum of the Hungarian radiation protection trainings and educations, which were re-introduced and revised during the harmonisation of 97/43/EURATOM directive as the Order of the Minister of Health No. 16/2000. on the execution of certain provisions of the Act No. CXVI. of 1996 on Atomic Energy came into effect. These trainings have a long history, and the experience collected during the past 50 years was the baseline for the requirements of the new trainings. There are three levels of trainings: basic, advanced and comprehensive; and two types. Each certificate is valid for 5 years, after that they should be renewed by attending proper refreshment courses. It is not unique to make special lectures or specialised lessons and demonstrations for a given group of radiation workers, e.g. interventional radiologists, technologists working with isotopes, security personnel, radiation therapy etc. The need for such trainings is recognised as an important tool of optimisation, however the different schools requirements and needs, altogether with the knowledge and experience of the lecturers are different, sometimes lacks flexibility and thus provide different depth of knowledge.

There are strict requirements concerning the educations and several special issues regarding the practical demonstrations held during the comprehensive level trainings, thus only two licenses for teaching are valid at present. The licenses for training are issued by the National Public Health and Medical Officer Service. There are 35 valid licenses, most of them are companies, specialised in education of adults and there are only a few private entrepreneurs, all of them are radiation protection experts.

The primary aim of the radiation protection training and education is to provide enough knowledge for the users of ionising radiation to handle a given source of radiation. It is proven, that with proper knowledge, the students are able to prevent accidents and unnecessary overexposure. The above aim is reached and its successfulness has been demonstrated several times, as there weren’t serious accidents during the past forty years.
1. Introduction

Education and Training (E&T) could be considered as the baseline for the implementation for safety of nuclear and radiological protection.

The legal base for the E&T in Hungary was laid down in 2001, as the 31st decree of the Minister for Health ("decree"). Thus the harmonisation of the 97/43/EURATOM directive was done before the join of Hungary in 2004 to the European Union. Several revisions throughout the years were issued but all of them left E&T untouched. In the last one, just before the issuance of the new EU BSS which would surely have an impact on the matter at hand, a new issue of the decree is underway. The most important changes would affect E&T, but are based on our past experiences and these would surely improve the quality of education.

Basic level education is required for any person who comes into contact with radioactive material or machines which could emit ionising radiation, altogether: source of radiation.

Extended level educations are required by those who operate the source of radiation and comprehensive level training is required by those who supervise and authorise the use of given sources.

A well prepared individual, educational institution or a training centre which could be part of a university or could work as a company may be eligible to organise E&T after a thorough accreditation process. The licensees shall prove that them or their employees could give lessons and were properly trained and has acquired experience in the given field.

The Office of the Chief Medical Officer (OCMO) and the "Frédéric Joliot-Curie" National Research Institute for Radiobiology and Radiohygiene (NRIRR), work together under the institutional organisation of National Public Health and Medical Officer Service (NPHMOS). A training centre is found eligible if its E&T curriculum meets the requirements of the decree and was found as such at the NRIRR during an accreditation process. If the would-be licensee acquires the NRIRR’s opinion and it states that the requirements are met, then, following a simple authorisation process at OCMO, the license is handled to them. This system gives some flexibility, which is necessary, as it would be mindless to teach a radiographer about the know-how of handling other sources of radiation than X-ray machines.

The validity of the above licenses vary one by one, but the attendee’s certificate who have successfully passed the exam at the end of the given course remain valid for five years. The certificate is required to fulfil certain jobs, thus the certificate shall be renewed after five years, or the owner of it would be ineligible to fulfil the job requirements.

There is a period of one year available for everyone to acquire a certificate to handle a given source of radiation, but there is a restriction for such workers, namely the employee could only work under supervision until being certified.

A higher level certificate doesn’t have any prerequisites of lower level certificates. The training levels depending on the risk associated with the completion of the work.

2. Basic level educations

It is a must that attendees or students are taught about the (minimum time in brackets): principles of radiation physics (2 h); principles of protection, dose limits and the authority monitoring system (4 h).

The basic level trainings could be attended if the student has finished elementary school.
The most common practice on the part of the educators is to use a multiple-choice written exam which shall be saved at least for five years and if at least 60% of the answers were correct then no further oral exams are necessary. There are altogether 50 institutions, universities and private contractors who have a valid license to educate on basic level courses, however only two-third of them do it at least once in a year. There are no specialised courses available on basic level, as the education should not take more than a working day. This could have been questionable, but the current system is based highly on trust and personal contact. Two hours should be spent on every course with consultation. It is really satisfying if someone has question, because it shows that their interest has been raised. Consultation could also be considered as a conversation or a dialog between people. As an example, when there are current matters concerning the topic, e.g. “Fukushima” or the “Isotope Institute” then it is up to the lecturer how to spend the given time – most often they speak about the radiological or nuclear event. When the exam was successfully passed by the attendees then it is not a must for them to know everything about radiation protection, but they know who they shall ask first if they have a question.

In the following sections, some diagrams could be seen, but basic level education is left out completely, since there are no specialisations concern this level of education. Between the years 2005 and 2011, there were 4659 workers who had a valid certificate which they gained for successfully passing a basic level course.

3. Extended level educations
Students attending this level of E&T usually have a medical or other scientific background (exclusively natural sciences), however engineers are scarcely present on these E&Ts. The curriculum is broken up into segments just like on basic level (minimum lessons in brackets): radiation physics principles (4 h), principles of protection, dose limits and the authority monitoring system (12 h) and have a more extensive consultation (4 h). Because the students’ knowledge with this level of E&T shall be more thorough, and the certified worker should later take measurements, do some basic shielding and dosimetric calculations and should know how to handle the sources, there are three more lessons, taught in 2-2 hours. These are: dosimetry principles, health physics principles, radiobiology and practice. Practice is a useful demonstration to show the students how each type of radiation monitoring and measuring devices work. This lesson also includes how they should carry out measurements themselves, how shielding and time could be used to reduce exposure and so on.

Every student participating in an extended level education shall prove that they have preliminarily finished elementary school and successfully passed their final exam. A degree or a diploma is not a must. Altogether ten universities, and 38 private contractors and companies offer extended level educations. Extended courses always have a specialisation, because this way the lessons could be addressed directly to listeners who have certain experience in a field. An interventional radiologist may know how shielding works and may have in-depth knowledge in radiology, but does not necessarily have information about the laws and regulations applicable for interventional radiology. Students could specialise in human or veterinary radiology, isotope techniques, industrial applications, research or agricultural applications. The certificate a student gets does show which extended
course the student had, but does not require the student to work at that given field explicitly, e. g. an X-ray operator from a hospital can decide that she will change her job, and from then on will work as an industrial radiographer (with a mobile X-ray). In this case, she would not have to take the course again in theory – this case and every such are quite improbable.

4. Comprehensive level educations and trainings
Radiation protection officers (RPO) working as supervisors of licensees must have a certificate of comprehensive level E&T. If a licensee has multiple workplaces and has several organisational subdivisions and divisions (an important hospital with several radiological workplaces and therapeutic modalities etc.), must employ a leader of the radiation protection service and each subdivision using ionising radiation shall have at least one person with extended level education.

Comprehensive level is compulsory for the following workers and decision-makers, who:

a) independently fulfill or manage or supervise activities accompanied by risk of high exposure to ionizing radiation, or monitor such activities from radiation protection point of view.

b) are involved in the planning of the radiation protection of work sites exposed to radiation hazard or in the evaluation such schedules from radiation protection point of view.

c) are involved in the design, management or supervision, from radiation protection point of view, of medical therapy procedures using ionizing radiation, in health welfare institutes,

d) perform authority inspections of work sites exposed to radiation hazard,

e) perform Health Physics or radiation protection expert activities,

f) give lectures or conduct examinations for advanced or higher grade radiation protection trainings,

g) are authorized managers, in the field of nuclear accident prevention entitled to give instructions in emergency.

5. Statistical evaluation of the radiation protection E&T
The following table (see: Table 1) summarises the amount of lessons for various levels of E&T.

<table>
<thead>
<tr>
<th>Basic level training course</th>
<th>Extended level training course</th>
<th>Comprehensive level training course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultation</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Radiation Physics principles</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Radiation protection principles, dose limits, authority monitoring system</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Dosimetry principles</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Health Physics principles, radiobiology</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Practice</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Radiation accidents and medical attendance of radiation injured people</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Nuclear accident prevention</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Sum of spent lessons on E&amp;T</strong></td>
<td><strong>8</strong></td>
<td><strong>26</strong></td>
</tr>
</tbody>
</table>
Table 1: Summarised curriculum of radiation protection educations and trainings

In the following chart it is clearly visible, that not only the number of refresher, but also first course has increased during the years between 2005 and 2011. We could simply conclude that it is due to the increased discipline associated with the radiation protection E&T. The explanation goes as the OCMO has declared that every worker shall be evaluated whether they had acquired proper knowledge and about radiation protection. The estimated number of “A” type workers from an earlier ESOREX survey stated that there were roughly 9760 of them in Hungary in 2007. In 7 years altogether about twenty-thousand workers attended E&T courses and 95 % of training centres have answered the questionnaire. To estimate how well training centres perform and how strictly the users abide the regulations, we have estimated that about 84 % of the workers are well educated. The remaining fraction may work with supervision as it was described before. The above fraction may seem a little high, and shows that the process of “brain-drain” is settled. It is such a scenario, where the well-educated and well-performing workers leave the country to seek better conditions and/or salary. The radiation protection and especially the safety associated could suffer seriously in the future, as high fluctuation tends to lead to safety issues.

![Figure 1: The number of certified workers between 2005 and 2011](image)

6. Other professionals
The potential professionals who would be able to become radiation protection experts (RPE) are physicists and engineers. However, in the past and still at the present, more RPEs were engineers due to the fact that Hungary actively participated in the development and distribution of medical X-rays in the late factory of Medicor. Currently several universities organise MSc. education for physicists, but only at the Budapest University of Technology and Economics (BME), at the Department of
Nuclear Techniques could someone become a Medical Physicist, since 2010. The graduated students in the future would hopefully satisfy the demand for RPEs. RPOs, who supervise the licensees, are well-trained and have acquired vast experience, but only a handful of physicists are available at the regional Radiation Hygiene Centres (RHC). Reinforcement is scarce and it is hard to find well-trained physicists nowadays – the authority may need to fill their lines.

7. Conclusion
The current system of radiation protection E&T calls for raised attention as the new BSS would be issued and the number of RPEs is getting thin. No serious accidents happened in the past 40 years, yet the current status of E&T is just fair. Several improvements shall be made concerning the requirements and outcomes of the trainings and educations to close up to the requirements of the European Union.
DRAFT OF REVISED SWISS REGULATIONS ABOUT
RESPONSIBILITIES OF PERSONS IN RP
AND THEIR NECESSARY CAPABILITIES AND SKILLS

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ABSTRACT

Currently the Swiss “Ordinance on Radiation Protection” and the “Ordinance about
Education and Training in RP” are undergoing a revision process. Concerning the
responsibilities and obligations as well as the capabilities and skills in RP the new
ordinances are supposed to take account on the new EU Basic Safety Standard on
the one hand and on the other hand to resume the approved approaches on RP in
Switzerland. An overview of the planned content of the revised ordinances will be
given in this report.

1. Introduction

In contrast to countries with a rather centralized approach to radiation protection competence
embodied in highly qualified experts, Switzerland follows a decentralized concept. A license
holder generally needs to employ an authorised person, with an education in radiation
protection approved by the competent authority, and with the obligation to locally reassure
regulatory compliance. The capabilities and skills of this “commissioner for RP” (CRP)
required to fulfil this function strongly depend on the radiological risk for a given type of
facility/practice. The function of the CRP is similar to that of the radiation protection officer
(RPO) as described in the new EU-BSS draft (2012). Furthermore the CRP assumes some
of the obligations which are assigned to the radiation protection expert (RPE) in the EU-BSS
draft. However in most cases the level of knowledge and experience for a CRP is lower than
as it is required for RPE by the EU-BSS draft. Experiences in Switzerland with this approach
are very good. Therefore basically there is no need for change concerning this approach.
Persons with the level of knowledge and experience equivalent to that of a RPE as is
required by the EU BSS draft are appointed in the RP system of Switzerland although they
are not referred to in the legislation. In contrast to the function of an RPE according to the EU
BSS acting as an obligatory external advisor for the licensee the “Swiss RPE” may have very
different functions. The revised ordinances will establish those persons.
Further improvements in the revised ordinances will take place in some parts of the approval
and recertification process. Instead of a particular list of lessons and their contents for each
training course (syllabus) the new ordinance will include a list of educational objectives for all
kinds of RPO.
Because the revision process is presently taking place the following overview is only a draft.
2. Education and Training in the revised “Ordinance on Radiation Protection”

The draft of “Ordinance on Radiation Protection” describes the following principles about education and training:

- duties of the licensee concerning the information of persons present on his premises (e.g. non occupationally exposed employees, visitors, new employees)
- duties of the licensee concerning the competences and capability of persons handling radiation sources on his premises,
- general regulation about the possible ways for education and training in RP taking into account
  o vocational education (e.g. radiographer)
  o third level education (e.g. university education as a med. doctor)
  o advanced training (e.g. RP-course after any vocational or third level education)
- identification of categories of persons and their different responsibilities and functions,
  1. persons handling radiation sources are responsible for self-protection and in some cases for protection of others (e.g. occupationally exposed employees, radiation workers)
  2. persons appointed by the licensee, to reassure regulatory compliance locally (preliminary term: “commissioner for RP”)
  3. persons applying radiation on humans (e.g. medical practitioner, radiographer)
  4. persons taking over responsibility in RP from a third party (e.g. RP professionals in nuclear facilities, medical physicist)
  5. persons with superior responsibility in RP
     o for complex or high radiation risk facilities (e.g. RP manager of nuclear power plant),
     o for leading emergency organisations (e.g. instructor for fire brigades)
     o for advising licensees (e.g. scientific institutes or engineering offices)
     o for RP services (e.g. RP specialists in calibration laboratory, dosimetry services)
     o for assessments and inspections (e.g. member of regulatory body)
     o for coordinating approved education and training courses in RP
- minimal requirements for learning objectives for all persons handling radiation sources as
  o they are informed about the health risk of their activity
  o they know the basic rules of radiation protection
  o they cope with suitable work techniques
  o they are able to apply the corresponding RP regulations
  o they know the hypothetical radiological impact of an exposure by malpractice
- need for approved education and training depending on the category of responsibilities (categories 2. – 5.)
- conditions for the continuing education and retraining
- administration of a registry of persons with approved education and training
- regulation of the specific requirements on the learning objectives for approved education and training depending on the category of persons and on the type and magnitude of radiation sources
- regulation of the approval of education and training programs
- regulation of the approval of individual qualifications
- governmental support of education and training programs
Besides these principles there are some special requirements in the ordinance about approval of RP qualification in order of certain occupational groups in the medical field. In addition to the principles of education and training the “Ordinance on Radiation Protection” will specify hazardous tasks permitted only for persons with approved qualifications related to occupational groups. This list of tasks and occupational groups will be in an appendix to the ordinance. This list will be of greater importance as the same ordinance sanctions the carrying out of certain hazardous tasks without having the appropriate and approved qualification.

3. Further regulations in the revised “Ordinance on Education and Training in Radiation Protection”

More specific requirements and approval of education and training will be defined in detail in the “Ordinance about Education and Training in RP”. Starting by the definition of “task areas” for each “occupational group” the “learning outcomes” will be decreed. These learning outcomes will be divided into “Core Learning Outcomes” and “Group specified Learning Outcomes”. Therefore it would make sense for some education and training programs to be split in several course modules, because the core learning outcomes are similar for several occupational groups. Furthermore the “Learning Outcomes” consist of elements about “Knowledge”, “Skills” and “Competences”. An education and training program or an individual qualification has to comply with these requirements in order to achieve the approval of the regulatory authority.

Nevertheless the “Ordinance about Education and Training in RP” will also contain a list of “Learning Topics” for certain “course modules” with a recommended amount of lessons with a typical duration of 45 minutes. This makes it easier for referees and course instructors to find the best approach for teaching.

Beside the definition of requirements on “Learning Outcomes” and “Learning Topics” the “Ordinance about Education and Training in RP” will contain further requirements for approving an education and training program according to:

- the assumed prior education and job experience
- the classroom and its infrastructure,
- the training laboratory and its equipment,
- the professional and didactical qualification of referees,
- the practical training, exercises and project thesis,
- the tests (multiple choice, written, oral, practical) and the final examination,
- the form and contents of certification

Another group of requirements which will be regulated in the revised “Ordinance about Education and Training in RP” deals with the continuing education and retraining and defines

- the maximum time period after which the qualification has to be refreshed, depending on the type of occupational group or magnitude of risk of their responsibility
- the enforcement for continuing education and retraining
- the test after continuing education and retraining
- the main topics of continuing education and retraining:
  - recapitulation of core learning outcomes as well as specialized skills
  - information about the newest state of science, technique and legislation
  - feedback and lessons learned from events, new projects and good practice

Finally the “Ordinance about Education and Training in RP” comprises also regulations about exceptions, which may be permitted by the appropriate authority.
Sector specific training needs
“IDENTIFICATION OF EDUCATION AND TRAINING NEEDS IN RADIOLOGICAL PROTECTION: APPLIED SYSTEMATIC METHOD”

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ABSTRACT

The gradual enhance of radiological protection and safety in the application of ionizing radiations in the country has been the result, among other aspects, of the education and training of technicians, regulators and workers in these topics. Several institutions have contributed and, still do, to the formation of qualified personnel. The definition of regulatory requirements according to the qualification level, labor experience and preparation has stimulated training capacities. Even with this premises, there was no a clear definition of the real needs according to current and future applications in the country. The present paper presents the applied conception to identify and characterize the needs of education and training in radiological protection in Cuba, using a systematic approach that aims at ensuring the sustainability of the training infrastructure the country has. Some aspects are described the adopted process, the used information sources, the regulatory concepts that lead the process, the experiences applied for the adequate categorization of persons to be trained according to their level of responsibility in safety and the particularities of the practice they are involved, the adaptation of the IAEA model to the domestic scenario and the documents published by ICRP in this field. Finally, a consolidated summary of identified needs is presented and the actions that can be undertaken are proposed in order to achieve a systematic update of such needs that would allow the improvement of the national education and training program on radiological safety and protection.

1. INTRODUCTION

It is recognized that safety in nuclear applications strongly depends on the competence level in radiological protection and safety both the staff directly involved in the practice and the manager or licensees of the applications have, understanding education, training and work experience as competence components. The Basic Safety Standards, (BSS) [1] of the International Atomic Energy Agency (IAEA) widely show this aspect, defining the responsibilities with competence from the government to licensees.

Regularly in Cuba, the basic education requirements, workers and managers should have before starting working in areas related to safety, are clearly established by the employers or licensee and accordingly they are “sine qua non” requirements that determine the incorporation to the job position. Such requirements generally include a second or tertiary educational level and the technical specialty according to the work that is going to be carried out by the candidate. Frequently, the demands of the labor market permit the identification of candidates that comply with the education demands, thus this component of competence is nearly always met by licensees or employers, and satisfactorily supervised by the regulator. The case of qualified experts, when this figure is related to an academic degree, is an exception, since it is not defined in the Cuban scenario.
National situation is different when it is about the other component of competence, training on radiological protection. Several occupational categories demand a specialized preparation on this matter, that are far over the capacities the licensees or employers have to deliver it. Even when there are diverse institutions that offer or may offer such training in the country, there is lack of a sustainable system that may ensure it. That is why, the challenge has been accepted to establish national strategy that allows reaching competence efficiently in radiological protection using available national resources and international cooperation they have access to.

The identification of training needs play a key role in the development of the national strategy. The current paper shows the conception adopted in the country to establish such needs systematically.

2. GENERAL CONCEPTION OF THE PROCESS FOR THE IDENTIFICATION OF TRAINING NEEDS

Lately, IAEA has been promoting the creation of national capacities for education and training on radiological protection. Part of the strategy, that have been applied in the last decade and that has been recently updated until year 2020, is based on the promotion of a model of national strategy that it is documented in the IAEA Series of Safety Standards No. RS-G-1.4 “Building Competence in Radiation Protection and the Safe Use of Radiation Sources” [2] and that has been recently complemented with documents aiming at facilitating the interpreting and implementation of this model “Draft safety report, “A methodology for establishing a national strategy for education and training in radiation, transport and waste safety”, IAEA Viena 2011 [3]. This model, even though in its total conception has been applied very limited, is the result of the international experience and accordingly it is expected that its application in our country permits to reach expected results and it has been adopted considering this.

Though authorities in the country are still working in the statement of a national strategy that will be subject to the approval of competent organizations, de facto a series of guidelines shared by all interested parties has been defined. It is worthy to highlight some of them: the validity of having a national strategic with systemic approach and based on the model promoted by IAEA (Series No. RS-G-1.4 [2]), the priority the creation of a national training system should have, the importance of the contribution of all organizations potential suppliers of training actions and the need of keeping an active participation in international formation that would complement national capacities.

A work group was created with the representatives of the Regulatory body (National Center of Nuclear Safety, CNSN, acronym in Spanish ) and one of main organizations in training supply Center for Radiation Protection and Hygiene (CPHR, acronym in Spanish) based in the aforementioned guidelines. This group was in charge of leading an identification process of the needs considering the following precepts:

- Develop the work as an integrating project that should be based on a formally documented and traceable process, in a way that it can be periodically executed to keep updated the status of the needs.

- Design the identification process of the needs bearing in mind that the expected final result is the conception and appropriate implementation of the national training program on radiological protection and taking into account that the success of all this effort will depend on how well the needs are known.
• Include all the applications of nuclear technologies with the following priority: radiotherapy and nuclear medicine applications, industrial and research applications and medical radio diagnosis applications.

• Cover all occupational categories explicitly established in the Cuban regulatory frame, including the figure of the qualified expert according to the shared international definition.

• Identify all the training needs independently that a priori it was known that the country has not resources to satisfy them.

• Promote the participation of representative from all organizations and institutions that are involved in a way or another in radiological protection safety and/or formation. As occurs with the Nuclear Agency of the Ministry of Science Technology and Environment, organization in charge of the promotion of nuclear techniques in the country, the “Instituto Superior de Tecnologías y Ciencias Aplicadas” (InSTEC), university that ensures the basic formation of nuclear specialties as well as the academic post graduated formation of related sciences, which are representatives of relevant users in the different application spheres and other interested parties.

3. DEVELOPMENT OF THE PROCESS FOR THE IDENTIFICATION OF TRAINING NEEDS

Based on the aforementioned model promoted in RS-G-1.4 of IAEA [2] and aware of the probable lack of information and aspects not included in the regulatory frame, the process of identification of needs was carried out following the stages mentioned below:

a). Definition of the occupational categories that will be object of training.

b). Identification or definition of the training requirements according to the occupational categories and, when applicable, of the specificities of the practice in question.

c). Identification of the practices existing in the country, the completing of the personnel in accordance to defined categories and the training level they have.

3.1. Definition of occupational categories

In the country, there is no an unequivocal definition of occupational categories in accordance with the conception described in RS-G-1.4 del OIEA [2], which is based on the level of responsibility and knowledge on radiological protection the workers have. For this reason it was necessary to review national regulatory documents in order to identify the existing classification. The following national documents were consulted:

• Safety Basic Standards [4]
• Specific regulations tending to provide safety requirements by type of practice. [5, 6, 7]
• Regulation for the selection, training and authorization of personnel [8].
• Sector regulations that might identify occupational categories.

In general the legislation currently in force defines positions with direct responsibility in safety such as, the Radiation Protection Responsible (Radiation Protection Officer as defined by
BSS No. 115), which is established for all practices or some of them, as in the case of a radiotherapy service; it also characterizes the positions that should conform a staff, for example Physic doctor, Radiotherapist doctor, dosymetrist, etc.

The application of categorization in accordance with the training demands results more appropriate when defining needs. Accordingly, the occupational categories of the IAEA model were assumed. Several positions, defined in the legislation in a determined occupational category, were grouped so as to apply categorization. In medical practice, technicians in radiotherapy, in nuclear medicine, in radiopharmacy and dosymetrists were considered in the category Operators, while radiotherapist doctors, nuclear medicine doctors and physic doctors in Health professionals.

For medical practices, considering its importance in the domestic scenario, the adoption of the classification promoted by the Publication ICRP 113 “Education and Training in Radiological Protection for Diagnostic and Interventional Procedures” [9] was analyzed. However, it was understood that the country lacks a specialization level that supports such detailed classification. Currently, this focus allows keeping coherence between the identification of needs and the potential national training program that will be developed, nonetheless, there are written evidences of the analysis carried out that would permit to revise the focus in coming years.

Special attention was given to the category “qualified expert”. Cuban Basic Standards [4] recognize this category, however, neither its definition is clear in terms of the requirements he/she should have complied with, nor has the specific function in the authorization system been identified. Based on the consensus of specialists, this category was included in the analysis of needs, presuming the level of knowledge that certain positions or functions demands.

It was evidenced that the approach applied in the definition of occupational categories should be equally reflected in the regulatory processes of individual licenses in order to reach consistency in all regulatory activities. For that purpose, the adopted conceptions for each category were written down in a document, which also contribute to the traceability of the process.

3.2. Identification or definition of training requirements

As previously stated, competence, in the applied conception, consists of education, training and experience. Even when the main objective is training, the requirements for the three components of competence were identified, using the same national regulatory documents that were defined in the above item.

For practices of higher relevance in the country in both medical and industrial applications, the regulatory frame clearly established the requirements for competence. This fact, among other reasons, is due to the existence of a process of individual license [8] that requires necessarily the proper definition of such requirements. In terms of the number of occupationally exposed workers and of the impact in the control of medical exposure, the personnel specifically involved in radiodagnosis practice in all specialties, including interventional radiology, are an important exception. This regulatory gab is an important weakness that should be considered in an immediate future.

Another aspect, regarding training requirements that should be kept in mind is the definition of the characteristics and demands of continuous training. In that respect, provisions stated in the regulation do not permit the unequivocal identification of potential training needs.

Table 1 is an example of how the requirements of competence were documented.
Recently, the regional project, sponsored by IAEA, RLA 070 “Strengthening the Education and Training Infrastructure and Building Competence in Radiation Safety” gave specific recommendations on qualification requirements in radiological practices for different occupational categories in the practices [10] and for the personnel of the Regulatory Body [11]. The detailed revision of the relation between the recommended requirements and those established in the country should be included in the subsequent stages of the national strategy. Taking into account the current status, the application of these recommendations was not considered opportune since the regulatory frame has already included requirements for most cases.

<table>
<thead>
<tr>
<th>Position</th>
<th>Basic formation</th>
<th>Specialized formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physic Doctor in Radiotherapy</td>
<td>University Degree in Nuclear or related specialty</td>
<td>Theoretical – practical course in Radiological protection and safety (at least 80 hours) Specialization Course in Medical Physics</td>
</tr>
<tr>
<td>Industrial radiography operator</td>
<td>High School</td>
<td>Theoretical – practical course in Radiological protection and safety in industrial radiography (at least 55 hours)</td>
</tr>
<tr>
<td>Technician in Radiotherapy</td>
<td>Technician in Health Technology</td>
<td>Theoretical – practical course in Radiological protection and safety (at least 40 hours).</td>
</tr>
</tbody>
</table>

Table 1. Example of the requirements of competence for positions

3.3. Training needs

Up to this stage, the work of the group was focused in document analysis, as could be observed, most of them regulatory ones; however, the identification of training needs using the occupational categories and the defined requirements necessarily demanded an interaction with user entities. It was developed in three steps:

a) Characterization of both existing and foreseen practices in the country  
b) Identification of the existing and/or necessary personnel including foreseen practices.

c) Individual evaluation of the compliance degree of competence requirements

3.3.1 Characterization of practices

The characterization of practices means knowing the number of existing entities and sources in the country and the territorial distribution. The latter because presumably the potential national training program, due to reasons related to available material and human resources, should be designed with formation actions in all provinces and not only in the capital.

Considering the level reached in the country implementing the regulatory system, the revision of the registries of the Regulatory Body should be enough to identify the existing facilities. In this case, the properly updated informatics system RAIS was used. Obtained data were complemented with the information registered in the files of the users and the reports of inspections carried out that are managed by the regulatory authority. This type of analysis was sufficient for entities directly supervised by CNSN; however such information level on entities of diagnostic radiology practice is not appropriately available.

Data from the National Dosimetric Registry were used to have an estimate of the entities of diagnostic radiology. This national registry has been recently developed in the country and
has the dosimetric history of all occupationally-exposed workers and data of the entities where they work. Therefore, it was a main tool in this stage.

The national training program should include foreseeable new facilities in the country. This is important not only for the fact that the new facilities will demand new personnel and therefore personnel to be trained, but also because sometimes the included practices may incorporate new technologies that frequently are a challenge regarding safety. The introduction of new technologies in the health area, with the inclusion of cyclotron facilities and the corresponding PET-CT applications for diagnosis and radiotherapy is an example. The available information in the Regulatory Body on foreseeable new practices was necessarily complemented with the perspective studies AENTA has in its development program.

The summary of the existing and foreseeable facilities in the country according to the foreseen development programs are shown in Table 2. In the case of diagnostic radiology practices, the entities are shown not the total of sources.

<table>
<thead>
<tr>
<th>Practices and Activities</th>
<th>Existing</th>
<th>Foreseen (5 years)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>industrial radiography</td>
<td>14</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Irradiators</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Nuclear gauze int he industry</td>
<td>19</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Accelerators</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Well logging</td>
<td>2</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Dental Radiology</td>
<td>202</td>
<td></td>
<td>202</td>
</tr>
<tr>
<td>Diagnosis and intervention Radiology</td>
<td>688</td>
<td></td>
<td>688</td>
</tr>
<tr>
<td>Radiotherapy (lineal accelerator, teletherapy, brachitherapy)</td>
<td>9</td>
<td>2 (sources)</td>
<td>9</td>
</tr>
<tr>
<td>nuclear Medicine</td>
<td>14</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Disposal management facility</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Production of isotopes</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2. Summary of entities per type of practice in the country

3.3.2 Persons requiring needs. Training needs.

The definition of training needs, expressed in the quantity of subjects that requires to complete their formation to reach the wished competence in radiological protection, was carried out in two stages.

The first stage aimed at knowing the quantity of persons that presently work in each previously defined occupational category and in each of the entities already identified in previous steps of the process. For practices where the requirements for personnel are established [5, 6, 7], the existing personnel was compared to the required one, and in those cases that did not cover regulatory expectations, the ruled number of persons for each category was assumed. In the case of practices that are predicted to be introduced in the future in the country, the type of personnel or the regulatory requirements if already established were assumed.

The second stage demanded an individualized evaluation of each person, in each category and in each entity to define if currently the worker has the knowledge defined in the competence requirements that were previously identified in the process.
Several information sources were indistinctly used in both stages, such as:

- Registry of individual licenses issued by the Regulatory Body.
- Regulatory documents (for the definition of required staff)
- Reports of the inspections accomplished to the user entities (revision of the teaching registries, of the number of occupationally exposed personnel).
- Institutional authorizations.
- Results of working meetings carried out by the system in charge of the supervision of diagnostic radiology practices.
- Reports of the debates of the Regulatory Annual Conferences. Activity promoted and directed by the Regulatory Body.
- Reports of the analysis of the radiological events
- Reports of the results of the emergency exercises.

In the individualized evaluation, it was assumed that there was a training need when any of the following precepts coincided:

- They do not have individual license or there were no evidences of having completed the established training in the competence requirements for the corresponding occupational category.
- All occupational categories in the entities of diagnostic radiology practice.
- All persons from the occupational category “qualified expert”.

In addition to the aforementioned aspects, it was considered that all persons that should be involved, from any occupational category, in predicted new facilities or to complete the personnel in the existing practices, will require training.

A Consolidated summary of training needs in radiological protection identified in the country for adopted occupational categories are shown in Table 3. This information is available in details by territories, entities, types of practices and occupational categories.

<table>
<thead>
<tr>
<th>Practices and activities</th>
<th>Qualified experts</th>
<th>RPO</th>
<th>Operators</th>
<th>Health professionals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>6</td>
<td>6</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Medical</td>
<td>19</td>
<td>448</td>
<td>4258</td>
<td>75</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>1</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Regulators</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 Consolidated summary of training needs in radiological protection in the country

4. CONCLUSIONS

As described in the present paper, the identification of national training needs on radiological protection can be developed using a systemic approach, based on a structured process that begins in its conception and ends with the data obtainment that will allow the design a national training program. The model developed and promoted by IAEA for the establishment of a national strategy in this field is a vital helpful tool in the design and implementation of this process, but logically it should be adapted to national conditions and specificities.

The implementation level of the system and of the regulatory frame is a conditioning element in the conception and development of the process, thus key elements like the definition of the
requirements for competence, occupational categories and others are essential in that process. Nevertheless, in the paper it is also shown that the implementation of the study itself resulted in information and definitions that will improve the regulatory activities.

Obtained results in the identification of training needs have an inestimable value for the design of a national program. Undoubtedly, such program will be a technical challenge and will demand great effort from the interested organizations. The evolution of application of nuclear techniques in the country, the modifications in the labor system as well dynamics in individual interests of specialists involved in the applications force to develop periodically this process of identification of needs, thus a precise evaluation of such needs can be objectively obtained. The adopted systematic approach will make easy the implementation of this work.

5. REFERENCES


NUCLEAR SAFETY AND RADIATION PROTECTION IN POLAND

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ABSTRACT

Polish Government is currently developing the draft version of Polish Nuclear Power Program. Implementation of this Program involves introduction of necessary modifications to the nuclear regulations in force, especially in the field of nuclear safety and radiation protection. Considering that the nuclear research center, operating small research reactors, has already been running in Świerk (near Warsaw) since 1958, the present situation requires that Polish authorities update the existing regulatory framework and train young experts. It is in PGE EJ 1’s best interest as the future operator of the first Polish NPP to see such updates and trainings implemented.

1. Introduction

The history of nuclear power in Poland goes back to the 1950s. That is when the idea of a nuclear power plant (NPP) build in Poland was born. In 1955, the Institute for Nuclear Research in Świerk (Warsaw area) was founded. Three years later, in 1958, the first research reactor (called EWA) in Świerk nuclear center began operations. The plans to construct an NPP in Poland were re-launched in the 1970s. In 1982, the construction of the first two VVER nuclear reactors began in Żarnowiec. Unfortunately enough, the construction project was cancelled in 1990. In the meantime, the subsequent small research reactors (MARYLA, ANNA, AGATA) were started-up in the nuclear center in Świerk. The biggest of them all – MARIΑ, commissioned in 1974, is still operating as part of the National Centre for Nuclear Research (NCBJ), called into existence in 2011. The idea to construct an NPP in Poland resurfaced for the third time in 2005 as part of the Government energy planning. In 2009 the activities relating to the development of the Polish Nuclear Power Program were launched. In the same year, two nuclear companies were created within PGE Capital Group. They shoulder the responsibility for the execution of the first NPP build project in Poland.

In general terms, a nuclear power plant operates on a similar basis as other, so-called “conventional” power plants, which include, among others, coal and gas power stations. The centre of every power plant is the heat source. The heat is captured by the working medium (most often water) that gets turned into vapor. The vapor, subsequently, fuels turbogenerators that produce electric power. The main difference between a nuclear power plant and a conventional power plant is how the heat is produced. While the power stations powered with fossil fuels are centered around a furnace (or boiler) where the fuel is burnt, the heat source in a nuclear power plant consists of a nuclear reactor. Generally speaking, the main difference between a nuclear power plant and other power stations is the little magic word - “radiation”.

1

186 of 434

20/03/2013
2. Radiation

There are as many definitions of radiation as there are various kinds of radiation. The concepts of nuclear safety and radiation protection revolve around ionizing radiation, that is the kind of radiation able to ionize the matter it comes in contact with. Since 1896, when radioactivity was discovered by Henry Becquerel, numerous myths and legends have grown and come to surround the radiation. At the beginning, the general opinion had it that radioactive substances together with the invisible beams of energy they emit are a miracle cure to all human ailings and diseases. After the tragedy of WWII and nuclear bomb explosions in Hiroshima and Nagasaki, the contrary opinions started to prevail and culminated in a Cold War-induced hysteria and general radiophobia. Sadly enough, an omnipresent fear of radiation, combined with general ignorance in the area, are not uncommon today.

Generally speaking, ionizing radiation is everywhere around us. It is also produced by conventional power plants, which is easy to verify if you use Geiger-Mueller counter to examine the fly ash piles that consist of waste produced in a coal power station. Relatively high concentration of carbon isotope $^{14}$C results in levels of radiation even a few times higher than the natural background radiation levels.

The radiation emitted by a nuclear power plant is much lower that generally thought. In the course of normal operations, dose rate measured right at an NPP’s fence does not rise over 0.01 mSv/year [1]. This is a much lower dose rate than the one received from natural background radiation, which in Poland amounts to approx. 2.4 mSv/year [2]. The reason why this dose rate is so low is as follows: all radioactive materials, including the nuclear reactor core, are extremely well protected and safeguarded. They are subject to very restrictive regulations on nuclear safety and radiation protection.

3. Nuclear safety and radiation protection

The Polish Atomic Law act [3] defines the radiation protection as prevention of human exposure and environmental contamination, and if preventing such situations is not possible - limitation of their consequences to the lowest reasonably achievable level, taking into account economic, social and health factors. The definition quoted refers to the ALARA principle (As Low as Reasonably Achievable) - the ground rule for radiation protection worldwide. The newer adaptation of the ALARA principle is ALARP (As Low as Reasonably Practicable), which calls for limiting the exposure to the lowest practicable level as not everything that is achievable is also practicable. The nuclear safety is defined as achievement of appropriate operating conditions, prevention of accidents and mitigation of their consequences which result in a situation where workers and general public are protected against risks related to ionizing radiation from nuclear facilities [3]. In the light of this definition, nuclear safety is nothing else than radiation protection of nuclear installations. However, these two concepts - nuclear safety and radiation protection - must not be confused and are applied separately in practice. While talking about nuclear facilities, they are used jointly as “nuclear safety and radiation protection”.

187 of 434 20/03/2013
4. Polish nuclear safety regulations

The main collection of Polish regulations on nuclear safety is the Polish Atomic Law act. A number of detailed, secondary pieces of legislation have been issued with respect to the Atomic Law act, including for example:

- Regulation by the Council of Ministers of 10.08.2012 regarding detailed scope of work for characterization activities for a site where a nuclear installation is to be seated, (...) as well as location report requirements for a nuclear facility;
- Regulation by the Council of Ministers of 31.08.2012 on nuclear safety and radiation protection requirements to be considered in the nuclear installation design;
- Regulation by the Council of Ministers of 10.08.2012 on activities important from the nuclear safety and radiation protection viewpoint and performed within an organization conducting start-up, operations or decommissioning of a nuclear facility;
- Regulation by the Council of Ministers of 27.12.2011 regarding the periodic safety assessment of a nuclear facility.

Due to existence of the nuclear research center in Świerk near Warsaw [4], Poland has long experience in operating nuclear research reactors. However, many regulations have only been implemented recently. Intensive efforts aiming at the development of legislative acts to be promulgated in the near future are still under way. The comments by the National Atomic Energy Agency (PAA) [5] state that regulations pertaining to the nuclear safety are based in most part on the safety standards developed by IAEA (NS-R-1, DS414/SSR 2.1), complemented with guidelines formulated by WENRA (“WENRA Reactor Safety Reference Levels. January 2008” and “Safety Objectives for New Power Reactors. Study by WENRA Reactor Harmonization Working Group. December 2009”) as well as with the selected EUR and American 10CFR50 requirements, and provisions by some of the EU countries (Finland, Germany, Czech Republic, Slovakia and Bulgaria). NAEA (PAA) is also planning to issue more detailed guidelines pertaining to particular issues [5].

Additional requirements concerning the first Polish NPP can be established by the investor - that is PGE EJ 1 Sp. z o.o. These requirements will be based, among others, on the EUR (European Utility Requirements) document [6].

5. Main requirement: III generation

The only thing that can be said at present about the nuclear technology to be selected for the first Polish NPP is that it must be a generation III technology. There is no strict definition for the generation III technology, however the most quoted characteristics of the generation III, as opposed to generation II, include: redundancy of safety systems, use of passive safety features, defense in-depth, minimizing the risk of human error etc. Generally speaking, the Atomic Law act in force [3] does not allow for the implementation in Poland of a nuclear reactor technology older than the generation III technology.

Recent accident in the Daiichi-Fukushima plant, caused by a catastrophic earthquake followed by a tsunami, has resulted in additional requirements being imposed on reactor technology providers. The accident has also demonstrated clearly the importance of passive safety features, the same that constitute one of the generation III characteristics. Key
element of these safety systems is the possibility to evacuate residual heat. It was exactly
the inability to do so that has led to the reactor core meltdown in some of the Fukushima
reactors.

6. Future NPP surroundings

The potential site for the first Polish NPP is no more than a greenfield at this moment. However, a number of radiation protection measures must be undertaken before any work to construct an NPP on the site begins. These measures, quite obviously, encompass measurements of the natural background radiation levels that must be performed before an NPP is built on the selected site. It is not unheard of that, due to some particular geological conditions for instance, for the natural background radiation levels on the site to be more elevated than in the neighboring areas. In case these elevated radiation levels are detected only after an NPP is commissioned, the future operating organization might find themselves accused of causing contamination of the site [7]. For this very reason, the Polish regulations pertaining to siting nuclear facilities impose an obligation to perform measurements of distribution of the radioactive isotopes concentration in the ground, surface waters, ground waters and atmosphere as well as the dose rate distribution before an NPP can be constructed on a given site.

Another aspect directly related to nuclear safety and radiation protection in the NPP’s vicinity is the radiological impact that the facility exerts on the population and environment. Even if low doses of ionizing radiation give practically no risk to human health, the application of the ALARA principle embedded in the legislation in force has resulted in the introduction of the so-called restricted use area [3]. Restricted use area is defined as an area designated by boundaries within which an annual effective dose does not rise above 0.3 mSv/year during regular operations of an NPP. Moreover, the definition of a restricted use area includes a provision that in case of a nuclear accident without a reactor core meltdown, an annual effective dose measured outside of the area’s boundaries cannot rise above 10 mSv/year [3]. In practical terms, restricted use area for a generation III plant should not be larger than an area within 800 m radius from the reactor building itself. This provision is of high importance, considering the land use and development density on the Polish coast.

7. Trainings

The obligation for the personnel to undergo appropriate training in matters involving nuclear safety and radiation protection does not arise earlier than during the construction phase of an NPP implementation project. However, the personnel working for PGE nuclear companies have already attended specialized courses organized by the National Centre for Nuclear Research in Świerk. At the end of such courses, the trainees sat a relevant, written exam and were awarded graduation certificates. Moreover, a number of specialized lectures were organized specifically for the benefit of PGE Energia Jądrowa S.A. and PGE EJ 1 Sp. z o.o.’s personnel. Some staff members attended various conferences and workshops abroad. Two certified Radiation Protection Officers are also employed in PGE nuclear companies. PGE nuclear companies cooperate with National Centre for Nuclear Research, Warsaw University of Technology, Gdańsk University of Technology, Polish Nucleonic Society as well as with
the International Atomic Energy Agency in matters regarding trainings, specialized workshops, post-graduate studies and internships.

A studies program for the first (elementary) stage of an in-company course on nuclear safety and radiation protection has also been developed recently.

8. Conclusions

Nuclear safety and radiation protection are a matter that has been given priority by the PGE nuclear companies: PGE Energia Jądrowa S.A. and PGE EJ 1 Sp z o.o. At present, the companies concentrate on training their workers in matters regarding nuclear safety and radiation protection as well as on requirements imposed on the site characterization contractor with regards to e.g. natural background radiation measurements. Baseline documents that establish the requirements to be imposed on the nuclear technology providers are the Polish Atomic Law act (together with secondary legislation thereto) as well as recommendations made in the EUR (European Utility Requirements) document.

9. References


RADIATION SAFETY TRAINING IN THE VETERINARY SECTOR

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ABSTRACT

The veterinary profession uses ionising radiation for both diagnostic and, less frequently, therapeutic purposes. X-ray sets are widely used in veterinary practices for small animal radiography, and mobile units for undertaking radiographs of larger animals in the animal's own environment are used by more specialised practices. Use of radioactive material is generally restricted to larger teaching veterinary hospitals. Training for staff involved in performing radiography or administering radioactive material is required as part of the training programme undertaken by veterinary staff in order to gain professional qualification in the UK. However, the Ionising Radiations Regulations 1999 (IRR99) [1] place additional training requirements on Radiation Protection Supervisors (RPSs). It should also be recognised that some veterinary surgeons practicing in the UK will have received their initial training outside the UK hence may not be familiar with UK radiation safety legislation.

The Health Protection Agency (HPA) provides practical radiation protection advice to veterinary staff as part of its Radiation Protection Adviser (RPA) consultancy service, and during the review of radiation safety within practices we are able to assess the additional training needs of those working with ionising radiation. Generally, all staff have received an appropriate level of radiation safety awareness training, however it is unusual for RPSs to have undergone any recent training prior to being appointed. Specialised Radiation Protection Supervisor training courses have been developed by the HPA based on these reviews.

Generally, feedback from these training courses is positive, however the level of attendance on these courses is low compared with the number of practices throughout the UK that would appear to need to appoint an RPS. The reason for this is unclear, however it may be a reflection of the lack of awareness of the additional training that is needed to undertake the role of RPS, or a belief that refresher training following their initial professional qualification is not required. Further work is needed to investigate this, and to promote the importance of this sector specific training need.

1. Introduction

In the United Kingdom there are approximately 5000 veterinary practices, of which the large majority routinely carry out diagnostic radiography of animals using X-ray sets within a fixed location in a surgery [2]. Less commonly, mobile equipment is used in open areas, stable blocks, etc. for equine or other large animal radiography. A handful of more specialised units
use more sophisticated equipment such as CT scanners and undertake investigations and treatment with radioactive material; dental radiography is also becoming more common. Given the nature of the work with ionising radiation, IRR99 requires those connected with the work to undergo radiation safety training to ensure they are adequately informed about the associated risks. Additionally, where a controlled area has been established within which the exposures will be undertaken, IRR99 requires an RPS to be suitably trained and appointed. Guidance on the appropriate training that an RPS should receive has been issued by the Health and Safety Executive (HSE) [3], and meeting their guidance ensures that the RPS is fully able to undertake and appreciate their role of supervising the safety of staff working with radiation, and implement local safety procedures.

There are currently very few RPS courses on offer in the UK that are specific to the veterinary sector, and the HPA is among them, offering on average 5 courses per year. However, given that there should therefore be approximately 5000 RPSs within the veterinary community in the UK, it appears that perhaps only 1 % of the potential RPSs in the UK attend one of these courses each year. The question this raises is whether veterinary practices throughout the UK have trained and appointed RPSs, and, additionally, where RPSs are not suitably trained, are other members of staff suitably trained to work with radiation?

Questionnaires were completed by those attending an HPA veterinary RPS course at the end of 2012. Although the number of responders was small, the comments received do appear to be consistent with observations made during reviews of practices undertaken by HPA’s RPAs. This paper makes reference to some of the comments made.

2. The Veterinary Practice

A ‘standard’ veterinary practice operates a diagnostic X-ray set, within a dedicated radiography room, where it is used to radiograph small animals. In a busy practice, tens of radiographs could be taken each week. At practices catering for larger animals (for example farm animals, horses or even exotic species housed in zoos) equipment is mobile, and can be used ‘in the field’ to avoid the need to transport large animals to the radiography facilities at the practice itself.

In a typical small animal practice the radiological risks are generally confined to the radiography room itself which becomes a controlled area during exposures, and the significant issues that the RPS supervising the work needs to consider include staff competency, adequate local rules, and means of access control. In well designed facilities, the operator will stand outside the X-ray room and view the inside of the room through a shielded lead glass window. In other facilities, the operator may stand at an open door or within the X-ray room but will be at a sufficient distance from the X-ray set to ensure that occupational exposures will be minimal. Under special circumstances, a member of staff may need to stand close to the X-ray set. The animal may be held in position by a member of staff because it is too unwell to be sedated. Large animal radiography introduces additional factors to consider, including the suitability of the controlled area during every exposure and the identification of a suitable location. The radiographer needs to consider the use of available shielding, beam stops and warning devices to protect other personnel in the area from both the main X-ray beam and any scattered radiation. Larger animals are more likely to need restraining by their owner, rather than by veterinary staff, as the owner is best placed to calm a horse where there is a real risk of injury to unfamiliar humans. So the RPS
also needs to consider how to best inform the owner about the risks from the radiation exposure they may receive.

Additional regulatory controls are required for work with radioactive material used for either diagnostic or therapeutic purposes. In addition to the requirements of IRR99, radioactive substances regulations [4][5][6][7][8][9][10] must be considered. Usually, responsibility for day to day compliance with these regulations falls to the RPS. Nevertheless, the employer remains responsible for ensuring that suitable arrangements are in place to manage work with ionising radiation. Additional requirements include ensuring adequate storage, administration, accountancy, monitoring and disposal of the radioactive material, and compliance with any other conditions stipulated in the practice’s Permit to work with the material, issued by the appropriate environment regulator.

Thus the factors to be considered by the RPS increase in number and complexity as the services offered by the practice increases. Subsequently, the level of knowledge required to successfully work with radiation, and to fulfil the role of the RPS can vary greatly between practices.

3. The Need for Training

The consequences of a lack of training are evident in the course of routine inspections by regulators, auditors and RPAs. In the UK, the Ionising Radiations Regulations are enforced by the Health and Safety Executive. In the past, targeted inspections by HSE have highlighted areas of concern in radiation protection standards. As recently as 2005, a veterinary surgery in Cornwall was prosecuted for deliberately radiographing people. In the last five years, HSE issued 15 improvement notices to veterinary practices in the UK, 7 of which referred directly to IRR99 and 2 specifically to training requirements of IRR99 [11].

There is both anecdotal and real evidence of exposures of personnel to the X-ray beam, with radiographs showing unprotected hands restraining animals. Such incidents would appear to be rare, or at least they are rarely reported. Paradoxically, reporting would indicate a level of competence and training of staff particularly where they have recognised a fault in the X-ray equipment and taken appropriate action. These may represent the tip of the iceberg, however, with numerous hand exposures unreported and dismissed as routine or trivial by those who lack the training.

Particularly evident is a lack of understanding about radiation risks with widely varying attitudes towards radiation. Two groups emerge. Under certain conditions, dependent on the needs of the animal, manual restraint of animals is practiced. There are clearly defined ways of doing this while ensuring that exposures to veterinary staff are kept as low as reasonably practicable. It should not be done as a matter of routine however as there are numerous ways of immobilising the patient without resorting to manual restraint. Nevertheless we encounter the daredevil who claims to have all the children they want and are therefore somehow immune to radiation. They hold animals as a matter of routine with 50 % of exposures being recorded as manual restraint in one practice we visited. We also encounter the radiophobe who refuses to risk his life for any animal. These attitudes can extend to corporate policy where manual restraint may result in dismissal. Arguably neither attitude is conducive to the ALARA principle, particularly when we encounter vets who insist that the owner holds the animal, without the owner being trained or having the necessary understanding to be able to give informed consent.
4. Professional Training

A typical veterinary practice is run by a practice manager, and employs several veterinary surgeons and veterinary nurses. Although only the surgeons and nurses will undertake procedures involving radiation, any one of these can be appointed as the RPS.

In order to become a practicing veterinary surgeon (or ‘vet’), a candidate must be registered with the Royal College of Veterinary Surgeons (RCVS), the profession’s regulatory body, having gained a recognised educational qualification [12]. In the UK, 7 teaching institutions offer a veterinary science graduate qualification approved by the RCVS [13]. The training lasts between 5 and 6 years, and includes clinical rotations to gain practical experience, which are predominately based in veterinary practices. Training in diagnostic imaging forms part of the syllabus [14]. An additional, post graduate qualification in veterinary diagnostic imaging is also available [15].

There are two routes to become a qualified veterinary nurse, either academically by obtaining a degree in veterinary nursing, or vocationally, obtaining a Level 3 Diploma in Veterinary Nursing, whilst working in a veterinary practice [16]. As with veterinary surgeons, the training is overseen by the RCVS. Again, part of the training includes modules on diagnostic imaging [17].

The content of the modules in diagnostic imaging is, by the very nature of the training, focused on animal care and diagnosis. Radiation safety is an integral part of the training, but whether the training is extended to include the supervisory aspects of the RPS role, and the duties they are then required to perform are explained, is not clear. Certainly, it is a requirement of post graduate training that all evidence submitted to achieve the qualification shows evidence of compliance with IRR99, however this again does not demonstrate RPS knowledge [18]. It would therefore appear that, although staff working with radiation are receiving suitable radiation safety training, additional, focussed training is also required for those needing to undertake the RPS role.

Given that a practice manager is an administrative role, it is unlikely they would have received any radiation safety training, therefore a dedicated RPS course is potentially the only training option for those managers appointed as RPSs.

5. Guidance for Veterinary Practices

Around 50% of the veterinary practices in the UK are accredited under the RCVS’s voluntary Practice Standards Scheme [2], and are inspected regularly to ensure they meet the minimum standard set by the RCVS. Their requirements are given in the Practice Standards Scheme Manual [19] which covers all aspects of running a veterinary practice and mainly reflect legal requirements. The safety requirements for work with X-ray equipment form part of the manual, and mirror the wording of IRR99.

Additional, stand alone guidance on compliance with IRR99 in the veterinary sector is given in ‘Guidance Notes for the Safe Use of Ionising Radiations in Veterinary Practice’, published by the British Veterinary Association and prepared with the support of the HSE and the National Radiological Protection Board (the precursor to CRCE, HPA) [20]. These notes are currently under review.
In addition to the requirement for the training of staff in radiation safety, both documents require the practice to appoint a ‘suitable’ RPS. Neither document stipulates the depth or format of training required, but both state that the RPS should have an adequate understanding of the requirements of the regulations, and know what to do in an emergency.

The HSE’s more detailed guidance on RPSs [3] gives a summary of the subjects to be included in the training, a list that is much more extensive and with a wider remit, than that contained within the BVA’s guidance. Has the profession’s focus on its own guidance lead to the widespread view held within the veterinary community that the initial professional training is sufficient?

6. The Veterinary Sector’s Understanding of Training Requirements

The HPA currently provides RPA services to over 150 veterinary practices. Visits are made in order to assess the suitability of X-ray equipment and radiography facilities, review the arrangements and provide advice on any improvements that should be made in order to comply with IRR99. A common finding is the lack of recent training received by the RPS. However, although dedicated RPS training and suitable refresher is accepted as best practice throughout other sectors working with ionising radiations, it does not seem to be the case in the veterinary sector.

A frequent belief held by the delegates questioned was that RPS training wasn’t mandatory, and that because the training didn’t result in a formal qualification, many appointed RPSs didn’t attend any training after their initial professional training. Additionally, a significant proportion held the view that the professional bodies did not encourage RPSs to be formally trained to undertake the role. One in fact noted that they ‘assume that you should know it as you are a ‘qualified vet’’. This view does little to encourage post graduate study.

The ongoing demonstration of competence within the veterinary sector is done through a voluntary Continual Professional Development (CPD) scheme [12], therefore there is less emphasis on qualifications expiring and needing to be re-done. One delegate commented that there is a lack of enforcement of formal training, and although this may be the case for the voluntary nature of the CPD scheme, there remains the legal requirement to be suitably trained, stipulated by IRR99.

The cost of attending a training course, and impact of being away from the practice whilst undertaking the training, were also mentioned as contributory factors for not undergoing dedicated RPS training.

There is a lack of guidance in general about the frequency at which RPS training needs to be refreshed, and this also applies to the veterinary guidance that has been issued. However, HPA would recommend training is refreshed every 3 to 5 years. This ensures that, not only is the delegate appraised of any changes to legislation or standards of best practice, they are reminded of the key issues relevant to their role. The majority of those questioned believed that they should undergo refresher training every 5 years, with delegates commenting that the lack of change to the regulations and the absence of any new developments in the field resulted in the low priority given to both attending both dedicated RPS, and subsequently, refresher courses.
7. The Future

To ensure that the appropriate level of radiation safety training is undertaken by the veterinary sector, it is paramount that we significantly raise the profile of both the need for appropriate training, and the availability of suitable training courses. Input into the revision of the BVA’s ‘Guidance Notes for the Safe Use of Ionising Radiations in Veterinary Practice’, presents one opportunity to raise the profile of training further. Training is not solely concerned with awareness of legislation, although this remains an essential aspect, but also about giving people the knowledge and understanding about radiation risks so that they may make proper judgements about protecting themselves and others.

8. Acknowledgements

The authors are very grateful to colleagues John Burton (HPA), Liz Grindrod (HPA), and Axel Macdonald (HPA) for sharing their experiences and views on this subject.

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RADIATION SAFETY TRAINING FOR EMERGENCY RESPONDERS

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ABSTRACT

Emergency responders (front line ambulance, fire and police) expect to face situations where a range of hazards are present. Only by understanding radiation risk in perspective and practical radiation protection in an emergency situation, can the exposures of responders (and others) be restricted so far as is reasonably practicable.

HPA’s Centre for Radiation, Chemical, and Environmental Hazards has been offering radiation protection training for key personnel within ambulance and fire services for a number of years. Most recently, this included a series of courses for ambulance staff who, when required, advise incident attenders and incident commanders on managing radiation risks. A substantive course has been developed, with the key objectives of:

- Ensuring the existence, magnitude and potential significance of the radiation hazard at an incident is properly identified;
- Enabling attendees to engage in meaningful dialogue with experts, consultants and other agencies; and
- Ensuring attendees can confidently implement agreed protocols.

The material is delivered through both presentations, and group work, including a series of practical exercises running in real time. Assessment of competence is achieved through observation of students’ performance in a practical setting. This method of assessment is particularly appropriate for this audience and effectively identifies both strong and weak performance.

This paper summarises the experience gained in providing this training, describes how the trainers addressed the issues unique to emergency responders and discusses the merits of a practical-based assessment.

1 Introduction

For many years, the Health Protection Agency’s Centre for Radiation, Chemicals and Environmental Hazards has provided radiation protection training to emergency service first-responders. Due to a package of work for the ambulance service, the volume of this work increased significantly in 2009. Since then approximately 200 individuals have been trained.

2 The Audience

The target audience is operational emergency first responders, who are required to co-ordinate radiation protection during the response to an incident with the potential for a radiation exposure. Such incidents might include (but are not limited to) CBRN, transport and industrial (including nuclear site) incidents.
The course students are typically:
- Fast-thinking and fast-acting (keen to take action)
- Highly practical and used to being active
- Team-players, relying on colleagues and collective decision-making
- Comfortable with seeking and implementing expert advice
- Clear and confident communicators
- Focussed on patient well-being
- Looking for a quick ‘black or white’ solution

3 Training Aims and Objectives

The overall aims of the training are that, on completion, students will have the competence to:
- Identify a radiation hazard, and evaluate its significance
- Ensure compliance with radiation policies drawn up by the employer
- Liaise with other parties, including owners of incident premises, receiving hospitals, other agencies (fire, police, ambulance) and radiation protection experts

Underpinning these aims, the specific training objectives are that students will:
- Understand the nature and properties of ionising radiation
- Be familiar with, and confident using radiation protection terminology
- Understand the potential hazards associated with ionising radiation (and the need to restrict exposure)
- Understand the basic principles of practical protection
- Be aware of the use of radioactive material in industry and medicine, and of readily-available, information about specific radiation sources
- Understand how measurements can be made in the field and know how to use available instrumentation
- Be familiar with agreed national protocols for dealing with radiation incidents.

Periodic refresher training aims to ensure the knowledge, skills and competence is maintained.

These training aims and objectives, along with the type of students attending, helped to shape the course content and delivery, which is outlined below.

4 Training format

4.1 Initial training

The initial training is delivered over four days, using a programme comprising of five modules:

1. Radiation Protection Basics
2. Regulations and Supporting Schemes
3. Hazard Recognition and Situation Analysis
4. Implementing Policies and Protocols
5. Assessment of Competence

This structured, modular approach, allows the radiation protection basics to be taught at the beginning of the course, without secondary discussion on practical issues. The advantage is
a focussed consideration of the relevant principles of radiation protection, still delivered using straightforward language, and still at a depth relevant to their role and responsibilities.

Taking more time on the first module does not mean more concepts, or more difficult concepts are taught, or that they are taught in more depth, it means that there is ample opportunity to explain, discuss, practice and provide experience (in the case of monitoring and dose calculations) resulting in a sound grasp of the principles that is called on later in the course and during their work. A short test is provided at the end of module 1, covering Radiation Protection Basics. This aims to identify any mis-understanding, to enable this to be corrected before moving on.

After a session on Regulations and Supporting Schemes, the session on Hazard Recognition and Situation Analysis takes the students through reasonably foreseeable types of incident, explains how likely internal and external radiation hazards are to arise, and what the magnitude of those hazards might be.

Towards the end of the course, the module “Implementing Policies and Protocols” comprises a full day of practical work, made up of three, one-hour practical exercises followed by full discussion and feedback.

The three exercises focus on the issues of managing:

1. an internal hazard (contaminated casualty in a contaminated area)
2. a modest external hazard (a casualty in a high dose rate area) and
3. a very significant (potentially life-threatening) external hazard.

The primary objective with these exercises is to consolidate taught material, this is achieved by remaining focussed on the relevant hazard; none of the exercises involves both internal and external radiation hazards.

The exercises take place in real time. Beginning with the initial telephone call, students are required to gather relevant information, evaluate the hazard based on readings or other available information, plan a course of action, taking into account the condition of the casualty and the potential dose to the crews, seek expert advice if required, undertake a brief dose / risk assessment for the task they must carry out, and finally treat or rescue of the casualty. Students are not guided, but a trainer provides immediate feedback at the end of each session.

Dose rate and contamination simulators add authenticity and enable external exposures to be quantified, so that the groups can compare the doses received.

4.2 Refresher training
Refresher training is undertaken at 3-5 year intervals

The refresher course is delivered over a day and a half. The objective is to refresh principles, discuss any experience gained since initial training, and re-assess competence via a challenging exercise.

5 Assessment

The end-of-course assessment (at the end of the initial full course), which incorporates both desk-top and practical assessment aims to test knowledge, understanding, judgement and skills. Based on a single scenario (eg a transport accident), the first, written part of the
assessment requires students to indicate where they would find the information they require, then plan the next steps and indicate how they would advise those at the scene. Students can obtain about 50% of their overall score in this (written) part of the paper.

Students are physically taken to the scene of the (simulated) accident for part 2 of the assessment, and asked to make a series of measurements, demonstrating, to the satisfaction of two independent observers, that they can competently enter a potentially contaminated area and make both dose rate and contamination measurements. This part of the assessment is undertaken in small groups.

5.1 Advantages
The assessment method combines a test of knowledge with a test of skill and judgement. This is a fair test for candidates who must make quick decisions, on which incident management will depend. Where candidates perform poorly, it is usually in the practical section. Observing performance in a practical setting is the only means of genuinely testing, for example, monitoring skills and contamination control.

5.2 Disadvantages
Judging five candidates on a group performance means some loss of specific and individual assessment. There is a risk that a group is judged according to the performance of the strongest personality. The problem can be further confounded when colleagues who know each other are placed together, particularly if students are in the same group as their superiors.

On balance, however, the testing of skill and judgement is important for this audience and, we believe, important enough that this technique should continue. Options for overcoming some of the difficulties are currently being explored. To date, 88% of candidates achieved more than 65% in the exam – the nominal ‘pass’ mark.

6 Experience gained
The experience gained over the 14 courses has lead to some refinements to content and structure; specific examples are discussed below:

6.1 Perspective
Students have demonstrated a tendency to consider all presented radiation hazards to be a significant risk. Often the first consideration in the exercises is a ‘snatch rescue’ (i.e. grabbing the injured person and dragging him/her to safety in 30 seconds or less) even if this only prevents a dose of a few mSv. The injuries that the casualty might sustain in this process may be overlooked or considered to be justifiable. In more recent courses, students have been strongly encouraged to pay more attention to the condition of the casualty; presenters often have to remind students to balance the risk!

6.2 Timing
Because of the students’ desire to take quick action, it can be a challenge to make exercises last long enough for the issues and solutions to be fully explored. Various techniques were used on refresher courses recently to extend the exercises, for example the groups are brought together periodically to brief each other on their progress, so that all options are discussed. These (refresher) exercises also develop and change in real time, for example by injecting evidence of contamination, or making new measurement equipment available at short notice.
6.3 Teaching the basics
It is important not to present concepts in overly mathematical or scientific language. For example, a simple rule of ‘double the distance, quarter the dose rate’ and ‘10 times the distance, dose rate reduces by 100’ - rather than discussion of the ‘inverse square law’ - is enough on a working level (uncertainties are no more than they would be in practice).

Similarly, the terms ‘alpha particle’ and ‘beta particle’ cause confusion, particularly during discussion on contamination. The terms ‘alpha radiation’ and ‘beta radiation’ fit this audiences’ needs very well in practice and eliminate this potential for confusion.

7 Conclusion

Overall, both course managers and students have found this course to be successful, evidence is given in the competent performance of students during subsequent emergency exercises. Refinements and further developments are on-going.
ACCREDITED RADIATION PROTECTION TRAINING
FOR THE AUSTRIAN POLICE

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ABSTRACT
Although there is no nuclear industry in Austria, there are still many possible scenarios which require proper actions by First Responders and specially trained radiation protection personnel. The legislative basis for the interventions of the police are the radiation protection act and the based upon interventions regulation, furthermore the penal law and the law on the transport of dangerous goods.

The Austrian Police has 515 persons specially trained and equipped in radiation protection who act as intervention personnel for radiological emergencies following the interventions regulation. Their training consists of three consecutive courses and follows the interventions regulation and the Austrian standard ÖNORM S 5207. It is held at the Civil Protection School in Traiskirchen near Vienna which is certified as a training centre for intervention personnel by the Austrian Standards Institute.

This paper describes the modular structure of the sector specific training and its duration and content as well as the further trainings available to the radiation protection personnel of the Police. For example, there are special trainings for gamma-aeroradiometry from Police helicopters.

Practical exercises are an essential part of the three-week training. During those exercises, specific value is set to the training of extraordinary situations to make sure the intervention personnel have solutions ready when needed in real emergencies. For example, medical emergencies are simulated to train first aid skills.

Finally, the authors will show how feedback from experience is implemented into the trainings. From all radiation protection events the Police handles all over Austria, reports are sent to the Civil Protection School for evaluation. Thus, continuous improvement of the training is guaranteed.

1. Introduction
By Federal Constitutional Act, Austria is “atom free” – fortunately, in reality it is not. However, in Austria it is forbidden to obtain energy by nuclear fission and to transport fissile material for this purpose as well as for disposal [1]. But even without any nuclear industry, radiation protection is a very important issue for the Austrian Police. Scenarios include, but are not limited to nuclear events in neighbouring countries, accidents with high activity sealed sources or within Austrian facilities and the re-entry of satellites with nuclear or radioactive inventory. This paper outlines the structure and content of the three consecutive training courses conducted by the Civil Protection School within the Federal Ministry of the Interior.
2. **How Police is involved**

Due to the Radiation Protection Act, the Austrian Police is responsible when radioactive sources are lost or found. It also serves as an auxiliary to each of the nine states (like, for example, Vienna, Tyrol or Lower Austria) during large-scale radioactive contamination scenarios [2]. The Radiation Protection personnel of the Police is named as Intervention personnel in the Federal intervention plans for radiological emergencies [3]. Furthermore, the Police has to investigate cases of criminal or terrorist use of radioactive or nuclear material [4]. Controlling transports of dangerous goods, in this context especially focused on the transport of radioactive material, is a Police matter as well [5]. In those scenarios, Police actions can include dose rate or contamination measurements, taking probes, cordonning off contaminated areas or areas with high dose rates etc.

Only 515 of the more than 20,000 Austrian Police members are specially trained and equipped to respond to radiological incidents.

3. **Certified Training**

The Civil Protection School, which is part of the Federal Security Academy of the Ministry of the Interior, conducts three consecutive training courses on radiation protection (basis training, advanced training I and II). All three courses follow the Austrian Standard S 5207 [6] as well as the Intervention Regulation [7]. Currently, the Civil Protection School, located in Traiskirchen near Vienna, is Austria’s only certified training institution [8] (Fig. 1).

![Fig. 1. Representatives of the Austrian Standards Institute together with Federal Minister of the Interior Johanna Mikl-Leitner and head of the Civil Protection School Günter Timal.](image)

The basis training has a minimum duration of 30 teaching units. It includes basic knowledge and skills on radiation physics, radiation protection, biological effects of radiation, radiation measurements, dosimetry, first aid, labeling of radioactive material, tactics and contamination control. About half of the training is conducted “hands-on” to make it as understandable and practical as possible.
Advanced training I lasts another 30 teaching units at least. During this course, the participants learn more about radiation physics, radiation protection and radiation measurements. New topics include transport of radioactive materials, decontamination, use of man-made radiation sources, legal issues and taking of environmental samples. Once again, as much of the training as possible is done hands-on. Very much is done to make the training as realistic as possible. For example, decontamination forces of the fire brigade are an important player in one of the exercises. When the participants return from the “contaminated” area, contamination control is conducted and, if “contaminated”, they have to go through the decontamination process (Fig. 2).

![Fig. 2. Decontamination of police forces, conducted by the fire brigade](image)

Having passed advanced training I, participants will take the radiation protection challenge in bronze at Seibersdorf Laboratories. During this contest, the knowledge and skills are tested in a very practical and realistic way.

With another 30 training units, advanced training II is the final course of the three-week training for intervention personnel. Participants who pass this course are enabled to act as an incident commander within their organization during a radiological emergency. Consequently, the content is very much focused on leadership qualities which are needed for radiological incidents and emergencies. In-depth knowledge about radiation physics, dosimetry and tactics is provided. For this purpose, the Civil Protection School cooperates with several external institutions. The participants visit the TRIGA Mark II research reactor of the Atomic Institute of the Technical University of Vienna to learn more about nuclear fission. A representative of the national regulatory authority, the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) informs about emergency preparedness on a national level. The Austrian Armed Forces (CBRN Defense School) provide information about nuclear weapons.

Following advanced training II, there is the radiation protection challenge in silver which is conducted on location in Traiskirchen at the Civil Protection School. It is based upon a set of regulations that has been in force for 50 years, compiled by Seibersdorf Research Center, Austrian Armed Forces, Police, Fire Brigade and the Red Cross in the 1960s.
4. Retraining

All intervention personnel have to attend 16 hours of retraining each year, following the Intervention Regulation [7]. Thus, each year about 25 identical two-day courses are conducted by members of the Civil Protection School to provide the retraining for all 515 radiation protection specialists of the Police. Those courses take place all over Austria. Additional eight hours of training are provided regionally by the local police command of the referring federal state.

The retraining includes both theoretical and practical parts (Fig. 4). Its contents depend on the requirements as well as on up-to-date developments. The scenarios for the practical parts are mostly in line with the actions the police has to conduct due to the legislative provisions, for example:

- Search for a lost source on an industrial site
- Radiation/contamination control of items with radiation warning symbol
- First Responder duties after traffic accidents with radioactive materials involved
- Control of dangerous goods transports with radioactive materials
- Screening for illicit trafficking of radioactive materials

Each year, different scenarios are chosen to avoid boredom. Furthermore, the context of known scenarios is changed every time to keep up the suspense. Specific value is set to the training of extraordinary situations to make sure the intervention personnel has solutions ready when needed in real emergencies. For example, medical emergencies are simulated to train first aid skills. The presence of extra radiation sources (like, for instance, three sources when only two were said to be lost) puts a strain on the trainees as well. Also, sometimes no radiation sources are used to simulate misuse of the radiation warning symbol – the teams have to decide whether there is a radiological danger or not.
5. Aeroradiometry

As a follow-up training, there are special courses held for gamma-aeroradiometry. During large-scale contamination situations, the Austrian police would conduct gamma-aeroradiometry flights by helicopter (Fig. 5). All over Austria, the Police have ten aeroradiometric sets at their disposal which can be brought into action within almost no time.

![Gamma-Aeroradiometry results of the police flights](image)

Of course, this specialised task demands a lot of training. All participants must have passed the advanced training II and the radiation protection challenge in silver. Then, they learn how to conduct measurements from the helicopter in another four-day course. Each year, a one-day refreshing course is obligatory.

6. Constant improvement

If the Police responds to a radiological incident or conducts controls of transports of radioactive material, all reports are sent to the Civil Protection School. Thus, there is a lot of data available on what the needs of the personnel are. Ideas for new exercise scenarios are often taken from real events that happened some months ago. Also, the media are screened to find out what is happening outside Austria. Thus, a constant improvement of the courses is given.

7. Concluding remarks

Thanks to a certified training, the radiation protection experts of the Austrian Police are well prepared for radiological emergencies of many kinds. Collaborations with science, regulatory bodies and other organisations are an essential part of the success. Experiences from both exercises and real events help to improve the training even further.
8. References


EDUCATION AND TRAINING IN RADIATION MEDICAL PHYSICS IN BELARUS: AT THE STARTING POINT

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ABSTRACT

After the decision of Belarus government to introduce education and training in radiation medical physics in Belarus the preliminary work has been done: Ministry of health has analyzed the demand in medical physicists up to 2020, the main professional requirements were worked out and the new specialty called “Medical physics” was authorized at the undergraduate level. There is the time to process the educational standard and typical syllabus to launch since September, 2013 the training in medical physics at the base of International Sakharov Environmental University (ISEU) where many of experienced lecturers and instructors are collected. It is anticipated to create an ISEU department of medical physics at the Republican Research and Practical Centre of Oncology and Medical Radiology in the nearest future. Efforts of specialists involved in preparation of educational and training programme are concentrated now on developing core elements of the syllabus in correspondence to national requirements. There are 5 blocks of general education to be harmonized between each other in the syllabus: higher mathematics, general and theoretical physics, computer science, basic chemistry, basic medical knowledge. Special education and training embraces physics of a nucleus and ionizing radiation, radiation detection and measurement, radiochemistry and radiation chemistry, biochemistry and biophysics, biological effects of ionizing radiation, dosimetry, radiation protection, medical exposure and devices, etc. The details how to form the content of each discipline in accordance to professional requirements to future specialists are discussed in the report. There are also formulated the suggestions how to develop the system of education and training of medical physicists in Belarus to reach its sustainability.

1. Introduction

There understanding of the necessity to introduce education and training in medical physics in Belarus was maturing during many of years. Rapid development of equipment and radiation technologies in cancer clinics was challenged by the growth of cancer diseases in Belarus last years. The estimation of the demand in specialists that are to be occupied in medical radiology except relevant physicians was done in 2010 by one of the authors of the present paper, Prof. I. Tarutin and was about 500 specialists to be trained until 2020. He also listed for the health authorities the specific professional requirements to medical physicists that were based on internationally recognised approach (look at e.g. [1,2]).

The role of medical physicists in Belarus hospitals is playing now by engineers – radiologists but their training is not carried out by any university or other higher education institution. The basic professional training they received, in the best case, at the nuclear physics department of Belarus state university. The majority of them are very experienced but very adult people, commonly, after retiring age. So, the country is faced by problem to form a new generation of specialists in the field.
The IV congress of oncologists, held in November, 2011, called to the Ministry of Labor and social protection to introduce the jobs of “Medical physicist” and “Physician of radionuclide diagnostics”.

The decision to establish education and training of medical physicists in Belarus was taken in May, 2012. Since that time some important steps where passed.

- The position of “medical physicist” has been introduced in the legal system of labour in the country.
- The undergraduate specialty “Medical physics” was inserted in the legal list of specialties in Belarus.
- The demand of medical physicists in the country was assessed by the Ministry of health of Belarus in 200 people up to 2020.
- The development of education and training programme and its implementation was committed to the International Sakharov Environmental University.

2. The capacity of International Sakharov Environmental University to host the education and training in medical physics

International Sakharov Environmental University (ISEU) was created in 1992 for alleviating the consequences of Chernobyl disaster. Now it becomes an institution that educates and trains specialists at the interface of physics, chemistry, engineering, biology and medicine. During dozens of years except the first times of Belarus independence in early 1920\textsuperscript{th} it was not habitual for all the classical universities in Belarus to have medical departments up to now. There was ISEU that had “mixed” physicists and biologists in one glass to give rise to penetration into ideas of each other and had produced the mutual understanding how the problems laid at junction of different fields can be solved.

During the years of its work the ISEU had developed and implemented a number of multidisciplinary syllabi for undergraduate level: “Radioecology”, “Radiobiology and radiation medicine”, “Environmental engineering”, “Medical ecology”, “Medical and biological deal”, “Environmental information systems”, “Information systems in human health”, , “Nuclear and radiation safety” etc. The last three of them are under renovating and re-establishing now for further education and training within 4-5 year term. There are also several master programmes developed in ISEU in the fields listed above to continue the education and training at higher level for purposes of academic system and science.

There are several educational departments in ISEU like “Nuclear and radiation safety department”, “Department of radiobiology and radiation medicine”, “Human biology department”, “Department of molecular and environmental genetics”, “Radiation hygiene and epidemiology department” and some departments that play auxiliary role to train in general and theoretical physics, electronics, computer science that are able to implement all the parts of a syllabus for medical physics except, may be, narrow radiological topics. All the departments are staffed by professors of biology, medicine, physics, chemistry and engineering that are able to play leading role in the development and implementing the appropriate academic programme. The departments are equipped enough to start the education and training process in medical physics.

The training specific to radiation medical physics is supposed to be supervised and carried out by highly experienced staff from National Cancer Centre of Belarus. Some of them are currently part time professors in ISEU. The facilities of the Centre are available for students during their practice and implementation of project works. The Post-Graduate Education Course (PGEC) on radiation protection and safety of radiation sources implementing in ISEU during last 13 years provide a great
contribution into human development of ISEU staff and its collaborators to be at the up-to-date level in education and training in medical physics. IAEA Education and training appraisal mission in the middle of 2011 had recommended [2] that ISEU should apply to the authorities in concern to start the training in medical physics. At that time it was considered to be more convenient to start with the post-graduate course. But the life had lead, first of all, to establishment the full undergraduate course for 5 year education and training in medical physics.

3. New undergraduate academic plan in medical physics

Any academic plan in medical physics is new for Belarus that started to go in this way only now. The draft that is now for discussion is composed on the base of experience in the field of many of institutions providing education and training in medical physics round the world. Comparing the actual draft with relevant programmes of other universities one should assume that there are a lot of specific regulatory requirements within the educational system in Belarus established by the Ministry of education that are aimed to assure appropriate quality of education at the stage of planning.

First of all, there is the strong reference that medical physics is one of the specialties belonging to the block of the physical sciences. That is why the undergraduate academic plan on medical physics in Belarus should contain obligatory subjects related to higher mathematics, general physics and theoretical physics that form the firm platform of qualification of any physicist despite of his/her job after graduation. They are:

- **Mathematical and General**
  - Mathematical analysis (15 ECTS);
  - Analytical geometry and higher algebra (7,5 ECTS);
  - Theory of complex functions and functional analysis (4,5 ECTS);
  - Computer science (7,5 ECTS);
  - Probability theory and statistics (4 ECTS);
  - Tensor calculus and computer geometry (5 ECTS);
  - Differential and integral equations (6,5 ECTS)
  - Methods of mathematical physics (5 ECTS);

- **General physics**
  - Mechanics (9,5 ECTS);
  - Molecular physics (9 ECTS);
  - Electricity and magnetism (9 ECTS);
  - Optics (9 ECTS);
  - Physics of an atom atomic phenomena (7,5 ECTS);

- **Theoretical physics**
  - Theoretical mechanics (6 ECTS);
  - Electrodynamics (7 ECTS);
  - Quantum mechanics (7,5 ECTS);
  - Thermodynamics and statistical physics (8 ECTS).

At the stage of nuclear physics the draft of academic plan differs from the same plans for other physical specialties. The discipline “Physics of a nucleus and elementary particles” is converted into the “Physics of a nucleus and ionising radiation” (7,5 ECTS) supplemented by the separate course on “Radiation detection and management” (7,5 ECTS). After that the subject “Dosimetry” (6 ECTS) is studied. It is finished by measurement practice in laboratory with defending a project onto a
specific topic within the discipline. This direction is ended by studying “Radiation metrology” (2 ECTS) and “Radiation shielding” (6,5 ECTS). There is the special ‘chemical line’ in the draft of academic plan for medical physics. The starting point is given at the second year when students study chemistry comprising two parts: “General and inorganic chemistry” and “Organic chemistry” (4 ECTS each). It should help to prepare students to listen then to specific courses like “Biochemistry” (3,5 ECTS), “Radiochemistry” (3,5 ECTS), “Radiation chemistry” (2 ECTS) that are aimed to give students the background for understanding specific requirements to preparation, storing and acting of radiopharmaceuticals that is studied in “Nuclear medicine” (2,5 ECTS).

The ‘biomedical line’ is started rather late, only in the 4th year. Students are briefed in “Anatomy and physiology” (4,5 ECTS), “Cytology and histology” (1,5 ECTS) and “Genetics” (1,5 ECTS). Together with “Basic biophysics” (4 ECTS) it provide the base to understand then the “Biological effects of ionising radiation and human health” (4 ECTS), “Oncology” (3,5 ECTS), “Molecular-genetic radiation effects” (3,5 ECTS) and block of disciplines covering the medical radiology issues – “Diagnostic and intervention radiology” (3 ECTS), “ Radiation therapy” (5 ECTS) and “Nuclear medicine” referred above.

There is also radiation safety and regulatory line in the academic plan: “Basic radiation safety” (4 ECTS), “Radiation protection at medical exposure” (3,5 ECTS) and “Regulatory framework of radiation safety” (1,5 ECTS).

The content of all the subjects are under development now to meet qualification requirements to the medical physicists.

The academic process finishes by practice in clinics (10 weeks), passing the state exam on major topics of the specialty and, finally, preparation and defending the project work.

According to regulations in educational and training system in Belarus the academic plan briefed above must be accompanied by the educational standard that should include the field and objects of the professional activity of the medical physicist, description of competences that a medical physicist have to possess, typical academic plan and main content of compulsory subjects with description of the specific requirements to knowledge and skills of a graduate gained as the result of completing programme for each compulsory subject and demonstration how these requirements meet competences mentioned above.

On the base of these two documents the other relevant courses can be developed to form the entire system of education and training in medical physics in Belarus.

4. To establishment of education and training system in medical physics in Belarus

Medical physics is rapidly developing branch of applied physics that include not only ionising radiation issues but action of all physical factors on humans and their use to diagnose and treat patients. However, the radiation medical physics occupy the main room in the brunch. Nevertheless, the build-up of the academic plan drafted above provide the opportunity to develop it easily for other physical applications in medicine, if necessary.

The other way to develop the training programmes is to establish the appropriate post-graduate course. Its content and duration can be assumed from the same well developed training programmes in Europe and United States.

To train highly qualified specialists that then can play a role of experts in medical physics the specific master course on medical physics is desirable. The sustainable system of education and training medical physicists in Belarus in the nearest future may looks like according to the chart depicted at the Fig. 1.
The content of training specialists in medical physics at the tertiary level may be assumed from the experience of leading countries in the field. It should be focused on specific issues that require deep knowledge of particular things, like, for example, specific shielding, image processing, tools for exposure planning, dose assessment, etc.

The sustainability of the scheme can be provided by application of the cycling process described in [1] where the appropriate assessment of training needs play the key role. This is the crucial point of any education and training system.

References

NORM AWARENESS TRAINING: AN OVERVIEW OF HEALTH EFFECTS OF NATURALLY OCCURRING RADIOACTIVE MATERIAL IN THE OIL AND GAS INDUSTRY

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ABSTRACT

There has been an exponential rise in oil and gas exploration, particularly with hydraulic fracturing more commonly known as “fracking”. Naturally occurring radioactive material (NORM) still remains a problem in oil and gas exploration. Radioactive wastes from oil and gas drilling take the form of produced water, drilling mud, sludge, slimes, or evaporation ponds and pits. In many parts of the USA the soil contains radioactivity that becomes concentrated in mineral scales on the pipes, storage tanks and other extraction equipment. The radionuclides $^{226}$Ra and its daughter products $^{222}$Rn, $^{210}$Pb, from $^{238}$U and $^{228}$Ra from $^{232}$Th are the primary radionuclides of concern in the waste. Enviroklean Product Development Inc. (EPDI) is a company that specializes in NORM waste cleanup in West Texas. EPDI has developed a module to help the managers and workers in the field become aware of the precautions needed when handling these materials. A detailed and comprehensive overview of the NORM training program given to all the EPDI employees is presented.

1. Introduction

In the past few decades there have been significant reforms to the way that NORM or technologically enhanced NORM (TENORM) in the oil and gas field is being regulated. New laws and guidelines on disposal of NORM have changed many ways in which companies can handle and dispose the products contaminated with radionuclides. Since NORM is not federally regulated the changes have primarily come from three states including: Texas, New Mexico and Louisiana. However other states are now beginning to exploit many of these resources in the oil and gas field with improved technologies. As these changes take place and are enforced many state government agencies are requiring that more training classes be given to workers in the oil and gas field. Improved teaching methods are being put into place to ensure that the people working in the field have a comprehensive knowledge of NORM. In Texas the Rail Road Commission (RRC) (1) and Texas Department of State Health Services (DSHS) (2) set down laws and regulations for dealing with NORM in the oil and gas industry. The RRC regulates the disposal of oil and gas NORM. The DSHS regulates NORM contaminated substances such as soil and equipment. They also set regulations for storage, transportation and commercial distribution of the products from oil and gas drilling including produced water. Any waste, substances or commercials products that are above the limits set by the state must be handled as NORM.
During the process of drilling for oil and gas, radionuclides are removed from beneath the earth and increase in concentration. Uranium, thorium and radium tend to have an affinity for crude oil and collect in higher concentrations. In particular $^{226}$Ra, $^{222}$Rn and $^{210}$Pb the daughter products of $^{238}$U and $^{228}$Ra the daughter product of $^{232}$Th are brought up to the surface while drilling for the hydrocarbons trapped within geological layers. Although uranium and thorium are mostly insoluble, their daughter products are soluble and can easily be transported to the surface in water produced from the drilling operations. The radionuclides also tend to result in scale build up inside the pipes and tanks. Scale is a mixture of calcium, barium, strontium and radionuclides that adheres to the inside of the pipes during production of crude oil and gas. Figure 1 shows the scale buildup on the inside of pipes.

![Figure 1. Scale buildup inside pipes from the oil and gas field](image)

### 2. Training NORM Regulations

The training is not only limited to employees directly dealing with the NORM or in the field. It is also beneficial for employees in management positions to be trained in health and safety and current regulations. It is a valuable resource for other companies in the oil and gas field to have their employees trained in NORM awareness so that they understand the risks and regulations of working with this part of the oil and gas field industry. These other companies may then train other field or environmental workers as well as executives. The class needs to comprise a general introduction to radiation as well as worker safety and health concerns. This includes going back to the fundamentals of general chemistry including what an atom is and its components. Taking the extra time and care to go over the basics will help provide benefits in both health and safety and avoid any potential violations. Next it is important to determine where the radiation in the oil and gas field comes from using decay series and visual aids. A general description of where NORM collects during the process is also useful.

One of the most important aspects in the training course is worker safety. This includes but is not limited to on the job site safety, emergency preparedness and personal protective equipment (PPE). The PPE varies depending on what the particular job entails and can include fire-retardant clothing, gloves, safety goggles, mask, steel toed boots, TLD badge, hydrogen sulphide ($\text{H}_2\text{S}$) monitor, hard hat and self-contained breathing apparatus. Stressing the importance of PPE is not only vital to the safety of the workers but important for adhering to
state and national guidelines. This part of the training should be ongoing and emphasized everyday by the radiation safety officer (RSO) of the job site. For example forgetting to wear an H₂S monitor can lead to potentially serious health effects and could easily be prevented. It is mandatory that each day the onsite RSO go over the safety guidelines for the specific job site. Greater precautions should be exercised in regard to closed container operations. The radionuclides especially ²²²Rn (radon) tend to build up in the lower levels of the tanks or containers, therefore a self-contained breathing apparatus is always necessary. The class also highlights the importance of monitoring for low levels of radiation each time someone leaves the restricted area. This method, called “frisking out”, is when the RSO on duty runs a pancake probe Geiger Müller (GM) counter over the person’s body focusing especially on the hands. If the readings are above background, the employee is required to wash the affected area and change clothes if necessary. This procedure is outlined with great importance in order to prevent accidental ingestions of radionuclides from the job site.

Another imperative section of the training is the education pertaining to the health effects of NORM. Since all high doses of radionuclides can potentially cause damage, the class focuses on the four radionuclides that pose the most concern in the field: ²²⁶Ra, ²²²Rn, ²²⁸Ra and ²¹⁰Pb. Emphasis is also placed on how NORM is indistinguishable from non-radioactive material. Providing pictures of scale and buildup on pipes helps reinforce proper safety when dealing with these radionuclides. Explaining how radiation enters the human body is also a key point. Using a chart to describe the simplistic interactions between the gamma rays, alpha and beta particles is also advantageous. This supports the point that the highest risk of working with the NORM comes from ingesting the radionuclides containing alpha and beta particles and also helps highlight the necessity of using gloves and frisking out when working around this material.

The class ends with a review of the important facts followed by an examination of the material learned. After passing the test employees can work with NORM knowing the proper procedures and protocols required for its handling. For new workers it is important to stress the key facts learned during the course to ensure proper safety procedures. A refresher course for employees that have worked with NORM for a number of years is beneficial since it is easy to become complacent and forget NORM’s safety and health effects. An overview of the implementation of these rules and regulations is seen in Figure 2.
3. **Training Different Levels of Education**

A big hurdle in training for NORM in the oil and gas field in Texas is the wide array of academic backgrounds that one may come across of those taking the course. Many times the knowledge of NORM or radiation can be limited. This then necessitates spending more time on the basics of radiation or even chemical science before the employees are able to properly understand the meaning of radiation. Taking the time to teach the individual class members the fundamentals immensely helps them to understand the class material. It is useful to show how a typical person interacts with low levels of radiation in their everyday life and that working with radioactive materials does not have to be a hazard, providing proper precautions are followed.

The population of Spanish speaking residents is growing in Texas. The need to train employees who are not fluent in English is becoming more common. During these classes it is important to make sure that everyone follows the instructions. This is best accomplished by ensuring that there are bilingual people in the class who can help with translation.
The training of employees with a non-scientific background also entails that they understand the importance of taking samples and correctly labeling them for further off-site analysis. Receiving samples that are improperly labeled or not labeled at all can be a major problem especially when dealing with radionuclides such as $^{222}$Rn that have a short half-life. In order to get an accurate reading of radionuclides, it is important that the air samples be labeled with the date they were taken and length of sampling time. This portion of the training needs to be refreshed at least once a month to ensure that the employees adhere to proper sample protocols. This should include an explanation of the importance of the sample and how it is analyzed. A simple depiction of this training process is seen in Figure 3.

![Figure 3. Integrated Overview of NORM Worker Training](image)

4. **On the Job Site Monitoring and Training**

Each job site that EPDI works on has to be monitored at all times because of the nature of the NORM/TENORM that is being decontaminated and cleaned up. On the job training may be necessary if a new or different situation is encountered. If this is the case it is the responsibility of the RSO on the job site to help train and monitor the site. It may be required for a portion of the actual job training to take place on site to better inform the employees. Hands on training in addition to in class instruction, helps to reinforce the material being taught.

5. **Conclusions**

Training workers on NORM is valuable for the health and safety of the employees in the oil and gas industry and the general public. Refreshing all employees on the subjects they have learned will help create a safer work environment and minimize accidents. It is important to update and make changes to the ongoing training as new laws and guidelines are put into effect. With the training course and proper on site job monitoring, the risks of working with NORM are greatly reduced making it a safe working environment for all.

6. **References**

1. Texas Rail Road Commission, www.rrc.state.tx.us
2. Texas Department of Health Services, www.dshs.tx.us
RESULTS AND LESSONS LEARNT FROM THE 2010 AND 2011 INTERNATIONAL TRAINING COURSE ON MANAGEMENT OF WASTE IN ACCORDANCE WITH IAEA SAFETY STANDARDS AND INTERNATIONAL BEST PRACTICE ETRAP2013-A0070

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ABSTRACT

The Waste and Environmental Safety Section (WES) and the Waste Technology Section (WTS) of the International Atomic Energy Agency (IAEA) are jointly responsible for supporting Member States in the exchange of information, to increase capacity and to enhance national capabilities concerning all aspects of management and disposal of radioactive waste (RW). Increasingly it has been the IAEA’s experience that regulatory authorities and radioactive waste management organizations are becoming more reluctant to provide fellowship training opportunities to applicants from IAEA Member States with developing programmes, largely due to operational pressure and the commercial nature of some of these organizations. To this end, a decision was made to develop a comprehensive RWM curriculum that jointly covers aspects of both safety and technology with an appropriate balance and that ensures that the two dimensions are delivered in a complimentary and consistent manner, including integration where appropriate.

In 2010 and 2011, WES and WTS jointly established and managed a comprehensive 6-week training programme for predisposal and disposal of radioactive waste in co-operation with the Technische Universität Clausthal (TU Clausthal). This course was aimed at new entrant professional staff from operating, regulating and supporting organizations who currently are, or are envisaged to be, involved in developing national policies or strategies, developing and implementing legal and regulatory framework, or managing radioactive waste from its generation until disposal, discharge, or clearance from regulatory control.

The objectives of the course were to provide participants with up-to-date knowledge and lessons learned on issues specific to radioactive waste management; familiarise them with relevant international requirements and guidance as laid down in the IAEA safety standards, supporting documents and international conventions; and provide practical experience and opportunities for exchange of information and sharing of experiences. The course was structured to address each of the following elements in a balanced manner: theory (lectures); practical exercises; technical visits to waste management facilities; workshops and plenary discussions.
1.0 Introduction

The IAEA, under the terms of Articles III and VIII.C of its Statute, makes available and fosters the exchange of information relating to peaceful nuclear activities. Building competence through education and training is fundamental to the establishment of a comprehensive and sustainable national infrastructure, which in turn is essential for protecting people from the harmful effects of radiation. Such training provides important foundations for the safe implementation of nuclear activities, and increases confidence in Member States, especially those that currently possess limited resources or are at an early stage of programme development.

The Waste and Environmental Safety Section (WES) and the Waste Technology Section (WTS) of the International Atomic Energy Agency (IAEA) are jointly responsible for supporting Member States in the exchange of information, to increase capacity and to enhance national capabilities concerning all aspects that relate to the management and disposal of radioactive waste (RW). At the present time the IAEA provides numerous opportunities for the training of managers and experts representing national programmes, regulatory bodies, and organizations with responsibilities in management and disposal of RW, and staff of national regulatory bodies responsible for licensing and inspection of such facilities, either through bilateral agreements or through the mechanism of thematic projects and networks (e.g., PRISM, GEOSAF, SADRWMS, URF Network, Disponet, IDN, Environet and Labonet).

Increasingly it has been the IAEA’s experience that regulatory authorities and RW management organizations are becoming more reluctant to provide fellowship training to applicants from the IAEA, largely due to operational pressure and the commercial nature of some of these organizations. To this end, a decision was made to develop a comprehensive RWM curriculum that jointly covers aspects of both safety and technology with an appropriate balance and that ensures that the two dimensions are delivered in a complimentary and consistent manner, including integration where appropriate.

In 2010 and 2011, NSRW-WES and NEFW-WTS jointly established a comprehensive 6-week training programme for predisposal and disposal of radioactive waste in co-operation with the Technische Universität Clausthal (TU Clausthal, an institute of technology located in Clausthal-Zellerfeld, Lower Saxony, Germany). The first (pilot) programme was offered at the TU Clausthal campus (6 September – 15 October, 2010); and on the basis of the feedback received, a 2nd course was offered again at TU Clausthal in 2011 (September 5 – October 14, 2011).

2.0 Programme Objective and Structure

The objectives of the 6-week training programme were to provide participants with up-to-date knowledge and lessons learned on issues specific to radioactive waste management; familiarise them with relevant international positions as laid down in the IAEA safety standards, supporting documents and international conventions; and provide practical experience and opportunities for exchange of information and sharing of experiences, considering the main technical areas:

- **General Aspects**: Basic Principles of Radiation Protection and Radioactive Waste Management; National Legal, Institutional and Regulatory Infrastructure for Radioactive Waste Management; Waste Arising and Waste Classification; Principles of Radiation Monitoring; Principles of Quality Assurance

- **Predisposal Management of RW**: Storage of Radioactive Waste and Spent Nuclear Fuel; Safety Assessment of Predisposal Facilities; Regulatory Control and
Methods for Assessing Dose from Discharges; Off-site Transport, On-site Handling and Transboundary Movement of Radioactive Waste

- **Management of Special Radioactive Waste**: Disused Sealed Radiation Sources; Mining and Milling Waste; NORM Waste; Environmental Restoration; Decommissioning of Nuclear Facilities; Remediation of Contaminated Sites

- **Radioactive waste disposal**: Principles, Criteria, and Options for Disposal; Requirements for Near Surface Disposal of Low and Intermediate Level Waste; Requirements for Geological Disposal of High Level and Long-lived Waste; and Safety Assessment


The 2010 and 2011 courses were structured to include theory (lectures); practical exercises; technical visits to waste management facilities; workshops, and plenary discussions. The starting point for the provision of content was based on existing training materials (RWM course syllabus with supporting MS Powerpoint slides) developed by WES in 2007, in which the focus of the material was on those issues that were considered essential for both regulators and operators in terms of ensuring safety and demonstrating compliance with the IAEA safety standards and criteria. The main rationale for the original training material was that safe radioactive waste management requires the implementation of measures that will afford protection of human health and the environment, since improperly managed radioactive waste could result in adverse effects to human health or the environment now and in the future. It is also a feature of radioactive waste management that special attention is given to the equal protection of future generations and ensuring that there is no additional burden placed on these future generations through the consequences of activities that are carried out today. Considerations related to future generations may include potential radiation exposure, economic consequences and the possible need for surveillance or maintenance. Even though there are large differences in the origin and characteristics of radioactive waste; for example, concentration, volume, half-life and radiotoxicity, these principles provided a common basis for the development of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management as well as for IAEA Safety Standards and a basis for national RW management programmes. The main reference sources for the courses included:

- IAEA safety standards and other international recommendations
- Results of IAEA Coordinated Research Projects
- Proceedings of IAEA training courses and workshops
- Training material provided by national organizations

The 2007 learning material was reviewed and further developed by IAEA technical officers from WTS and WES with expertise in one or more of the above technical areas. Individual modules were designed to provide specific information within the broader thematic technical area.

### 3. Target audience

The target audience was professionals from the IAEA Member States, mainly drawn from Member States receiving assistance through the IAEA Technical Cooperation Programme (e.g., developing parts of the world), with responsibilities for RW management activities or managers within their respective organizations. The courses were aimed at newly engaged professional staff from operating, regulating and supporting organizations who currently are, or are envisaged to be, involved in:
• developing national policies or strategies,
• developing and implementing legal and regulatory framework, or
• managing radioactive waste from its generation until disposal, discharge, or clearance from regulatory control.

It was expected that applicants would be new entrants to the nuclear industry, or experienced personnel but with a development need to understand wider issues concerning management of RW. The participants were expected to have a good knowledge of the existing situation concerning RW management strategy for pre-disposal and disposal activities in their countries. Participants were also required to present the status of RW management in their country, addressing the following:

• Updated inventory of the radioactive waste in the country, including the identification of the present and potential sources of generation of radioactive waste;
• Information on the present status or plans related to national policies and strategies on radioactive waste management in the country;
• Status of the national practices of radioactive waste management;
• National legislation or regulations (on radiation protection and waste safety) that influence in the elaboration of the safety case of centralized predisposal facility for radioactive waste.

Participants were required to participate actively in the training course and group activities and discussions; to participate actively during technical site visits; and to complete one or more comprehension and evaluation exercises throughout the duration of the course.

4. Results and Feedback

The programme was structured to provide a combination of general information regarding RW management, followed by more intensive specialized training in a specific area. The programme was structured to provide 4 weeks of general (“Level 1”) information on RW management as a whole, followed by 2 weeks of more intensive (“Level 2”) lectures on deep geological disposal (host institute TU Clausthal’s area of expertise). Table 1 illustrates the distribution of topics.

<table>
<thead>
<tr>
<th>Thematic Area</th>
<th>Time Spent</th>
<th>Number of Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Issues</td>
<td>10 hours</td>
<td>2 lecturers</td>
</tr>
<tr>
<td>Predisposal RWM</td>
<td>40 hours</td>
<td>5 lecturers</td>
</tr>
<tr>
<td>Decommissioning</td>
<td>4 hours</td>
<td>1 lecturer</td>
</tr>
<tr>
<td>Disposal (general plus intensive)</td>
<td>15+32 hours</td>
<td>7 lecturers</td>
</tr>
<tr>
<td>Remediation, NORM, mining &amp; milling waste</td>
<td>10 hours</td>
<td>2 lecturers</td>
</tr>
<tr>
<td>Field trips (covering multiple topical areas)</td>
<td>6 days</td>
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</tbody>
</table>

Material delivery was through use of MS Powerpoint slides and IAEA documents that were distributed electronically immediately after lectures and on a DVD at the end of the course. Lectures and classroom exercises were provided by a combination of IAEA technical officers, international experts recruited by the IAEA, staff from TU Clausthal, and staff from German organisations recruited or recommended by TU Clausthal.

Feedback from the participants and from the lecturers indicated that the training course was extremely successful - the lectures, discussions, classroom exercises, and technical visits permitted the participants to develop a much better appreciation of key RW management concepts, methods and technologies. The experience and lessons learned from this training...
course will also further the IAEA’s goal of developing future comprehensive curriculum that can be provided at IAEA Regional Training Centres of Excellence.

The host institute TU Clausthal provided lecturers, organisational support; support during lectures; software installation, and access to computer labs, Wi-Fi, internet. Professor Dr. Klaus-Jürgen Röhlig was the course organizer and was provided with daily support by TU Clausthal professional staff Mr Elmar Plischke and Mr Saleem Chaudry. Their combination of scientific contributions and organizational skills highly contributed to the success of the course.

5. Lessons Learnt and Future Activities

Since the last course was run in 2011, anecdotal evidence from discussions with the managers of those who took part in the two courses, indicates that the opportunities offered by the IAEA and TUC are greatly appreciated. All of the feedback received indicates that although employers may lose the services of their employees for six weeks over the duration of a course, this is viewed as an investment as they come back to their working environment with a much enhanced appreciation of the interdependent nature of radioactive waste management and an understanding of how their own work is a fundamental element of a multi-disciplinary endeavour.

However, it is recognised that there are some limitations in the current approach (IAEA-organized face-to-face training), because it is extremely resource-intensive and presently can only be delivered to a limited audience. In particular, the following limitations are noted:

- The selection of appropriate candidates for face-to-face training has always been a significant challenge. The review of applications needs to achieve a balance between the expertise of the individual, his/her current and potential future role in the employing organization, language ability and the geographical distribution of the candidates. It is acknowledged that the screening of suitable candidates is difficult on the basis of the relatively condensed information supplied in the application forms that are submitted to the IAEA.

- Face-to-face training courses are generally run for groups of 15 to 20 people, often travelling from all corners of the globe. Travel and accommodation is expensive and lecturers must sometimes be especially employed to deliver the courses and this also adds to costs. Due to the limited financial resources available to the IAEA, every year there is a clear limit on the number of people who can benefit from such training.

- With regards to the suitability of the training course content, it has been noted through feedback that whilst newly qualified professionals often require exposure to a broad understanding of RWM through courses covering the fundamentals of the nuclear fuel cycle, radioprotection, the predisposal of waste (treatment, conditioning and transport), disposal, decommissioning, environmental remediation etc., others require more advanced training in a number of specialist topics.

In order to overcome these limitations, the IAEA has committed to identify and utilise alternative and more cost effective avenues for the delivery of training. To this end, a decision has been made to develop a comprehensive RWM curriculum that jointly covers aspects of both safety and operations with an appropriate balance that ensures the two dimensions are delivered in a complimentary and consistent manner, including integration where appropriate. The training materials that will result from the development of the curriculum will be delivered through the medium of the Internet and personal computers (eLearning) and also through extended face-to-face courses to be delivered in Regional Centres of Learning (which are being established). The curriculum will be developed collaboratively between the IAEA, international experts and the learning centres.
5. Conclusions

The IAEA is committed to assisting its Member States to develop the competencies and skills necessary to allow them to implement viable, safe, secure and cost-effective RWM solutions. Two six weeks training courses focused on geological disposal were successfully held at TU Clausthal in 2010 and 2011. The new IAEA eLearning initiative in RWM will provide trainees with materials for self-learning at a pace to suit the individual, and has the potential to reach a vastly broader audience than the limitations of face-to-face traditional training course can. It is hoped that it can also serve as a method of preserving vital nuclear knowledge and expertise, and can also help to facilitate “just-in-time” learning to professionals.
Radiation protection training has been the framework for site induction training throughout the history of Loviisa NPP. Legislation and regulations have set requirements for the content of radiation protection training but also the development in safety culture and aspiration to improve the prerequisites for good working conditions have motivated ameliorating the training process. Co-operation in the field of education with the other nuclear power plant in Finland was initiated in its present form in the 90's and it has been expanded to other Nordic countries. For example the general employee training has been developed together with the Swedish nuclear power plants. The aim was to get similar practices to the Nordic power plants; a general employee training gone through in one of the power plants is valid in all of the others. This is also a way to deliver a unified message regarding the practices.

In the present situation a new person goes through a certain training schedule when starting work at Loviisa power plant. This includes general employee training, profession specific familiarisation and both a radiation protection familiarisation and project related radiation protection training for those working in the radiation controlled area. It can also be stated that project and work related pre-job briefings complete this schedule. All of this aim at the person being able to work safely at his/her own work site taking into consideration the special conditions of a nuclear power plant.

There is already proof of the benefits of this training; the number of occupational accidents leading to absence has decreased, the collective radiation doses have become smaller and the share of contamination cases of the total number of measurements has decreased.

Future changes in human resources due to change of generation will keep the training process in progress. Implementation of radiation protection and - safety training into covering the project management and contractor chains in designing will be a challenge.

1 INTRODUCTION

Loviisa NPP consists of two pressurised water reactors, Loviisa 1 and Loviisa 2 (LO1 and LO2 respectively). LO1 started its commercial operation in 1977 and LO2 in 1980 with the expected operating life of 30 years. The staff employed then was very devoted and committed and turnover of employees during the first three decades was low. In 2007 the operating license was renewed and it is now valid for the next 20 years leading to 50 years of operation. This decision raised a need to replace a majority of the staff within a few years because of retirement. The
largest challenges have been met at passing tacit knowledge to new professionals and getting them to the same level of expertise as the original personnel has been. Also the contractors are retiring, the older generation is reaching its retirement age and a new generation of specialists is being raised.

From the beginning of the production of nuclear energy in Finland, the nuclear safety guides (YVL guides) of Radiation and Nuclear Safety Authority (STUK) have directed the development of radiation protection training given by nuclear energy operators. [1] YVL guides set requirements for training when the first Finnish nuclear power station unit was pressed into service. As times have passed, requirements for training have changed and affected to the areas of focus in the contractor and staff training at Loviisa NPP.

In addition to regulatory requirements, the ambition to develop the safety culture has directed the plant to pay increasingly attention to training. On the other hand, the whole industry is facing change of generation when experienced experts are retiring and young employees beginning their working careers. These factors have challenged Loviisa NPP to strengthen its training processes.

2 RADIATION PROTECTION TRAINING IN FINLAND

2.1 Regulatory requirements for radiation protection training in Finland

Fortum's power plant in Loviisa employs ca. 530 people, permanent and temporary personnel included. In addition to this, there are ca. 150 permanent contractor workers at the NPP and during the outages further ca. 800 contractors work in the power plant area. Fortum has put extensive efforts to promoting safety during the last few years and the main task in the training of contractors today is to give them the same overall idea of safety that Fortum's own personnel has adopted.

The Industrial Safety Act [2, 3] has from the mid-1950's given general requirements for employers to give sufficient training in regard to working environment circumstances, right working procedures and possible health risks related to work. It deals with training on a general level, not paying attention to a certain industry or work.

The nuclear safety guides (YVL guides), instead, have guided the development of radiation protection training throughout the history of the plant operation. In 1981, guide YVL 7.9, Radiation Protection of workers at nuclear facilities [4] gave requirements for the radiation protection training about the topics that were expected to educate to the workers. The content was expected to include at least the applicable parts of radiation legislation and regulations, fundamentals of radiation and radiation risk. New guides will be published and implemented in 2013, the major difference in radiation protection training expectations concentrating on delivering an awareness of the health risks related to ionizing radiation.

2.2 History of radiation protection training in Finland

Radiation protection training was begun in late 1970's when the first unit of Loviisa NPP was pressed into service. Radiation protection training was then the framework of general employee training (GET). During the next two decades the training was developed by for example visualization and introducing a written exam to measure the training effectiveness. Since the mid-1990's more effort has been put on making training films and also adding subjects such as industrial safety to the content. Awareness of the benefits of cooperation also arose then and a joined general employee training was established with the other Finnish power company.

Co-operation between the Finnish power plants has been easy and fruitful, due to the same culture, same regulator, partially the same work force in the small country. The challenges are similar and the other power plant's staff members are seen as colleagues, not competitors.

In the beginning of the new millennium, the co-operation was enlarged to cover all nuclear power companies in Finland and Sweden. Training methods and exams were standardized as far as practicable and general employee training performed in any Finnish or Swedish nuclear
power plant is approved at other sites. Today co-operation means trainer exchange, especially during outages, benchmarking and mutual visits.

2.2 Current status of radiation protection training in Loviisa NPP

When a contractor starts work at Loviisa NPP, there is a certain training path obligatory to all workers. Every third year all contractors, as well as Fortum's own employees, have to take part in General Employee Training (GET), which lasts for 4 hours. For own personnel the training acts as refresher training. After GET the contractor is taken to his/her own work site to get acquainted with the surroundings and the environment. This helps in recognising the general safety issues and gives a deeper meaning to the profession specific familiarisation which is obligatory every year. The familiarisation has a job specific focus with related material and can last from 4 hours to two days. The most extensive familiarisation is given to the cleaning personnel. Their familiarisation is an addition to their vocational training with emphasis on the special features of industrial cleaning and cleaning inside the RCA.

During the last few years the general employee training has continued in its Nordic form but in addition, more and more attention has been paid in offering new employees and contractors site- and task-specific training including industrial safety training, education on plant working procedures and radiation protection.

General radiation protection training is offered first in the general employee training. The approach in this is in offering the worker a sufficient knowledge in order to operate correctly in radiologically controlled area. A basic knowledge on radiation, dose, health effects, dosimetry, means for minimizing doses and controlling radioactive contamination is given. The relatively unfamiliar and abstract subject is brought closer and made more concrete by using the means offered by digital technology. For example, radiation and contamination have been visualized by special digital effects in the training DVDs [5]. Although a training DVD does not replace human contact in training, it is an important factor to back up the instructor in delivering the message to the audience. Mock-up is generally used in nuclear power plants when demonstrating the correct procedures while working inside the RCA. Loviisa NPP does not yet have such mock-up included in GET, thus the training films have been developed and special emphasis has been put on visual effects. The difference between correct and incorrect behavior and its result can be easily demonstrated. Positive feedback has been obtained from both the authority and the trained personnel.

After GET and familiarisation, a contractor worker can either start working, or if the work is located inside the radiation controlled area (RCA), he/she will get extended training in radiation protection (project specific familiarisation), focused on the specific task. The classroom training is finished after the radiation protection training but before initiating work, the workers still have to participate in a pre-job briefing, which can also be classified as training promoting safety.
Contractor familiarisation at Loviisa NPP

Figure 1 Contractor familiarisation program

3 OBJECTIVE OF TRAININGS

3.1 Objective of General Employee Training

The objective of GET is to give an overall idea of the safety level Fortum's management expects from all workers and to give general information of the shared workplace, the local practices related to work arrangements, practical advice and the information what to do and where to go in case of an incident etc. Annually a large number of contractors working at Loviisa NPP during the outages are workers who have never been in a nuclear facility before. This brings challenge to the training given to the personnel who are professionals in their own field and know their substance but know basically nothing about nuclear safety, radiation or contamination. The contractors also need to be aware of the influence of their own work to the safety of the power plant's process systems.

3.2 Objective of profession specific familiarisation

Profession specific familiarisation aims at giving more detailed information of the safety measures related to the specific site and the influences the audience's work can and will have on the power plant's process. Depending on the task, the familiarisation can last between four hours to two days. A group working outside the RCA and carrying out work not related to safety-classified systems can have a lighter version of the training whereas e.g. contractors working in electrical rooms will receive a very detailed training with the accurate information of the various rooms, process states, electrical cabinets, control systems, importance of housekeeping etc. The profession specific familiarisation includes a written exam which has to be done annually.

3.3 Objective of radiation protection training

Today the contractors' extended training in radiation protection and project related radiation protection training give a practical insight to the work arrangements and risks on site. In the near future the aim is to put more emphasis on aiming at reaching a deeper knowledge of ionising radiation, how to protect oneself against gamma radiation and both internal and
external contamination. It will also guide to carry in mind the importance of own working methods and how to prevent the spreading of contamination as well as the importance of cleanliness and tidiness.

4 IMPACTS OF TRAINING

The impact of training can be seen in many improved statistics, for example in the figure below, which shows the decrease in the rolling average in radiation dose levels and decreased share of contamination cases in both pre and exit monitors. In 2012, there was the most extended 8-year annual outage at Loviisa 1 and the number of work tasks carried out inside the RCA increases both the radiation doses and the number of contamination cases.

![Figure 2. Rolling average of radiation doses 1977-2012](image)

![Figure 3 Pre-monitor measurements 5/2005-2012](image)
The present systematic follow-up of contamination cases in personnel monitors started in mid-2005. The location of Loviisa NPP personnel monitors is such that the pre-monitors are located at the border of the radiation controlled area and the monitored area whereas the exit-monitors are located between the monitored area and the non-controlled area. The limits are given by the authority. [1]

Best results in long-term radiation safety management would be achieved by concentrating in offering enough radiation safety training for people who make decisions about system layouts, modification schedules, component selection etc., naturally together with ensuring good radiation protection knowledge for plant workers and contractors. Steps have been taken into this direction in Fortum Company.

It is difficult to validate the direct influence of training itself on the positive trends and is probably not the only factor contributing to these improvements. Showing the effort and engagement put to these trainings gives the contractors a clear message that these matters carry a great importance and it affects their attitudes towards safety and careful work.

5 REFERENCES

Tools and resources, methods of delivery, introduction of modern learning tools
NEW LEARNING TOOLS DEVELOPED IN WP7 FOR ENETRAP II PROJECT: TEXTBOOK AND CYBERBOOK

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C. PESZNYAK
BME-NTI-1521 Budapest - Hungary

ABSTRACT

Providing examples of standardized training material meeting the requirements of the European Radiation Protection Training Scheme (ERPTS) is the main goal of the deliverables of WP7 of ENETRAP II. We present here the project as it will be at its final stage, as well as the necessary steps to achieve this purpose.

WP4 establishes the reference standard for Radiation Protection Expert training, thus the ERPTS. To issue standardized training material, we decided to start working on the “common basis” part and especially on its first module. Even if the conclusions of WP4 (ERPTS of RPE) were essential for the project, the training material has also to deal with conclusions of WP2 (Background of RPE) and WP3 (Background and ERPTS of RPO).

Taking all these points into consideration, it has been decided that the final training material will be made up of complementary textbook and cyberbook. The ergonomy of a textbook allowing the reader to have a complete idea of the content at a glance and the power of dematerialized resources used in an educational goal through a cyberbook are combined to create adapted training material.

The first step and main work consisted in the translation of the ERPTS learning outcomes's module 1 by contents. This detailed analysis showed us great parallel with the recently published book “Principes de radioprotection-réglementation” coordinated by C. Jimonet and H. Metivier. The result will be a homogeneous textbook, principally written at first for the French book and seriously completed by all dosimetry aspects, to deal with the ERPTS learning outcomes. The textbook was called “European Radiation Protection Course: Basis” and a convention was done with a publisher.

As already said, a cyberbook will also be part of the whole training material to develop the concept of “learning more”. Based on an integrative approach, we have selected a learning and content management system (LMS/CMS) able to manage several types of embedded educational resources. After assessment of several Leaning Management Systems, the Moodle platform has been selected. In order to insert complementary pedagogical resources in the cyber-book, specific ENETRAP II web pages have been created (http://www.rpe-training.eu/login/index.php). This summary of the cyberbook is organized in the same 6 chapters of the textbook.

1 Introduction

Euratom BSS are Guidelines of the Council of the European Union dated 13th May 1996 to stipulate the basic safety standards for the protection of labor and the population against the hazards of ionizing radiation.
COUNCIL DIRECTIVE 96/29/EURATOM, 13 May 1996 lays down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. The basic standards of 13th May 1996 are geared to the new scientific findings in radiological protection contained in the ICRP Publication 60.

The member states of the EU were obliged to enact the required national legal and administrative regulations to implement the Euratom basic standard by 13th May 2000.

The European Commission is currently developing a modified European Basic Safety Standards Directive covering two major objectives: the consolidation of existing European Radiation Protection legislation, and the revision of the European Basic Safety Standards.

The revision of the European Basic Safety Standards will take account of the latest recommendations by the International Commission on Radiological Protection (ICRP) and will improve clarity of the requirements where appropriate.

Following a recommendation from the Article 31 Group of Experts, the current draft of the modified BSS will highlight the importance of education and training by dedicating a specific title to radiation protection education, training and information. This title will include a general requirement on the Member States to ensure the establishment of an adequate legislative and administrative framework for providing appropriate radiation protection education, training and information. In addition, there will be specific requirements on training in the medical field, on information and training of workers in general, of workers potentially exposed to orphan sources, and to emergency workers.

The revised BSS directive will include requirements on the competence of a radiation protection expert (RPE) and of a radiation protection officer (RPO). The concept of a radiation protection expert will replace the current concept of a Qualified Expert (QE), which has been interpreted differently within Europe. These new requirements together with clearer definitions of the concepts RPE and RPO shall support harmonization in Europe.

2 ENETRAP II

ENETRAP II (European Network on Education and Training in RAdiological Protection II) belongs to the 7th framework programme and is following ENETRAP 6FP used as a basis for the development of a European Radiation Protection Training Scheme (ERPTS).

Overall objective of the European project ENETRAP II is to develop European high-quality "reference standards" and good practices for education and training (E&T) in radiation protection (RP), specifically with respect to the RPE and the RPO. These "standards" will reflect the needs of the RPE and the RPO in all sectors where ionizing radiation is applied (nuclear industry, medical sector, research, non-nuclear industry). The introduction of a radiation protection training passport as a means to facilitate efficient and transparent European mutual recognition is another ultimate deliverable of this project.

With respect to the RPO role the desired end-point is an agreed standard for radiation protection training that is recognized across Europe. Data and information obtained from the ENETRAP 6FP will be used to develop the reference standard for radiation protection training necessary to support the effective and competent undertaking of the role.

Specific objectives of the ENETRAP II project are:

1. Develop the European radiation protection training scheme (ERPTS) for RPE training;
2. Develop a European reference standard for RPO training;
3. Develop and apply a mechanism for the evaluation of training material, courses and providers;
4. Establish a recognised and sustainable ERPTS "quality label" for training events;
5. Create a database of training events and training providers (including On-the-Job-Training) conforming to the agreed ERPTS;
6. Bring together national initiatives to attract early-stage radiation protection researchers on a European level;
7. Develop some course material examples, including modern tools such as e-learning;
8. Develop a system for monitoring the effectiveness of the ERPTS;
9. Organise pilot sessions of specific modules of the ERPTS and monitor the effectiveness according to the developed system;
10. Development of a European passport for Continuous Professional Development in Radiation Protection
In this paper, we will explain the WP7: Develop some course material examples, including modern tools such as e-learning.

3 TEXTBOOK

In order to provide examples of standardized training material, meeting the requirements of the ERPTS, WP7 will foresee in European text books for several modules of the ERPTS. Since a lot of texts already exist in different countries (and thus different languages), the main work will involve the structuring of this material according to the developments of WP2, 3 and 4.

3.1.1 Collecting the training resources, provided by all ENETRAP II members

To create an accompanying text for the RPE training schemes, we firstly needed to identify different text books or other types of resources already existing on radiation protection. A lot of texts already exist in different countries and thus in different languages.

To collect these resources, we proposed to all ENETRAP II partners, to complete a form in order to have a common vision of the existing pedagogical materials helpful in RP education and training in each country. By the way, we identified the resources provided by project members. The books transmitted by our partners have been written in five different languages: English, Dutch, French, Spanish and German.

We classified all the answers in terms of interesting characteristics for each title to help us to choose the best one with different form: textbooks, e-books, PowerPoint slides, written manuscripts from various lectures of training courses theory; exercises; auto evaluation authors; date editor; ISBN; target audience; utilization; key-words; fields (nuclear, industrial, medical) origin.

Here is an example of the Spanish data.

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<th>Form</th>
<th>Key words</th>
<th>Años</th>
<th>Target Audience</th>
<th>ISBN</th>
<th>Date</th>
<th>Editor</th>
<th>Área util</th>
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<td>Textbook slides</td>
<td>Radiations ionizantes, Utiliacion y riesgos</td>
<td>1996</td>
<td>UP</td>
<td>UPC</td>
<td>Instn</td>
<td>Teaching Materials for Courses of obtaining licenses and instalaciones radiactivas y de radiodiagnostico licenses and acreditations for operation in radioactive facilities and radiology</td>
<td>José Acosta Mira</td>
<td>Jaume Ortega Aramburu; Xavier Ortega Aramburu</td>
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<td>E-Learning</td>
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<td>University of Malaga - Clínico San Carlos of Madrid</td>
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<td>2007</td>
<td>≥</td>
<td>Radioprotection training</td>
<td>José Jorba Bisbal</td>
<td></td>
</tr>
</tbody>
</table>

Tabl : Spanish data

Secondly, we selected according to criteria “Text books in English or in French”, “Text books published after 1990”. To complete this research, text books related to all RP fields (nuclear industry, medicine, regulation…) with the Key words: “radiation protection” and “radioprotection” research on Amazon web site was done.

84 results were found with the Key words for books “Radiation protection education” and 112 results with the Key words “Radiation protection training”.

3.1.2 Establishment of a table recording all the relevant text books

With these criteria, a data base was set up listing relevant text books. 66 entries were founded. The main characteristics were: theory; exercises; auto evaluation and others: authors; date; editor; ISBN; target audience; utilization; key-words; fields.

Here is the example of a part of the English data which had found:

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<th>Key words</th>
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<td>Teaching Materials for Courses of obtaining licenses and instalaciones radiactivas y de radiodiagnostico licenses and acreditations for operation in radioactive facilities and radiology</td>
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<td>José Jorba Bisbal</td>
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In spanish, published after 1990
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<tr>
<th>TITLE</th>
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<td>Text book</td>
<td>Colin J. MARTIN ; P.J. DENNY &amp; Richard H. CORBITT</td>
<td>2003</td>
<td>British Institute of Radiology</td>
<td>078-065746549</td>
<td>Medical physicist</td>
<td>Training &amp; education</td>
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<tr>
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<td>Auto Evaluation</td>
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<td>Mary Alice STATKIEWICZ SHERER &amp; Paul J. VACON &amp; A. RUSELL INTENDUR</td>
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</tbody>
</table>

Tab 2: Part of English data

The training scheme is a work package 4 deliverable and is organized in 3 modules for the common basis followed by 5 optional modules.

Common basis: Basics, Foundation, Occupational.
Optional modules: Nuclear Power Plants, Research, Waste management, Decommissioning, Non nuclear fields, Medical fields, NORM

To finish the work before the the end of the project, we consider publishing only the first module of ENETRAP II training scheme: Basics

After a detailed analysis of the data base, we only selected text books corresponding to the ENETRAP II training scheme, according to the table of contents.

Thanks to these tables, we identified three text books which could be used as reference for the creation of the WP7 text book

1. « Radiation protection » Euclid Seeram 1997
2. « An introduction to radiation protection » Martin and Harbison 2006
3. « Principes de radioprotection-réglementation » Jimonet and Métivier 2009

The third ENETRAP steering committee decided the “Principes de radioprotection-réglementation » Jimonet and Métivier 2009” will be the work basis for the textbook to come.

This book has been chosen due to its highly pedagogical approach: Reader becomes Actor of his own training. The pedagogy developed in practical work during the training period, has been transposed and adapted in this type of training text book: The trainee has questions to answer. With pictures, he has to find the answer and to fill tables
Here is an example of the pedagogical approach with pictures, questions and answers

Fig 1: Pictures with questions and answers

The methodology developed in text books could be transposed in a richmedia environment where pictures are improved with short videos. More detailed explanations could be given by trainers using synchronized slides and video.

In this kind of pedagogical resources, the scenarisation of tasks and activities proposed to the learners, required a lot of attention (cf. ENETRAP II – WP5 and b-learning pilot session WP7).

With this approach we can easily find an evolution from written mode to audio and video therefore an easy link with the second part of this work package (WP7. 2)

3.1.3 The first module of ENETRAP II training scheme

The module 1, “Basics” of the common basis corresponds to 5 chapters of the French selected book:
1 Radioactivity and nuclear physics/ Radioactivité
2 Interaction of radiation with matter and dosimetry/ Interactions rayonnements-matière et dosimétrie
4 Biological effects of radiation /Effets biologiques des rayonnements
5 Applications of ionising radiation (overview)/Principales utilisations des sources de rayonnements ionisants
6 Physical principles of detection / Détetection des rayonnements ionisants

But a very close and precise analysis has been done between the content of these 5 chapters of “Principes de radioprotection-réglementation” and module 1 of the training scheme developed by the WP 4. After this detailed analysis for the first module of ENETRAP II training scheme, with these five chapters we can say: 6/10 of the content are already written and must be translated, 4/10 has to be written.

To correlate with the 6 chapters of module 1 of ENETRAP II, a new one has been completely written: 3 Dosimetry: quantities and units
To have the level which corresponds to the European Radiation Protection Training Scheme (ERPTS), writing is more important than we can imagine at the beginning of the project and thus it took more time.

3.1.4 Degree of relevance of content

At this step, it is necessary to compare the contents of this relevant book with the common basis of ENETRAP II training scheme requirements (outcome of WP4). The work involves the structuring of this text according to WP4 and its translation into English. It is important to emphasize that to have complete resources which correspond to the European Radiation Protection Training Scheme (ERPTS), the contents not dealt with the text-book, will be in the complementary cyber book.

According to WP5, NRG has developed a table for the comparison of training material. According to reference WP7 –RPE text book, we fill in the table using the grades proposed by NRG. These grades are chosen to determine which course covers which topic to what extended.

Grades:

1 Global, quantitative. Familiar with the subject
2 Important subjects covered, quantitative. To be able to work with the subject
3 Detailed, quantitative. Good knowledge of the subject and able to work with it

With this methodology, we have compared the grades between the French PCR textbook and the future RPE textbook and cyber book. For the main topics the grades are the same but when a difference exists, the contents of the topic is completed by the authors.

Once more, to have sufficient grades which correspond to ERPTS, the missing parts not dealt with the text-book, will be in the complementary cyber book.

The different authors have always worked with the objective to write with a very progressive approach for the learner. They wrote each topic step by step with a lot of examples, a lot of exercises, to evaluate whether the topic has been understood.

The complementary of the textbook and the cyber book provides a variety of pedagogical approach and a flexibility of particular interest.

3.1.5 Textbook Edition – Deal

We deal with the private publisher “EDP Sciences”, and the contract has been signed.

The project was balanced with the participation of ENETRAP II, INSTN, and EDP Sciences.

Initially, the text was written in French, by ten French radiation protection experts. Then, the text was translated by a specialist of this kind of topic.

3.1.6 Title of the textbook

A title for this textbook, “European Radiation Protection Course - Basis”, has been put forward. We wanted to avoid, the word “Radiation Protection Expert writing in the title. In fact, the book may be of interest the RPE but also the RPO. The title of the textbook should not be restrictive to a specific function. It can interest all the radiation protection community.

4 CYBERBOOK

All trainees are different. They do not have the same way to learn, to study new subjects. They have their own approach of how to learn new topics. They don't accept similarly the different approaches of “how to be trained”. They don't appreciate tools to learn (text, video, only audio, simulation...) with the same keenness.

What has been said for trainees is also valid for trainers. They do not use the same way to teach.

In this context, it has been decided to propose, different types of educational resources, in this work package.

Thanks to a system of tracking integrated in a LMS platform, it will be possible to identify educational resources the most used and in the same way, those that are less visited or assessed less useful by the learners.

Based on an integrative approach, we have selected a learning and content management system (LMS/CMS) able to manage several types of embedded educational resources.

Work achieved in the previous ENETRAP WP5 project is used in this Work Package. We took into account the results and deliverables of its WP.
The ENETRAP WP5 “new concepts and tools for a European Radiation Protection Course (ERPC)”, had to assess new modern training tools (distance learning). For this purpose, a study was conducted on e-learning and b-learning methodologies and resources.

4.1.1 The ENETRAP “Cyber-book”: an integrative approach

The function of this cyberbook is to propose a panoply of additional educational resources to which the reader of the text-book will be able to refer. The concept of “to learn more” is often integrated into textbooks by using special frame. With this cyber-book, the participant will have access to different types of resources and he/she will choose those that suit to him/her. This summary of the cyberbook is organized in the same 6 chapters of the textbook.

Fig 1: A capture screen of the ENERTAP II Portal

In the framework of this WP, we will be interested in the following resources: Hypertext links and/or Flashcode, exercises with solutions, .ppt soundtrack with video Audio podcast Serious games radiation Protection forum. These resources will be integrated into the LMS. If the goal is that resources can be available at any time, in the one hand content could be more pleasant to read on a paper book than on a screen (ergonomic) and on the other hand, the other resources (videos, audio, exercises, serious game) could be easily accessible using PC or other internet connected devices. Therefore the two ways could be used simultaneously. These hypertext links will be able to be either next to the text to illustrate with videos, animations or at the end of a chapter with exercises and solutions for example.

4.1.2 Hypertext links and/or Flashcode

Next to the text-book, we created a web site hosted in a LMS, within complementary resources that will be available. We called it “cyber-book” because links could be found in the text-book as a classical internet link, (http://www.rpe-training.eu) as a flashcode or a QR code.
4.1.3 Exercises with solutions

For each chapter, we suggest a few examples of exercises with their solutions.

4.1.4 Powerpoint Soundtrack (RapidLearning)

An assessment of rich media resources using synchronized PowerPoint files was performed. As an example of the complement between the two pedagogical resources, we can name the topic “radionuclide’s chart” whose explanation and use are developed in chapter 1 “Radioactivity and nuclear physics” of the cyberbook whereas the concept is just mentioned in the textbook. The synchronized PowerPoint files were made by filming a pilot course in radiation protection at Karlsruhe Institute of Technology (KIT) in Germany. This pilot session was built according to the ERPTS training scheme (WP8 of ENETRAP II) at KIT in March 2011.

This course is about radioactivity. It belongs to the module 1 “Common Basis” of the training scheme (WP4 of ENETRAP II).

![Fig 2: A capture screen of the Powerpoint Soundtrack of the Radionucleide chart training course](image)

4.1.5 Audio podcast of RP courses

Podcasting means the way to fix a multimedia content on a digital file (the podcast) and its broadcast using the internet. The word « podcast » more extended than the traditional recording of a course to diffuse it by streaming. Nowadays, podcast is a process of universal diffusion of contents standardized (SCORM format), reachable and downloadable with a computer, tablet or Smartphone. The broadcast of training courses in podcast can be done by downloading or by direct visualization (streaming) on intranet or internet with restricted access (identification).

Nevertheless, the question of intellectual property rights has to be solved. For RPE/RPO training course, podcast could be restricted to short lectures (max. 20 minutes) and for subject more general than specialized. Indeed, in specialized conferences or lecture on very specific topic, the lecturer leans often on PPT presentations or slides with a lot of technical information. In this case, podcast is obviously not the best tool.

4.1.6 Serious Games

A demonstrator of what a serious game could be is presented in this chapter. This new concept was used for the first time in may 2011 and was assessed as a powerful and pedagogical tool by trainees. Using a dose rate cartography of controlled areas established by a RPE/RPO or a member of radiation the protection team, the trainee has to carry out a dosimetric study based on the ALARA procedure.
Several radiation protection actions can be created and their efficiency in terms of person.Sv saved is quantified. In this serious game, the learner is not disturbed because the dose rate meter’s design used is the same as the one used in real situations in nuclear power plant or installation. An enhancement of this tool could be based on an increased reality approach. In this case, the trainee is surrounded by a look alike representation of the nuclear installation (video capture) and he/she introduces dose-rate cartography by using a virtual dose-meter or by viewing representation of dose-rate levels (gamma camera) with virtual glasses in 3D mode. The trainee has the possibility to implement several RP actions such as:
- Building as in the steam generator area
- Removal of the highly contaminated ring in a lead container
- Protection shielding of the steam generator man-hole
- Choice of the steam generator man-hole tap
- Use of a distance tool for the speeder machine used inside the steam generator bunker

4.1.7 Forum: exchange in the RP community

This type of resources could be one of the missing components of a comprehensive capability to enrich the learning process of RPEs. Feedback coming from a recent free Radiation Protection forum (http://www.rpcirkus.org/) shows that such a tool is considered as a complementary and efficient means to enhance the radiation protection culture among beginners, skilled, knowledgeable experienced and expert RP staff. To date, more than 950 people have joined this RP group. It translates the fact that these people felt solitary in their RP occupational environment.

5 Conclusions

In conclusion, the production of the module 1 “common basis” training material in the combined form of a textbook plus cyberbook is a first step. In the next one, all the ENETRAP partners should collaborate to complete at least the whole “common basis” training resources, as learning tools contribute to facilitate mutual recognition and enhanced mobility of these professionals across the European Union.
SERIOUS 3D GAMES FOR EDUCATION AND TRAINING IN RADIATION PROTECTION

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ABSTRACT

The National Institute for Nuclear Science and Technology (INSTN Teaching Unit of Cherbourg-Octeville) and OREKA (a company specialized in 3D-engineering) have developed a prototype of an innovative teaching tool named O.S.I.R.I.S. (Tool for Simulation of work under ionising radiation).

OSIRIS provides a 3D virtual training environment that allows trainees to practice different aspects of nuclear safety for work-stations where workers are exposed to radiation. Typical users would be students or professionals (for example Competent Persons in Radiation Protection in France) who need to learn how to protect workers against radiation.

In this game, the action is located in the steam generator building of a pressurised water reactor during a check on the piping system. Users can move freely within this virtual environment, which they view through a camera positioned at eye level.

By using the navigating device, trainees are able to move from scene to scene in real time during different phases of the operation. They can use a range of instruments such as radiation survey meters, or probes to measure loose contamination on smears.

The objectives of the game are:
- To determine the individual and collective doses received by workers during all phases of the checking operation (“predictive dose evaluation”).
- To implement the principles of radiation protection (Principle of justifications, principle of optimisation - ALARA principle, As Low As Reasonably Achievable- and principle of limitation). In particular, trainees learn to think about the different ways of reducing the dose received (exposure time, shield, distance, and activity), and how to achieve an optimized assessment of dose.
- To supervise the collective dose performed (daily), and to know how to react in case of emergency (for example alarm on the dosimeters), or if the collective dose performed increases.
- To analyse the dose recorded during the operation (i.e. the discrepancy between the predictive collective dose and the collective dose achieved).
- To determine how to improve a) the accuracy of predictions and b) the identification of, and response to, emergency situations.
1. Presentation of companies

1.1. The National Institute for Nuclear Science and Technology (INSTN)

As part of the CEA (French Atomic Energy and Alternative Energies Commission), the National Institute for Nuclear Science and Technology (INSTN) is a higher education institution. The INSTN’s mission is to disseminate the knowledge and know-how developed at the CEA, especially in nuclear operation and maintenance, nuclear safety, waste management, clean-up and dismantling, radiation protection, radiation detection and measurement, nuclear medicine etc.

The INSTN offers:
- National, European and international academic degree programs for students, engineers and technicians, nuclear physicians, radiopharmacists and medical physicists;
- Continuing education courses for professionals and PhD students of all origins and nationalities;
- Training through research for which it serves as coordinator; it also offers assistance and guidance to PhD students and post-doctoral researchers working in the CEA’s laboratories.

The INSTN headquarters are located at the Saclay CEA Centre (20 km South of Paris). Four branches are set up in the CEA’s centres at Grenoble, Cadarache and Marcoule, and on the campus of Cherbourg-Octeville (for more information, you can consult our website: http://www-instn.cea.fr).

1.2. OREKA engineering

OREKA engineering is an independent company based in the Cherbourg area that was created in 2010, but whose personnel have been working together for the last 10 years. OREKA is engaged in various fields related to the improvement of working conditions. Our objective is to create a working environment that is safe, fully adapted to the client’s activity, and that promotes both operational efficiency and the well-being of workers.

We start at the level of the building, helping our clients define their needs and constraints (functional, technical, process, flow and financial), and assisting them in creating work spaces that will give optimal functionality. At the other end of the scale, we also work on the more detailed aspects of the work stations (e.g. glove boxes for the nuclear industry)

At the core of our activities, we have a 3D department that can work on all aspects of a project - to simulate and visualize a process, a flow, a building, the ergonomics of human postures, etc.

OREKA 3-D is active in a variety of sectors, one of which is the nuclear industry, with whom we have worked for almost 10 years - particularly in areas such as dismantling and maintenance, where 3D animation has been used to validate the various processes studied by engineers
OREKA’s first 3-D projects were in the field of animation. Over time, our work has also evolved into the area of software development, notably of serious games.

This has been made possible by a high level of re-investment in research and development in that area, a fact recognized by the status of “Young and innovating business” from the French State in 2012.

3D-software offers vast potential for industry, particularly in the area of training and safety. For this reason, OREKA has been developing serious games aimed at helping people improve working practices and methodology.

As of today we have developed 2 serious games for the nuclear industry:
- OSIRIS : A training tool for reducing exposure to radiation during maintenance operations
- DEM+: a simulation tool that facilitates the planning for the dismantling of nuclear facilities

2. The game environment

The case study used in OSIRIS corresponds to a systematic operation carried out on nuclear reactors during scheduled maintenance operations. During these operations, a certain quantity of nuclear fuel is replaced (the objective is to replace part of the nuclear fuel during each maintenance operation), equipment which is normally inaccessible during the operation of the reactor is checked, and any necessary maintenance is performed.

One of the checking operations is to monitor the condition of the steam generator tubes. These are at the interface between the second and third barrier of a nuclear power plant. They permit the isolation of the primary fluid in contact with the fuel rods, and the secondary fluid which is in contact with the outside of the nuclear building. Non-destructive examination of the tubes is made according to their “life history”, and following a sampling schedule that allows all tubes to be checked over the course of 3 or 4 visits.

Different methods are used to check the tubes: filling the ‘secondary’ part with helium to check their water-tightness, or use of Eddy currents to measure the structural condition of the tubes.

The tubes with defects, due, for example, to corrosion or to cracks, are blocked to prevent the primary circuit fluid from polluting the secondary circuit.

The trainees are asked to check the structural condition of the tubes using Eddy currents.

Several preparatory stages are required to perform this check, and requires human intervention at the bottom of the steam generators. During these phases, the operators are exposed to ionizing radiation.

Trainees have to make a study of the workstation in order to assess the associated risks and suggest ways to reduce them.
3. Presentation of the serious game

Double clicking on the ORISIS icon brings you to the home page shown below:

![OSIRIS Home Page](image)

Fig. 1: OSIRIS home page

The numbers below refer to the different zones identified by the numbers shown on Fig. 1, which shows the the OSIRIS home page:

1. A single click on the picture (top left of the image, labelled 1) gives access to the steam generator bunker. What you see changes according to the day selected and the choice of optimisation tools made (e.g. with or without use of lead blankets, intervention chamber…). An example can be seen on fig. 2.

2. The area in the bottom left of the image, (labelled 2) gives access to the various tools available to the user for optimising doses, and he/she can also choose whether or not to build an intervention chamber.

3. The chart (labelled 3) allows users to follow the collective effective dose and to look at the discrepancy between the predictive collective dose and the recorded collective dose.
Fig. 2: Example of view in the steam generator bunker

The numbers below refer to different zones identified by the numbers shown on the image in figure 2.

1. Window 1 on the image allows the user to know the duration of stay in the environment and also the effective dose received by the user in mSv.

2. Window 2 tells the user the dose rate measured in real time by the dose rate meter (in mSv/h). On the left there is a list of commands available to the user. On the right, the user can choose various different survey instruments (dose rate meter, telescopic probe, smears).

3. Window 3 is a map telling the user where he is in the building.

4. The pedagogical scenario

After some reminders about the functioning of a PWR reactor, the trainer presents and explains the operation stage by stage. The different stages are shown in a short video (the removal of the heat-insulation, the opening of the manhole, the worker jumping into the water box etc.)
4.1. Execution of the predictive dose evaluation and application of the principle of optimisation

The check list of the different phases of the operation, the approximate duration of each phase, and the number of workers needed is distributed to the trainees. Based on this information, the trainees identify the different stages of the job where dose rate or surface contamination need to be measured. By moving through the work environment, they identify any sources of danger and start to evaluate the risk that these represent. They then use the tool to generate a map of dose rate and loose contamination.

In the initial mapping, they consider the means of protection that might be used to reduce the doses received by the workers (e.g. rinsing of the piping and other equipment, filling circuits with water, installation of protection shields, limiting exposure time, remote working, organisation etc.).

Once these first optimisation measures have been carried out, the trainees return into the environment to determine the effectiveness of these different measures. They note the dose rate values on their mapping record.

The trainees proceed in exactly the same way for each stage of the job where there is an increased risk of exposure. (e.g. opening the manhole, installation of the steam generator plates, …). Apart from measures to reduce dose rate, the trainees also have to think about how to avoid ingestion or inhalation of radionuclides.

![Image: loose contamination measure](image)

**Fig3: loose contamination measure**
Once this job is completed, the trainees use all the dose rate information to produce a provisional evaluation of the collective dose.

\[ \text{EDP (man.mSv)} = \text{DED (mSv/h)} \times \text{VTE (man.hours)} \times k \]

EDP : Predictive dose evaluation  
DED : Equivalent dose rate  
VTE : Time of work under radiation multiplied by the number of workers for the task.  
k : coefficient for uncertainty about time of exposure (e.g. k = 1 if we know the time exactly, k = 0.5 if workers have to install or remove the shield).

This calculation is performed in however many tranches are necessary to take account of the choices made by the trainees.

These predictive dose evaluations by job stage are then added.

These calculations are carried out using a multi-tab Excel worksheet:
- The first tab allows calculation of the predictive dose evaluation with no optimisation measures ("Initial EDP"),
- The second tab allows calculation of the predictive dose evaluation with optimisation measures used, as well as other radioprotection measures (e.g. the installation of an intervention chamber) ("Optimised EDP")
- The third tab is used to compare the two values to evaluate the effectiveness of the optimisation measures.

The results of the optimised EDP (the green line) are imported into the OSIRIS interface, where they are compared to the equivalent collective dose actually received during the operation (the red line). This red line is calculated by OSIRIS.

4.2. Choice of workers and application of the principle of limitation

When the collective and individual effective doses are calculated, the trainees have to choose the workers who will participate in the operation.

To be eligible to participate, trainees must satisfy certain requirements regarding their employment status (temporary, permanent …) and their dosimetric history:

i) Temporary workers in France are not permitted a dose rate greater than 2 mSv/h.

ii) The combined total of the individual predictive dose and the individual effective dose received during the previous eleven months must be lower than 20 mSv. (In France, the total effective dose during a twelve-month period must not exceed 20 mSv).

Dosimetric histories for potential workers are taken from the SISERI^2 application and their employment status is provided to trainees. The employment status is given for each profession.

4.3. Supervision of the collective dose performed and analysis of the discrepancy

Once this preparatory work has been done, the trainees will perform the dosimetric monitoring of the operation, day by day, using the OSIRIS interface.

Using the daily schedule Chart (labelled 3 on Fig. 1), they will analyse the discrepancy between the projected and actual dosimetric readings.

During this work, multiple "alarm dose" alerts will appear in the user interface of the software. This is usually caused by an alarm on workers' electronic dosimeters.

![OSIRIS Interface](image)

Fig4: Example of alarm dose on workers' electronic dosimeters

The trainer gives information about the nature of the alarm to the trainees and then, he explains what they did after the triggering of dosimeter's alarm.

The trainees should then return to the virtual environment to perform measurements of equivalent dose rates and to identify the causes of the dosimeter alarm.

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2 The SISERI information system was developed at the request of the Ministry of Labour in order to centralise, verify and preserve all dosimetric data relating to each worker exposed to ionising radiation in France. For more information you can go to their website: http://siseri.irsn.fr/index.php?position=about.
4.4. Debriefing

At the end of the tutorial, trainees and trainers identify the lessons learned from this case study, in particular:

- Methodology for carrying out a projected dose (identification of exposure time, choice of the correct dose equivalent rate...),
- Choice of methods of optimization (which ones were the most effective, what changes are possible),
- Management of irregular situations (initial identification, what to do in case of emergency, what are the priorities...).

At the INSTN, we try, whenever possible, to have a radioprotection specialist from EDF (operator of pressurized water reactors) present at each tutorial where OSIRIS is used. He brings additional technical expertise that provides trainees with a better understanding of the context, the stakes and the constraints associated with this type of operation.

The participation of the EDF specialist also allows a wider discussion of the different areas of research into the reduction of radiation exposure during programmed maintenance work.

5. Initial feedback of experience, perspective and future developments

Our first experience shows that virtual reality tools such as OSIRIS are valuable additions to those traditionally used.

At the INSTN, we specialise in providing trainees with a real work environment, but one in which the sources of ionizing radiation are simulated (we use simulators for irradiation and contamination sold by the company APVL - http://www.apvl.com/catalogue/simulation-66/).

This OSIRIS software offers an additional training resource, through which trainees can perform more complex operations in a fun, yet realistic, game setting that closely resembles the real-life environment.

The realistic aspect of the case study and the possibility for students to move freely in the 3D environment, as they would in the real world, are greatly appreciated by users. The navigation controls are easy to use, especially for younger users, accustomed to game controls.

After our first experience with this prototype, the INSTN is planning to develop other case studies for other environments (e.g. treatment of spent fuel or new fuel fabrication plant, medical field...)

A commercial version of OSIRIS is being developed and should be on sale in 2013.
Public education/communication on radiation effects and radiation protection
INTERACTIVE WEBSITE ON RADIATION IN THE NETHERLANDS

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ABSTRACT

Radiation being swept along by the winds, contaminated sea containers, radioactive sushi en (highly) elevated radiation levels. Many questions and concerns arose in the weeks and months after the nuclear incident in Fukushima. There was an apparent lack in easy accessible, understandable and correct information for the layman. The Reactor Institute in Delft, The Netherlands, operates a pool type reactor for research and education purposes, with a focus on radiation, medical isotopes and nuclear reactors. Knowledge on radiation issues and know-how in training and educating students and professionals was combined to explain in a clear manner what radiation, radiation measurements and radiation doses are. With this end in view a website was build which contains interactive animations, movies, a quiz, FAQs and additional information. The site aims to objectively and clearly explain what causes radiation, what a radiation dose is and what is the best way to protect oneself against the effects of radiation.
1. Introduction

In the aftermath of the Fukushima nuclear incident there were many questions concerning radiation, radioactivity and dangers to the public. Information for the layman was not readily available because it was spread over different information channels and certainly not all were accurate.

The Reactor Institute Delft (RID) is part of the Delft University of Technology (TU Delft) and operates a pool type reactor for education and research purposes. Also it houses several research departments as well as the National Centre for Radiation Protection, largest provider in radiation protection training in The Netherlands. As such, there is a lot of expertise in the field of radiation, radioactivity and training. It was decided that an informative website about ionising radiation should be made both to inform members of the public about radiation and radiation risks as well as to present the RID as the knowledge institute on radiation and radiation protection.

2. Scope and used language

First the target group had to be selected. Initially it was proposed that the site should be aimed primarily at the reporters of local newspapers due to the (mis)information presented in the media after the Fukushima incident. Early in the process though, the scope was broadened to the interested lay-man with a minimal background in the natural sciences. This meant that also basic concepts such as atom structure had to be explained, another implication was that jargon had to be avoided where possible. One of the results was that the (physically incorrect) term “radioactive radiation (in Dutch)” instead of “ionising radiation” was used.

In the years after the accident in Chernobyl there had been many questions concerning radiation and radiation risks as well. In the Netherlands some of these questions had been answered over the phone and the questions and responses were available in small booklets [Bek86, Kev92]. Based on this information, questions found on the internet and information provided by the government [IenM], key concepts were grouped in four categories:

- What is radiation,
- What are sources of radiation,
- Whether and when radiation is dangerous and
- How to protect oneself against radiation.

The title “What is nuclear radiation?” (Wat is radioactieve straling?) was chosen for the website [www.watisradioactievestraling.nl]. In order to explain the basic concepts best, animations are used. Measuring radiation is shown in movies. Common fallacies are tackled with a small quiz and if all this information leaves the user wanting more they can read the extra information text.
3. Animations

At first, the animations were meant purely as illustrations for the more difficult concepts, such as radioactive decay, in the text. However, they turned out to be the perfect tool to keep the attention of the viewer as they are very pleasing to the eye. If a user browses through the pages of the flash animation without further explorations, he or she will pick up the most elementary information. When the play buttons are pressed, more detailed information is shown. The first animation (figure 1) for example explains that radiation is a form of energy that can be found everywhere. Only when the viewer moves the cursor over the page, more information is shown about the origins of this everyday (in this first case non-ionising) radiation.

To depict the concepts as simple as possible while still maintain the key information was an arduous task. Two examples will be highlighted. First, one of the contributors to background radiation is cosmic radiation. In the animation we show alpha and beta particles racing towards the earth’s atmosphere, where they are almost completely stopped according to the accompanying text. This is a rather crude approximation of the factual situation, but if at this stage also proton radiation and the creation of secondary radiation particles in the earth’s atmosphere needed to be described, most of the audience would really be at a loss. And thus we simplified the situation. Second, health risks posed by different amounts of radiation were depicted in a graph. According to the linear no threshold hypothesis, no dose is completely safe, since even the smallest dose gives a small chance of getting cancer. It was felt however that by already considering this as a potentially dangerous amount of radiation, people would get scared of day to day radiation doses. Therefore, we depicted all doses that are within the range of day to day exposures as safe, up until 20 mSv since this is the dose limit for exposed workers, see figure 2. Also, the effect of dose rate was omitted for reasons of simplification.
4. Movies

The video movies are meant to explain about the different kinds of radiation in a more personal way, by having two people explain the different types of radiation, radiation doses and the difference between exposure and contamination. The movies are all based on radiation measurements. Furthermore the movies were given more or less the same appearance. This was done by using special lighting, shooting with the same camera’s and by making sure that the laboratories and other spaces used were as empty as possible as can be seen in figure 3. Movies were posted on the website as well as on a special YouTube channel to reach a part of the public that would not directly look for factual information about ionising radiation but that might be interested anyhow. In the first movie (movie 1) alpha, beta and gamma radiation are measured. The types of radiation are described, the types of detectors, as well as the interactions with matter that are the basis for detection. Since the movie is quite long, almost six minutes, it was also split in three sections, alpha (1a), beta (1b) and gamma (1c), since it was expected that viewers would not want to watch a movie for six minutes on YouTube. In contradiction to the expectations however the longest movie has been watched most often, see figure 4.

Many people in the vicinity of the research reactor are curious about the inside of the reactor hall. Also some people wonder about the radiation dose that would be caused by either being close to the reactor hall or going inside for a guided tour. This was the basis for the second movie (movie 2), in which a glimpse is given of the reactor hall and information is given about the dose rate close to and inside the reactor hall. Radiation detection is the conversion of radiation energy to a measurable signal, this is shown in the third movie (movie 3). In the process it is also shown that exposure to high dose rates does not mean that the object subjected to radiation becomes radioactive. A few of the concepts that are most difficult to explain are contamination versus exposure. In the last two movies the difference between external exposure (movie 4) to radiation and a radioactive contamination (movie 5) is shown by using a $^{137}\text{Cs}/^{137m}\text{Ba}$ isotope generator. A side effect of the easy and carefree handling of the open and closed sources is that it is considered to be reassuring by viewers of the video’s. Not very surprisingly most views are from the Netherlands, since up until very recently no English translation was available.

![Figure 3. Screenshot from movie 1.](image)

![Figure 4. Number of views per movie.](image)
5. Text and Quiz

The basic concepts have been explained by using animations as well as movies. As indicated the use of jargon has been avoided as much as possible. The texts are considered to be an extra opportunity to explain in more detail what nuclear radiation is, jargon can be explained and where necessary used. It allows for the addition of extra content that is not useful for explaining the basics, but that could be very convenient as e-learning material to use in schools or as safety instruction material. A couple of concepts that are not required for basic understanding but that are considered to be needed when working with sources of ionising radiation are for example: activity, half-life, half value layers, range and dosimetry [Bro08].

The quiz was added to tackle common fallacies, by giving a certain statement such as: “If you are exposed to a lot of nuclear radiation it will make you radioactive.”. Then the visitor is asked whether this is true or false. After the answer is given the visitor gets the correct answer with feedback, also when the question was answered correctly.

6. Visitors

When the site was launched, it was announced by the communications department of the TU Delft homepage, as well as through the TU Delft Twitter channel. They also contacted local newspapers to place a short article about the website. The contributors to the website contacted their network and published two articles in specialist magazines, *Nederlands Tijdschrift voor Stralingsbescherming* (*NTvS*) and *Gamma Nieuws* [NTvS12, Gam12] furthermore they posted the movies on a dedicated channel on YouTube. Up until the end of January 2013 the website had generated close to 8,500 views. More than 1,000 in the first month after launching the site, but after that there is a steady flow of visitors giving between 400 and 600 views per month (figure 5).

![Distribution of page views per month over time.](image)
As it turns out, not only interested laymen are using the website. About one third of the views are due to returning visitors, indicating that the site is used to study the content (figure 6). A couple of schools, middle and higher education institutions are using the site as a tool in their lessons and lectures. Also the radiation training department of Dutch customs uses the site as well as DCMR Environmental Protection Agency and several hospitals, among which NKI-AVL, The Netherlands Cancer Institute.

![Figure 6. New and returning visitors.](image)

7. Acknowledgements

Many useful discussions between the makers of the site and several other experts within the RID, lead to the final result presented here. Especially Rik Linssen (general manager) and Marcel Schouwenburg (head training centre Delft) were driving forces within the institute. Many thanks as well to Eric Verdult (KennisInBeeld, www.kennisinbeeld.nl) for designing all Flash animations and giving his view on the project from a communications point of view. The movies were professionally directed, filmed and edited by Remco Stevens with his team (Moviebites, www.moviebites.nl). Finally, the website itself was build up by Youri Tegelaers.

8. References

Primary website addresses:
- [www.watisradioactievestraling.tudelft.nl](http://www.watisradioactievestraling.tudelft.nl)
- [www.whatisnuclearradiation.tudelft.nl](http://www.whatisnuclearradiation.tudelft.nl)

[Bek86]

[Bro08]
[Gam12]

[Kev92]

[IenM]
[http://www.rijksoverheid.nl/onderwerpen/straling](http://www.rijksoverheid.nl/onderwerpen/straling)

[NBC]
Everyday Radioactivity by Mr. Wizard.

[NTvS12]
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ABSTRACT

Studies in the UK have shown a strategic need for additional Qualified Experts (as described in the Basic Safety Standards Directive 96/29/EURATOM of 13 May 1996) in order to manage the demographic characteristics of the current workforce. With funding from the UK nuclear industry, the University of Cumbria has created new undergraduate courses in Radiation Protection (RP). The courses are part time and are currently designed for technical staff already working in industry who wish to develop themselves into so called “professional roles”.

The Foundation Degree in Radiation Protection (FdSc) is achieved by 3 years part time study and is intended to capture the enthusiasm of people who are perhaps not used to academic study. The qualification provides all the knowledge required by the Society for Radiological Protection’s technical grade - TechSRP.

The Bachelor of Science in Radiation Protection (BSc) is achieved by a further 18 months study at a more advanced level. It provides all the knowledge required to obtain graduate membership of the Society for Radiological Protection (GradSRP).

The first cohort of students has completed their first academic year and are now part way through their second year of studies; a second cohort of students started their course in October 2012. This paper will describe how the UK RP profession has been closely involved in the development and delivery of the teaching. It will also describe the nature and structure of the course as a model for part time, industry based students.

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INTRODUCTION

Following on from the identification by others of a potential skills gap in the field of Radiological Protection (Refs. 1 and 2), the University of Cumbria, working closely with the nuclear and non-nuclear sectors including industry, regulatory, medical and other academic partners, have developed a modular Foundation Degree (FdSc) in Radiation Protection. It is currently targeted at people who are already working in radiation protection, but at a technical level, rather than at a “Qualified Expert” level (as described in the Basic Safety Standards Directive 96/29/EURATOM of 13 May 1996) (Ref. 3). Opportunity is also provided for progression to a BSc Honours (BSc(Hons)) degree in Radiation Protection. The course is highly vocational and has strong academic content supported by a practical work-based element. This helps the student to develop the skills needed to move from a practical or technical role to a professional career in radiation protection.

DETAIL

The new University of Cumbria (UoC) qualification, now in its second year, has been specially designed for those who wish to enhance their career in this very topical radiation protection sector. The syllabus has been constructed to give the students a broad-based grounding in radiation protection, and is designed to link the work-based experience of the students with the academic knowledge gained at the University.

The course is delivered by a combination of university staff and experts from the appropriate sectors depending on the modules being studied. In addition to the end-of-module formal examinations, assignment and projects are developed with the students and their employers to maximise the relevance of the academic study to their work experience.

The course covers the academic requirements for legal recognition by the UK regulators as a Radiation Protection Adviser (RPA) and/or as a Radioactive Waste Adviser (RWA) as required by the European Basic Safety Standards Directive for a Qualified Expert. The qualifications are also recognised by the UK’s Society for Radiological Protection (SRP) for “Tech SRP” membership status following satisfactory completion of the Foundation degree and Graduate membership (GSRP) status on satisfactory completion of the BSc (Hons) degree. The SRP has been, and continues to be, closely involved in the development and design of the overall programme of study.

The course is offered part-time, allowing the student to learn whilst continuing to earn a salary. The FdSc takes three years to complete and four modules are studied each year. The BSc (Hons) degree takes a further 18 months of study and follows the same format: four modules per year to gain the necessary academic credits, i.e. a total of 6 further
Modules (see the list of Modules in Appendix 1). The combination of University lecturers and lecturers from other appropriate sectors, industrial, regulatory and medical, ensures that the information provided is entirely up-to-date in this fast moving subject.

Each module requires one week of classroom and/or laboratory study together with five weeks study in the workplace. During this 5 week period the students complete their chosen assignment. Whilst in the workplace the students are allocated a mentor to ensure that they get the most from this on-the-job learning phase of the course. This 5 week period will also be used to develop a compulsory experiential workplace portfolio to use as evidence when applying for RPA/RWA status.

The University also provides an online learning environment which is used by both staff and students, especially during the 5 week workplace period, for communications between staff and students and also as a valuable resource and learning tool.

CONCLUSION

This Higher Education initiative by the University of Cumbria seeks to bridge a recognized skills gap in the UK to provide the Radiological Protection specialists required by both European and UK law (Ref. 4). The outcome will help to meet the future national needs within the UK.

In addition to the FdSc and BSc degrees in Radiation Protection, described above, plans are being developed to enable validation of an MSc in Radiation Protection course to fill an identified gap in the post-graduate curricula (Refs. 1 and 5) and SRP status as a full Corporate Member.

Discussion is also taking place with a number of employers in the nuclear, medical and related sectors, in which the University is seeking to help with, and compliment, employers in-house training.

In a separate development at the University, validation is currently taking place of a MSc degree course in Nuclear Safety Management, led by my colleague Dr Chris Englefield, and this will be described in another paper at another meeting of ETRAP.

REFERENCES


Appendix 1: Module Summary

Foundation Degree

M4001 – Introduction to Radiation Protection
M4002 – Health and Safety at Work
M4003 – Environmental Radiation Protection
M4004 – Physics for Radiation Protection
M4005 – Biological Basis for Radiation Protection
M4006 – Maths and Computing for Radiation Protection
M5001 – Environmental Radiation Protection
M5002 – Radiation Protection for Employees
M5003 – Control of Radiation Exposure
M5004 – Communicating Radiation Risk
M5005 – Radiation Detectors
M5006 – Work Based Research Project

Supplementary Study for BSc (Hons) Degree

M6001 – Radioactive Waste Legislation
M6002 – Radiation Protection for the General Public
M6003 – Radioactive Waste Management
M6004 – Medical Applications of Ionising Radiations
M6005 – Nuclear Reactors
M6006 – Nuclear Security Management
AN ON-LINE GRADUATE COURSE IN
NUCLEAR ENVIRONMENTAL PROTECTION FOR
HEALTH PHYSICS AND
RADIOACTIVE WASTE MANAGEMENT

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ABSTRACT

Through funding by the US Nuclear Regulatory Commission we have developed a comprehensive course combining health physics and radioactive waste management entitled Nuclear Environmental Protection. This course is given at the graduate level and as an upper division senior class. Graduate students taking the course are mainly from the Department of Mechanical Engineering and include a number of distance learning students. Undergraduate students are in the Nuclear Engineering Certificate Program as well as in the Department of Physics pursuing the Radiation Physics Option. Typically there are about twenty five students taking the class each year. Topics include: Radiation in the Environment; History of Health Physics; Radioactivity; Interactions of Radiation with Matter; Dosimetry; Biological Basis for Radiation Safety; Radiation Safety Guides; ICRP Recommendations; External Dose Rates and Gamma Ray Shielding, Neutron Shielding, Radioactive Waste Management and Sources; Nuclear Fuel Cycle; Spent Nuclear Fuel, Transportation and Regulations; Environmental Restoration; and Atmospheric Dispersion and Release of Radionuclides. Also incorporated into the course is a one hour lab for simple shielding calculations. Through a long-term cooperation with Florida Memorial University, a Historically Black College University (HBCU) these modules are also available to their undergraduate students.

1. Introduction

With dwindling resources and ever an increasing number of distance learning students, many nuclear engineering programs in the United States and in Europe have elected to deliver on-line courses. Our small Nuclear and Radiation Engineering Program at the University of Texas necessitates that we attract qualified distance learning students to augment the on-campus graduate student population. Typically some 30-35% of our graduate student enrollment of approximately forty students (depending on the semester and year) makes our on-line courses vital to our graduation rate at the Masters of Science (MS) and Doctor of Philosophy (PhD). Equally important is that distance learning students often help to reach the minimum number of five students required for the course to be offered by the university. Currently, with the exception of three experimental courses in
radiochemistry, health physics laboratory and reactor laboratory, our graduate and undergraduate curriculum is completely available on-line

2. Delivery System

The technology for delivering on-line courses has greatly improved over the last few years. There are several platforms available for showing video-taped lectures. At the University of Texas, Blackboard (1) is the current choice for delivery. All classes are videotaped and placed on a secure website where the students can access both the video and the PowerPoint presentation simultaneously. Technology such as Smartboard (2) allows the instructor to write on the screen illustrating the PowerPoint slide thus enhancing teaching effectiveness. In this course all the lectures and assignments are pre-loaded onto Blackboard for the entire semester. Assignments can either be handed out in class for on-campus students or emailed to on-line students as Word or PDF files. Blackboard has the usual email communication for individuals, groups or the whole class. The instructor needs to be free in the evenings and weekends to answer any lengthy questions from distance learning students if email is not adequate. All the students appreciate that the course is always available on-line allowing them to refresh themselves on certain topics or to study the material for PhD qualifying examinations.

3. Curriculum

3.1 Course Book

There are two course books. One book is the 4th edition of the very popular Introduction to Health Physics by Cember and Johnson. The second book is the 2nd edition of Radioactive Waste Management by Salig and Fentiman.

3.2 Lecture Component

The lecture components were chosen in order to present the most pertinent parts in health physics and radioactive waste management. There were no lectures given on instrumentation, detailed calculations of the MIRD method, non-ionizing radiation or advanced calculations of risk estimates.

The following topics are covered with single, two or three 75 minute lectures:

Animation of Radiation
Radiation in the Environment
History of Health Physics
Radioactivity
Interactions of Radiation with Matter
Dosimetry
Biological Basis for Radiation Safety
Radiation Safety Guides
ICRP Recommendations
Probabilistic Risk Assessment
External Dose Rates and Gamma-Ray Shielding
Neutron Shielding
Radioactive Waste Management and Sources
3.3 Laboratory Component

There is one simple shielding laboratory in the attenuation of beta particles and gamma rays through various materials. While distance learners cannot perform this experiment, the data is available to them so that they can complete the calculations.

4. Student Grade Evaluation

The grade evaluation of the students is made up of several components:

1) Assignments given from the course books (10%)
2) Five examinations (14% each for a total of 70%)
3) One laboratory experiment (10%)
4) One research paper on any topic in health physics or radioactive waste management (10%)

5. Course Evaluation

Evaluations of the course and instructor are completed using the usual forms supplied by the University of Texas. These forms are filled out in private on the last day of class and then handed in to the teaching assistant. The specific questions as well as overall course and instructor evaluation are shown below. The University of Texas uses only the last two questions (g and h) as means of evaluating the course and the instructor. The first questions (a-f) are given as guidelines to the instructor of the strengths and weaknesses of the individual parts of the course. Each student also has ample space for hand-written comments.

a. Course Well-Organized
b. Communicated Information Effectively
c. Showed Interest in Student Progress
d. Assignments and Tests Returned Promptly
e. Student Freedom of Expression
f. Course of Value To Date
g. Overall Instructor Rating
h. Overall Course Rating
6. Conclusion

We have developed a comprehensive on-line course entitled Nuclear Environmental Protection which covers all the major components in health physics and radioactive waste management. While there is a great effort to produce these lectures including the creation of animations, the rewards to the students have been substantial. Access to the PowerPoint lectures and videotapes are always accessible since they are pre-recorded. Therefore if the instructor is unavailable to give a lecture the material can be seen without the need of finding a replacement. This results in a less fractured presentation of the material over the course of the semester. This course material is also available to other institutions such as Florida Memorial University (3) and the University Engineering Alliance which is multi-state consortium offering distance learning programs in engineering (4).

7. References

1. http://www.blackboard.com
3. http://www.fmuniv.edu
HOW TO INFORM THE PUBLIC ABOUT RADIATION EXPOSURE

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ABSTRACT

There are many situations in which people should obtain clear and adequately formulated information about the exposure they may be subjected to as patients during their examination or treatment involving the use of ionizing radiation technology or simply as members of the public in the case of any significant radiation or nuclear emergency situations including incidents, accidents, sabotage or radiological attacks. The exposure has to be expressed in a manner such that even a layman without any special education or knowledge regarding the harmful effects of radiation should be able to understand such information in terms of a resulting risk where it is important to see this risk in perspective with the other risks we are all facing at workplaces or in everyday life. The public should distinguish between low-level exposure risk where only stochastic effects are expected and high-level exposures, which will result in some visible detrimental health consequences characterized as deterministic effects. The paper will attempt to summarize our experience from teaching radiation protection to medical and para-medical students and personnel as well as from organizing training courses in this field for non-specialists where it is not always easy to quantify the amount of exposure in an understandable way since so many quantities have been introduced that even specialists are sometime confused concerning the correct interpretation of all those terms and units. Special emphasis will be placed on the relationship between the dosimetry and radiation protection quantities versus corresponding biological effects.

1. Introduction

Terms like atomic and nuclear weapons or radiological accidents as well as dirty bombs have become household terms with very bad connotations inducing a horrifying picture of disaster. This image originated mainly from the bombing of Hiroshima and Nagasaki in 1945. On the one hand, the media have negatively reported nuclear weapons tests and have sometimes included exaggerated stories of the impact of radiation and nuclear accidents, notably the Chernobyl 1996 [1] and Fukushima 2011[2] catastrophes. On the other hand, the media virtually ignored some very serious man-made accidents in other industries or fields although their consequences were much more serious with many casualties and huge contamination of the environment with highly toxic substances. For example, one can mention the accident at the chemical plant in Bhopal in India in 1994 [3] where several tens of thousands of people died and the site has not yet been completely rehabilitated. While in the cases of the nuclear accidents at Chernobyl and Fukushima everything possible was done in order to mitigate the consequences and to learn a lesson so that nothing similar may happen in the future, the Bhopal disaster went without almost any special measures.

It is not easy for members of the general public to understand and evaluate these accidents mainly because of their insufficient basic knowledge of modern technologies and especially because of the influence of the mass media.

The assessment and awareness of risk associated with radiation exposure is very important, especially in the case of an emergency situation where the people may receive high doses (above certain threshold levels) leading to so-called deterministic effects. The consequences of such situations will cause harmful effects, the severity of which is proportional to the exposure. These effects may be encountered in accidental cases or situations where, for
some reasons, the source is not under control. Such effects will appear in persons exposed to sufficiently high radiation doses received in these unplanned conditions.

Other types of biological effects involve the development of cancer or other diseases which will occur with a probability related to the exposure. In this case it cannot be predicted who exactly will be affected. These effects are called stochastic effects and they are the main concern in radiation protection where under normal (planned) conditions only low exposure is expected.

The public usually does not distinguish between the deterministic and stochastic effects, and they believe that any exposure is very dangerous. This is why it is important to have a basic understanding of at least three quantities used in dosimetry and radiation protection: the activity, the absorbed dose and the effective dose. The first quantity is used to characterize the power or amount of radioactive material or sources while the other quantities refer to the impact following the irradiation of a person with ionizing radiation emitted by radiation sources.

2. Basic quantification of radioactive sources, exposure and associated risk

Although ionizing radiation can be produced by so-called radiation generators such as X-ray tubes or accelerators, we will concentrate on radiation emitted by radionuclides. Any radioactive source can be quantified by its amount or mass and other relevant parameters, especially the half-life and the number and the type of ionizing particles emitted during a single radioactive decay. Historically, however, a quantity related to the number of radioactive decays has been adopted as a measure of a radioactive source. This quantity, called the activity, is defined by the number of such disintegrations per second. The old unit was Ci (curie); a new unit which is currently used is Bq (becquerel). While the unit Ci was too big, the unit Bq is rather too small. This is why we usually use normalized multiple prefixes. Since 1 Ci = 3.7 \times 10^{10} \text{ Bq}, one can write 1 Ci = 37 \text{ GBq} and 1 Bq = 2.7 \text{ nCi}. In the case of most radionuclides, those with activities in the range of tens of GBq or several Ci are dangerous sources.

The term of the exposure should be understood as a process under which a person is exposed to ionizing radiation either externally or internally. The first case includes the situations when the radiation source is outside the body and radiation strikes the body or its organs and tissues from the outside. Internal exposure is associated with the radiation emitted by a radioactive substance which entered the body usually via the inhalation or ingestion of radioactively contaminated air or foodstuffs, respectively. The total exposure of a particular human organ or tissue consists of the sum of two components, namely the external and internal radiation contributions.

The absorbed dose is defined as the energy absorbed per unit of the material (eg. tissue) and is expressed using a basic unit Gy (gray) which corresponds to the energy of one J (joule) per kg. The dose can be related to a point of interest or to a certain volume of material. For example, an organ or tissue dose represents the energy divided by the mass of the organ or tissue. The unit here is also Gy. One has to realize that the biological damage caused by the radiation is not due to the energy itself (which may result in a negligible increase of the temperature of the exposed mass) but because of other processes, mainly the ionization and excitation of atoms and molecules which may lead to damage of the cells. This damage may result in stochastic effects (at low exposures, up to about 0.5 Gy) or deterministic effects (at high exposures, above about 1 Gy).

It has been recognized that both stochastic and deterministic effects depend not only on the dose but are also affected by the density of the energy deposited by radiation along their track in the living tissues. This is why the dose has to be weighted by appropriate factors,
namely by a radiation weighted factor (in the case of stochastic effects) and a RBE (radiobiological effectiveness) factor (in the case of deterministic effects).

The main quantity for the assessment of the risk due to exposures at a relatively low level is the effective dose $E$ defined as

$$E = \sum_T w_T \sum_R w_R D_{T,R}$$

where $w_R$ is the radiation weighting factor, $w_T$ is the tissue weighting factor and $D_{T,R}$ is the average dose in organ or tissue $T$ produced by radiation of type $R$.

The basic unit of these quantities, as long as the dose is in Gy, is Sv. It is related to the old unit of rem which had been used previously in radiation protection as $1 \text{ Sv} = 100 \text{ rem}$.

We do not have an alternative system of similar quantities for the assessment of deterministic effects, although for organs or tissues sometimes the RBE-weighted dose is used, for which the unit Gy-Eq (gray-equivalent) was proposed. So far, the deterministic effects are usually expressed in Gy accompanied by some details with respect to the geometry of the exposure and the type of radiation.

It may not be easy for a non-specialist in the field or a layman to fully understand the interpretation of the effective dose, which is usually given in mSv. However, it is important to be able to link the exposure expressed in mSv with the associated risk. An example may be helpful: if each person in a group of one-million people is exposed to an effective dose of 1 mSv, this will result in the induction of about 55 cancer cases among the group. Of course, since these effects are stochastic nobody can predict who will be affected. For an individual this probability is $5.5 \times 10^{-5} \text{ mSv}^{-1}$ which represents a very low risk indeed. Here, we have to point out that among those persons considered (1 million) there will occur about 250,000 cancer cases due to other reasons. The situation can also be interpreted in the following way: while for an individual the risk is trivial and can be accepted as long as 1 mSv exposure is due to some practice having a beneficial contribution, 55 additional cancer cases in a group of 1 million may not be trivial from the point of view of society, which has to take some steps to treat those people affected.

In addition to the stochastic effects in terms of the occurrence of cancer cases, there are also some heritable effects although they are much lower than it was thought previously. In the example given above (the exposure of 1 million people to 1 mSv) we may expect something like two cases of some abnormalities among children born in this group. Again, the number of spontaneous cases in such a group of people is much higher.

In accordance with this definition, we cannot use the effective dose for high exposure where deterministic effects are expected. In this case the quantity of the absorbed dose in Gy is used instead. Sometimes, however, the unit Sv is used incorrectly, where for penetrating gammas and X-rays one can consider that 1,000 mSv is more or less the same as 1 Gy.

3. Exposure in perspective: How much is too much?

In communication with the public it is important to stress the fact that we are all exposed to a certain amount of radiation whether we like it or not. Nothing much can be done about it. This exposure is due to cosmic radiation and natural radionuclides present in rock, soil, water and air. This natural exposure, often referred to as the radiation background, may vary depending on the geographic location, local geology and other factors such as diet and type of dwelling, including design and building materials.

Obviously, the natural exposure is too low to be associated with any deterministic effects. Anything above the natural exposure results from the use of radiation and nuclear
technologies in various practices including medicine, industry, agriculture, science and some other areas. The average worldwide values of the individual exposure and their typical ranges due to both natural and man-made origin are presented in table 1 and illustrated in the pie graph in figure 1 (based on [4,5]). In the case of man-made exposure the data express the average values, which include the contribution from exposure under normal (planned) situations as well as due to radiological accidents. These accidents visibly affect the personnel of the radiation or nuclear facilities and local population rather than having any significant impact on the average exposure values worldwide.

Table 1. Annual per capita effective doses from natural and man-made sources of radiation worldwide

<table>
<thead>
<tr>
<th>Source</th>
<th>Annual effective dose (mSv)</th>
<th>Typical range (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural background</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cosmic rays</td>
<td>0.39</td>
<td>0.3-1.0</td>
</tr>
<tr>
<td>Terrestrial gamma rays</td>
<td>0.48</td>
<td>0.3-1.0</td>
</tr>
<tr>
<td>Internal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhalation (principally radon)</td>
<td>1.26</td>
<td>0.2-10</td>
</tr>
<tr>
<td>Ingestion</td>
<td>0.3</td>
<td>0.2-0.8</td>
</tr>
<tr>
<td>Total</td>
<td>2.4</td>
<td>1-13</td>
</tr>
<tr>
<td>Medical (primarily diagnostic X rays)</td>
<td>0.6</td>
<td>0.03-2.0</td>
</tr>
<tr>
<td>Man-made environmental</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atmospheric nuclear-weapons tests</td>
<td>0.005</td>
<td>up to 0.15</td>
</tr>
<tr>
<td>Chernobyl accident</td>
<td>0.002</td>
<td>highest 0.04</td>
</tr>
<tr>
<td>Nuclear power production</td>
<td>0.0002</td>
<td>up to 0.02</td>
</tr>
</tbody>
</table>

Notes: 1. About 3-4 mSv in the Czech Republic  
2. Peak was in 1963  
3. Not more than 0.6 mSv of life exposure in the Czech Rep. (even for children born in 1986)  
4. Highest for critical groups at 1 km from some nuclear reactor sites

Fig. 1. The contribution to the population exposure due to various natural radiation sources and practices (medical, industrial etc.)
In accordance with the data shown in table 1, there is a visible increase in the exposure coming from the medical use of radiation. This will likely continue and soon the average dose due to medical exposure may be higher than that due to natural radiation. This is why special attention should be paid to controlling medical exposure using strict measures to observe introduced guidance levels and optimizing the number of diagnostic examinations.

Another factor which members of the public may not realize is the exposure of air crews (pilots and flight attendants) due to the increased level of cosmic radiation with the altitude, which is about 5 mSv per year. This exposure is comparable with the exposure of the most exposed professionals, including reactor operators or miners in uranium mines.

Adequate protection of radiation workers (professionally exposed) and members of the public is ensured by keeping radiation exposures not only below recommended dose limits but at the same time reducing the exposure to a very minimum in accordance with one of basic principles of radiation protection – ALARA (As Low As Reasonably Achievable). The latest dose limits proposed by the ICRP and recommended by the IAEA, European Union and other international organizations are shown in table 2 [6-8].

All professionals in radiation protection, including the users of radiation sources, should be familiar with the average values of the exposure to natural sources, dose limits and at least approximately be aware of the exposure due to the most important man-made sources and their applications. They are supposed to make use of this information when dealing and communicating with the public. In order to establish a good communication atmosphere, no complex technical or scientific terminology should be used.

<table>
<thead>
<tr>
<th>Type of limit</th>
<th>Annual occupational exposure</th>
<th>Annual public exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective dose</td>
<td>20 mSv¹</td>
<td>1 mSv²</td>
</tr>
<tr>
<td>Equivalent dose to lens of the eye</td>
<td>150 mSv</td>
<td>15 mSv</td>
</tr>
<tr>
<td>Equivalent dose to the skin</td>
<td>500 mSv</td>
<td>50 mSv</td>
</tr>
<tr>
<td>Equivalent dose to hands and feet</td>
<td>500 mSv</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ¹Averaged over 5 years, with no more than 50 mSv in any one year
²Exceptionally, a higher value of effective dose could be allowed in a year provided that the average over 5 years does not exceed 1 mSv in a year

Under normal conditions, in accordance with the basic radiation protection requirements, the exposure is not supposed to exceed the above-mentioned dose limits. On the contrary, everything possible has to be done to keep actual exposures at the lowest achievable level well below those limits. However, in the case of an accident, some guidance levels have been recommended in order to restrict the exposure of emergency workers. In such situations, the guidance values for restricting exposure to external penetrating radiation of emergency workers can reach up to 500 mSv. This applies especially to those who are engaged in life saving actions or actions to prevent severe deterministic effects and actions to prevent the development of catastrophic conditions that could significantly affect people and the environment.

The public should be aware of some specific applications of radioactive sources where there is a potential for a very high exposure. This is why the IAEA has developed the
categorization of radioactive sources where five categories are recognized, category 1, which includes practices with the most dangerous sources, and category 5, which is characterized by low risk sources (table 3). This categorization is based on the so-called dangerous activity $D$ which is the activity of a particular source that could, if not under control, give rise to exposure sufficient to cause severe deterministic effects [7]).

Under normal conditions the annual population exposure from the effluents released during the operation of nuclear power plants is at the level of 0.01 mSv, which is many times below the natural radiation background. Some medical diagnostic examinations may result in exposures as high as 20 mSv. Professional exposures only rarely exceed 4-5 mSv per year. Any exposure above 50 mSv suggests that there is something wrong as to the procedures or equipment used, or it can indicate an accident which, if appropriate measures are not taken, may lead to much higher exposures.

Table 3. Categories for sealed sources used in common practices (based on [7])

<table>
<thead>
<tr>
<th>Category</th>
<th>Ratio $A/D$</th>
<th>Example of sources and practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$\geq 1000$</td>
<td>Radioisotope thermoelectric generators (RTGs), irradiators, teletherapy sources, multibeam teletherapy (“gamma knife”)</td>
</tr>
<tr>
<td>2</td>
<td>$1000 &gt; A/D \geq 10$</td>
<td>Industrial gamma radiography sources, high/medium dose rate brachytherapy sources</td>
</tr>
<tr>
<td>3</td>
<td>$10 &gt; A/D \geq 1$</td>
<td>Fixed industrial gauges incorporating high activity sources, well logging gauges</td>
</tr>
<tr>
<td>4</td>
<td>$1 &gt; A/D \geq 0.01$</td>
<td>Low dose rate brachytherapy sources (except eye plaques and permanent implants), industrial gauges not incorporating high activity sources, bone densitometers, static eliminators</td>
</tr>
<tr>
<td>5</td>
<td>$0.01 &gt; A/D$</td>
<td>Low dose rate brachytherapy eye plaques and permanent implant sources, electron capture devices, Mossbauer spectrometry sources, positron emission tomography check sources</td>
</tr>
</tbody>
</table>

Note: 1 This category also includes sources with an activity below the exempt activity, i.e. the activity of a radionuclide below which it is exempted from regulatory control.

Possible health effects resulting from external whole body exposure (based on [9]) is shown in fig. 2, which illustrates the range of exposures and their possible impact. In the case of internal contamination (intake or ingestion of radioactive material) the distribution of the exposure within the body may show some inhomogeneities.

4. Public perception of radiation: Myths and misconceptions

One of the main issues in communicating with the public is its basic (mis)understanding of radiation protection and the (un)biased perception of risks associated with numerous practical application of radiation and nuclear technologies which many people conjure up images of Hiroshima and Nagasaki, nuclear war, Chernobyl, Fukushima, cancer, deformed children, etc. The public is confused about radiation and its risks, and it is necessary to make a concerted effort to clarify the concept of risk (in perspective to other risks around us), to inform the public about the benefits this field, so that existing myths and misconceptions are dispelled.
Perceptions of the severity of risk by ordinary people are usually quite different from the risks actually assessed, measured or calculated for many hazards and activities. There have been many surveys conducted among various groups (typical representatives of members of the public) to determine how risks were perceived. Individuals were asked to rank 30 activities in order of most hazardous to least hazardous. Usually they considered the risk due to radiation or nuclear technologies as the highest, which is obviously not true.

Public communications should be considered an integral part of the overall management of any use of powerful radiation sources or nuclear reactors. In order to facilitate better perception of incidents or accidents by the public, an easily understandable and comprehensible risk factor scale associated with the exposure to ionizing radiation should be used. Experience has shown that any level of radiation is considered by the public and the media as absolutely dangerous and no differentiation of the real potential impact is taken into account.

The transfer of a comprehensive message to the public is largely complicated by different terminology used, most of which are not easily understandable to the layman, who may not adequately interpret a correlation between scale levels and risk factors. All possible measures should be undertaken in order to improve the understanding and communication between radiation protection experts and governmental decision makers, politicians and local authorities. This is important especially in the case of an emergency, where the public should be informed why certain countermeasures are introduced. Such procedures surely will improve the credibility of the authorities, which is crucial particularly in case of a severe accident or a radiological terrorist attack. It would be most appropriate to have a more general risk scale, perhaps something like the Richter-scale for the assessment of the earthquake magnitude, for the assessment of radiological risk.

For the public, it seems, radiation is just bad at any level and everything has to be done to eliminate any radiation exposure at all. The mass media usually provokes a general feeling of anxiousness in the public anytime there is an exposure involving ionizing radiation or in case of any small mishap which normally is under control and does not present any risk to the public. The media tend to give broad coverage of such situations regardless of how small...
the actual or hypothetical exposure level is. Even minor incidents with very little or no
exposure quite often appear on the front pages of the newspapers, while much larger
exposures by other carcinogenic substances usually never make front pages. Consequently,
the public, influenced by the media does not differentiate between high and low exposure.
Ironically, the fact that we can measure even tiny radiation levels well below the natural
radiation level is misused as evidence or a proof of the presence of radiation, which in such
cases is absolutely negligible (but the instruments give some reading).

An essential problem in the communication of radiation risk to the public is the various
quantities and units used in radiation protection which substantially contribute to the
confusion of the public. Particularly confusing are the different dimensions of the units where,
for example, for the quantification of the dose or activity such prefixes as micro, mili, kilo,
 mega, giga or tera are used to distinguish between units and subunits. The confusion arises
in particular when they are abbreviated (terms as Sv, mSv or μSv, all sound the same). In
addition, journalists usually do not use abbreviations, but write out "milli-Sievert" or "mikro-
Sievert and they easily change μ to m to yield e.g. "mSv" instead of "μSv", or m to M giving
"MBq" instead of "mBq". The lay public may not even understand the difference between
activity and dose or between dose and dose rate. This results in the difficulties of the public
to differentiate between low, medium and high doses and their possible implications.

5. A prerequisite for good communication with the public

Some basic knowledge from basic and secondary school or college, trust in responsible
authorities, education of teachers, medical doctors and journalists as well as people of mass
media are a good foundation to achieve appropriate conditions for good and transparent
communication with members of the public. Regular information provided to the public
around major nuclear installations would also help in creating an atmosphere of confidence
and trust in the safety of current technology.

To stress once again, radiation protection standards and policies for the protection of the
population are based on dose limits and constraints which have been set based on
radiobiological and epidemiological research and studies through which we know now about
radiation health effects more than we know about the detrimental impacts of any other
hazardous substances or agents. This should also be conveyed to the public to demonstrate
that the specialists in radiation protection care and are constantly working on improving the
safety of all nuclear and radiation installations.

The communication should preferably be arranged through a spokesperson, the selection of
whom should take into account primarily three factors: technical expertise, level of authority
and communication skills. To be credible, the spokesperson should be an expert in the area
and hold a position with a level of authority appropriate to the matter consistent with the
specific communication. The spokesperson is often a senior official, who should be able to
empathize with the public's concerns and be able to simplify scientific and technical
information.

There are many other factors and skills the spokesperson should possess when
communicating with the media. He/she should be self-confident, straightforward, clear,
simple, sincere, honest, comfortable and confident and his message should be brief and to
the point. Some special difficulties arise when a journalist asks for an interview through the
phone. One has to be sure to find out whether the interview will be broadcast live or recorded
and how much time will be allocated for answers to questions. We always have to keep in
mind that any interview is an excellent opportunity to get an important message to the public.
If an interviewed person cannot answer a question, he/she should give the reason why or
indicate who the question should be put to. It is recommended to avoid any theorization or
speculation. The public has the right to know only reliable information and facts about any
radiation situation and the risks. The education of the population and communication with the
general lay public should be carried out in such a way as to increase public understanding of
radiation protection issues and, for example, prepare it for acceptance of future nuclear
installations. The worst scenario would be a perception of radiation that would induce
considerable resistance and opposition even against the use of radiation and other nuclear
techniques in medicine where many of these modalities are irreplaceable.

We have to intensify our efforts in communicating with the public and ensure its continuous
education and enlightenment in order to avoid such situations where the public is under
strong influence of “green” groups which claim that any use of radiation is harmful and
spread among the public the false information in accordance with the lines “all radiation is
bad, nuclear power plant cause cancer”. They are trying to create an atmosphere which
leaves the layman with a strange feeling that he/she was not told the whole truth or that there
is still a risk he was not told about. One cannot deny that to explain the risk factors
associated with a certain exposure level is very tedious task requiring longer explanations,
especially when low doses are involved. This is particularly true in an accident situation
where there is not enough time for lengthy discussions and scientific explanations which,
anyway, the public being usually under some stress is reluctant to accept.

For the general public and the media there is surely a need for a simple, easily
understandable scale, for radiation exposure of human beings in order to assist in making
radiation exposure values and their consequences to health more easily perceived in the
context with other risks which are generally accepted.

In principle, there are two kinds of the communications with the public: normal situations,
when everything is going in accordance with the plan and thus everything is under control,
and emergency situations, where a radiation protection expert is expected to give relevant
information and guidance to concerned people. In emergency situations one has to admit
that something unexpected has happened and that one understands that people are deeply
worried. At the same time, the expert should try to convince the public that the responsible
authorities were well prepared for such event and are doing their best to eliminate or reduced
the impact of the accident to the very minimum.

Even some experts in radiation protection may not always evaluate the situation correctly
and in an unbiased way. A good example to document this menace has recently been
discussed in relation with the assessment of possible consequences resulting from the
Chernobyl accident [11], which is continuing to attract the attention of experts, decision-
makers and the general public. Now these consequences have been given added relevance
by the similar accident in 2011 at the Fukushima-1 nuclear power plant in Japan. Expert
analysis of radiation levels and effects has been conducted by international bodies—
UNSCEAR in 2008 and the Chernobyl Forum during 2003–5. At the same time, some other
scientists [12] suggested a departure from analytical epidemiological studies in favour of
ecological ones. This erroneous approach resulted in the overestimation of the number of
accident victims by more than 800 000 deaths during 1987–2004. Such mistakes in
methodology conclude that these errors led to a clear exaggeration of radiation-induced
health effects. Should similar mistakes be made following the 2011 accident at Fukushima-1
this could lead quite unnecessarily to a panic reaction by the public about possible health
effects and to erroneous decisions by the authorities in Japan.

6. Conclusion

It is generally understood that the further development of the peaceful applications of ionizing
radiation, radionuclides and nuclear energy (not only for production of electricity but also for
other uses such as hydrogen production and the desalination of sea water) would require
getting public support which can only be achieved by proper communications among the
scientists, engineers and the relevant authorities on one side and members of the community on the other side in order for the public to understand the advantages and importance of new technologies as well as their safety and security with regard to meeting relevant internationally developed standards. The positive response of the public cannot be assured without some proactive measures aimed at its education and basic understanding, which is a prerequisite for mutual comprehension of the role of both parties where the public should be convinced that there is a common goal in the interest of the whole society. This is why it is desirable to adopt a methodical approach in establishing a system of education of basic radiation and nuclear technologies during compulsory education, where special attention should be paid to the continuous training of teachers in order to transfer the latest philosophy of the protection of society against any excessive and unjustified risk associated with the use of radiation and nuclear techniques. Special attention should also to be paid to relevant medical personnel who should be able to inform patients about the potential risks due to the medical uses of radiation sources in a simple but honest way. This will be more and more important since the continuous increase in radiation applications may result in a dramatic increase of the collective exposure. Everything suggests that in the near future the exposure due to medical diagnostic examinations will exceed the current average exposure due to natural radiation. The public should be prepared for such a situation in order to prevent panic due to the fear of medical applications of radiation, which, in general, is extremely useful to get valuable diagnostic information. Effective public communication inter alia should reassure individuals who are not directly at risk by reducing rumours, fears and anxiety or panic. An adequate approach can facilitate relief efforts and also maintain public trust and confidence in the organizations responsible for ensuring the welfare of the public. Communicating with the public about radiation is a challenging task where plain language, trust and availability of relevant information are the key elements.

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Literature


Introduction of ethics in education and training for radiation protection
WHERE IS THE BORDER BETWEEN PROFESSIONAL AND RADIATION PROTECTION EDUCATION AND TRAINING

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ABSTRACT

Participants in radiation protection courses have different professional backgrounds and experience, and they come from various organisations and companies. They are dissimilar in motivation and expectations. We can identify four groups of participants: people, who just want to fulfill formal requirement for training and to get a certificate, people with concerns, who want to learn as much as possible about radiation effects, people with formed attitude who want to learn about their job and, finally, people with previous knowledge about sources who want to learn about radiation protection. If we want to achieve our goals as teachers and trainers, we have to increase their motivation and change expectations. Probably the most efficient approach is to introduce some subjects and topics related to their professional work.

General radiation protection courses require subjects related to “basic” sciences. These subjects could be discussed extensively and independently in broader professional courses (like reactor operator course) where radiation protection is integrated as one of the subjects, which is optimal also for radiation protection training. In case of stand-alone courses on radiation protection, these subjects, as well as topics related to technology applications and engineering branches are also part of the course. If we want to attract participants and increase motivation, it is useful not to limit ourselves on radiation protection particularities. This expansion of presentations to include details relevant to participant’s professional work has also other advantages, like adding credibility and increasing importance of radiation protection training. In minimal courses, where only basic radiation protection facts are delivered with minimal explanations, there is no space for additional details regarding professional work. This type of courses is usually not effective, unless the participants are homogeneous group with some previous knowledge of sources and radiation.

Border between professional and radiation protection education and training in these courses should not be rigid and imposed with radiation protection objectives of a course. For the final success and effectiveness of the radiation protection education and training, it should be possible (and welcome) to reposition it according to circumstances and needs.

1. Introduction

During our professional careers as radiation protection teachers and trainers, we all meet people with different professional backgrounds and experience, coming from various organisations and companies. As teachers and trainers, we would like to have homogenous and motivated groups of course participants, prepared to acquire knowledge and skills that we consider important for their present and future work with sources of ionising radiation.
Very often, this is not the case, and our intentions and course delivery are different from expectations of course participants.

For some of them, the motivation for attending radiation protection course is simply the need to fulfill formal requirement for basic training and to get a certificate. Their expectations are more or less related to fast delivery of course content and unproblematic examination at the end of the course. Second group are people with concerns, being not sure what they will be dealing with. They are usually confused with information about ionizing radiation and effects presented by their employers or managers and general public opinion. Although they are not prepared to believe everything, they expect from the teacher to explain as much as he can about health effects of ionizing radiation, and to assure them that working with their particular source is “safe”. Third group are people attending the course without some preformed opinion and attitude, but expecting to get some useful facts and explanations about their future professional work. There is, of course, also the fourth group that “complies” with our expectations. These are usually people with some previous knowledge about radiation sources from their professional education. They do not need to have practical experience, but it is important that they have received the first information about sources in some formal way.

As we can see, the motivation and expectations of participants are not always compatible with our intentions. If we want to achieve our goals, we should try to build their motivation and change expectations. Probably the most efficient approach is to incorporate some subjects and details related to participant’s professional work. This builds confidence and, in many cases, brings different views and deeper understanding of their professional work. At the end of the course, participants are “awarded” not only with knowledge of radiation protection, but also with some additional benefit.

2. Backbone of radiation protection training and education programmes

When we try to define an outline of radiation protection training (or education) programme some basic components will always emerge:

1. Description of radiation sources, interaction and detection of radiation
2. Description of biological effects of exposure to ionising radiation and dosimetry
3. Principles of radiation protection with general aspects of implementation
4. Practices and practical implementation of radiation protection
5. Regulations and rules

Since radiation protection is essentially interdisciplinary science, one would expect that background of these subjects is coming from different “pure” sciences. This is true and we can easily identify fundamental sciences like Physics, Biology, and Chemistry behind first two titles.

On other side, for the fourth title, Practices and practical implementation of radiation protection, background is mixture of science applications and different engineering branches where radiation sources are being used for different purposes. Pure description of practice is not enough; the benefit should come from the implementation of third title, Principles of radiation protection, during the conduct of practice. The fifth title, Regulations and rules are in fact formalised requirements for practices based on radiation protection principles with technical details of implementation and description of legal formalism on how to comply with these requirements.

The position of third title, Principles of radiation protection with general aspects of implementation, is not accidental, since radiation protection actually performs as a bridge between fundamental sciences and practical applications with the special purpose: to use knowledge for assessment, control, and optimisation of exposure to ionising radiation. Of course, there is much more in radiation protection than just applying the knowledge from
fundamental sciences, but in most cases it is the same knowledge that serves as basis for
different applications or engineering products. Therefore, a part of radiation protection course
always “overlaps” with courses in professional education and training.

An illustration of this statement is, for example, discussion on X-ray tube operation and
characteristics of X-ray radiation, which is equally important for radiation protection and for
understanding of X-ray application in industrial radiography. In this case, even the required
level of understanding is comparable. Another example is interaction of X-ray radiation with
matter, being equally important for radiation protection and understanding of radiography and
different analytical applications of X-rays. Other examples are modes of radioactive decay,
energy spectrum of different radiations, etc. While level of understanding required for
radiation protection in these examples it is not always as high as required for some jobs
involved in the use of mentioned sources, it is more than adequate for considerable number
of users.

3. Course types
3.1 Integrated courses

These findings are not new, and common contents between professional training and
radiation protection training are thoroughly defined and elaborated in the training of Nuclear
Power Plant reactor operators, for instance. In this case, the formal training in radiation
protection is limited to contents that are specific to the subject, while common contents are
discussed within other topics. This applies also to On the Job Training, where practical
aspects of radiation protection should be practised. The same approach has been
implemented in our country also in the training of Nuclear Power Plant field and maintenance
technicians, who must attend a course on the Basics of Nuclear Technology.

The advantage of this integrated approach is effectiveness and quality of radiation protection
training. Trainees understand radiation protection as integral part of their usual work and are
able to relate radiation protection requirements and consequences with their regular actions
and activities.

3.2 Stand-alone courses

Unfortunately, for majority of professions the integrated approach is not possible. This is true
for most of the professionals in other branches of industry and professionals working in
research institutions. Due to diversity of sources, limited number of professionals working
with a particular source or equipment, and workers typically coming from different
professions, in majority of cases there is either limited or even nonexistent previous training
about radiation source use.

Knowledge of the source background and operation is either result of self-study, information
passed on by the manufacturer’s maintenance staff, or, in some specific cases, acquired on
special courses organised by the equipment manufacturer. This approach is focused on
equipment utilisation, and radiation protection information is minimal.

Except in the case of Non-destructive Testing (NDT), legislation does not require formal
training and education on source use. However, legislation requires training in radiation
protection for all professionals regardless on their previous knowledge and in most cases this
training is the first (and for some also unique) occasion to get some adequate and organised
knowledge about background of sources, radiation, and radiation measurement methods.
And this is what many of them expect: to learn more about sources they will be working with,
since technical manuals and operating instructions tend to focus on applications, without
proper justification and explanation of “basics”.

281 of 434
20/03/2013
Discussion on application of radiation protection requirements for the practice can also reveal some additional information about the equipment and technology applied. It is our experience that clarification of theoretical background of sources and radiation measurement methods stimulates and encourages course participants for comprehension attempt beyond radiation protection particularities. Therefore, also some additional information related not only to radiation protection, but also to the professional work could be passed on to the participants. Since all this knowledge exceeding radiation protection enables participants to understand and perform their job better, it is beneficial to their professional capacity, and radiation protection courses should be considered also as a part of continuing professional education.

### 3.3 Minimal courses

The third approach is to limit the radiation protection training just on basic facts and requirement of radiation protection. I our basic outline this should mean omitting the first title and limiting presentation of second and other titles to basic facts.

The approach could be result of conscious decision to relay on participant’s previous knowledge, which is justified only in certain (special) environments with well-educated professional workers with solid knowledge of sources. However, this does not eliminate the need to discuss practical operation of sources and implementation of radiation protection procedures.

Using the approach for professional workers without previous knowledge of sources is not recommended. Although they could work safe, it seems that their not properly formed attitude sometimes may be a cause of unwanted complications, or even incidents.

This approach is often used for members of staff not directly involved in the work with the sources, but having duties related to equipment or areas where sources are located. They must obey certain rules that should be presented to them, but this is not enough. People not having previous knowledge about sources and radiation are prone to mystification that can result in anxiety and fear. Sometimes this could also lead to irrational conclusions on consequences for health of a person. Therefore, it is very important to explain and discuss biological consequences of exposure and health effects of the particular source, regardless of it’s insignificance.

### 4. Comparison of approaches from training effectiveness point of view

We can see that radiation protection courses generally include some subjects that could be considered as a part of professional education. In integrated courses radiation protection is in fact only a part of professional education course. We can see that more subjects in professional education support radiation protection training, and there is no clean border between radiation protection course and “pure” professional education subjects. In this case, radiation protection is an element of professional education. As we have said before, course participants accept radiation protection as a regular part of their profession. Therefore, we can say that this is probably the optimal approach.

In stand-alone courses, a part of a course is reserved for subjects that are also considered as professional education. Although the extent of content delivery is basically determined with intention to support radiation protection subjects, content should not be truncated to radiation protection related particularities. It must be comprehensive enough not only to enable understanding of radiation protection, but also to support understanding of operation and properties of equipment and clarification of methods used in the work.

The advantage of this approach is multiple:

- it is beneficial for course participant’s professional knowledge,
it adds credibility and importance to radiation protection training,
it gains attractiveness and motivation.

Discussing certain “professional” topics within the radiation protection aspects of applications has similar effects, and can additionally serve to improve lecture practice as a break point related to the lecture.

Extending radiation protection training to professional subjects has also unpleasant consequences: it requires extra time, or at least requires very careful time planning for the course implementation. However, if either of these is feasible and acceptable, then we can say that the approach is very good and should be used generally where integrated approach is not possible.

**Minimal courses** are limited to radiation protection facts with minimal explanation of background and consequences. The success and effectiveness of the course is highly sensitive to previous knowledge and profile of the course participants. For certain groups (with previous knowledge) the approach could be acceptable, or even successful, but for others this is not the case. If we want to achieve our objectives, it requires careful planning and implementation. The problem is especially with inhomogeneous groups, where people with different backgrounds are attending the same course. In this case, there are also problems with motivation and attitude during the course implementation. For example, mixing high-level staff with “ordinary” workers could be a problem.

As we have discussed before, this type of course could be used for workers not directly involved in work with sources. The contents of the course for them should be different from the course contents for other workers, and should deliver less radiation protection and more background of biological effects of exposure.

The approach with minimal courses is only conditionally acceptable and should be used only where homogenous group of participants could be formed. According to our experience, it is not effective for mixed groups of participants with dissimilar backgrounds, professional knowledge, or duties.

### 5. Conclusions

Participants in radiation protection training and education courses have different professional backgrounds, knowledge and experience. Their expectations and motivation for course attendance could be quite different from our intentions and course delivery. If we want to achieve our goals, we should try to increase their motivation and modify expectation. Efficient approach is to introduce some subjects and topics related to participant’s professional work.

All courses on radiation protection include some subjects that are related to either “pure” sciences or science applications and different engineering branches. When radiation protection course is integrated into professional training, the scope of these subjects is adjusted to conform to professional training objectives, which also include radiation protection. This integration is optimal for effectiveness and quality of radiation protection training.

In stand-alone courses, subjects related to professional education should be discussed in extent beyond minimal requirements for radiation protection course. As we have seen, many participants expect to receive information not only about radiation protection, but also comprehensive information about operation of sources, radiation and radiation detection to help them better understand their work. This approach has multiple advantages, also for attractiveness of course and participant’s motivation.
Minimal courses limited just to radiation protection facts are not effective, unless we are dealing with participants with previous knowledge about sources. This type of course is acceptable for people not directly involved in work with sources, but the course content should be more “educational”. It should not be entirely focused on radiation protection, but mostly on biological effects of exposure.

As it seems, border between professional and radiation protection education and training should not be rigid and imposed with radiation protection objectives of a course. For the final success and effectiveness of the radiation protection education and training, it should be possible (and welcome) to reposition it according to circumstances and needs.
Sustainable Development, Alara Culture and Ethics in the E&T programmes of the CHERNE Network

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Abstract

The inclusion of aspects of sustainable development, ALARA culture and ethics in the radio-logical and nuclear educational programmes in the Erasmus IP's of the CHERNE network is discussed.

Introduction

More than a decennium ago the European Council of March 2000 launched the 'Lisbon strategy'. This proposed strategy was very ambitious, in particular in terms of research and innovation. The strategic goal for the European Union had to be 'to become the most competitive knowledge-based economy with more and better employment and social cohesion by 2010' [1]. In this context, the EC proposed inter alia the 'European Research Area', with the aim of providing scientific world-leadership in a number of thematic priorities, including nuclear technology. This development had to be sustaina-
ble.

Sustainable leadership would have to be based on the full exploitation of the knowledge triangle: the creation, transmission and use of knowledge, through research, education and innovation.

In the educational field this European ambition had to be helped by the Bologna pro-
cess, which principally introduced a common bachelor-master structure in the European Union, but in our context also the student and professor mobility programmes of e.g. Socrates and Erasmus.

Radiation Protection and Sustainable Development

In the field of Radiological and Nuclear Engineering the mobility opportunities already from 2002 onwards have led us to a Socrates/Erasmus Intensive Programme (IP) PAN (Practical Approach to Nuclear Techniques) initiated by CVUT-Prague, ISIB-Brussels and UPV-Valencia, later joined by AcUAS-Jüllich and UHasselt/XIOS-Diepenbeek. The purpose of PAN was to introduce students to life size experiments and activities in nuclear techniques, not just lectures and laboratory experiments.
The PAN experience has led to the insight that radiation protection should always be a not to be neglected aspect in introducing radiological and nuclear applications in educational programmes.

This resulted in a new Erasmus-IP SPERANSA (Stimulation of Practical Expertise in RAdiological and Nuclear SAfety) from 2005 onwards with the same 5 partners (in 2008 joined by PdM-Milano), as a first attempt to include radiation protection explicitly in the objectives of the IP.

Meanwhile the organisers became the ‘founding fathers’ of the CHERNE network, where the vision and principles of the network were formulated in a 'CHERNE Declaration' [2]. CHERNE refers to 'Cooperation for Higher Education on Radiological and Nuclear Engineering'. The main objective of the network is to enhance the collaboration between European higher educational institutions in the radiological and nuclear field. This should be reached in the first place by sharing competencies and facilities in organising teaching activities for their students, mainly at the master and at the initial PhD level. In the second place the aim is to enhance the mutual support by learning from each other, by exchanging experiences and by regular mutual reflections. CHERNE now has already 18 partner institutions (see the contribution on the CHERNE network in this conference [3]).

During the consecutive SPERANSA IP’s education and training in radiation protection evolved gradually to become a cornerstone in these courses. Nevertheless the future of radiological and nuclear technology (in particular but not exclusively of nuclear energy) requires a discussion on more aspects of sustainable development than only radiation protection alone, and also on the ethical justification of nuclear and radiological applications. Therefore round tables and workshops specifically on sustainable development and on ethical aspects were included in the programmes.

The 2007 SPERANSA course firstly presented a ‘Students’ discussion statement on the future of nuclear fission in Europe’ by the students themselves, followed by a Round Table. The discussion was based on an analysis of the FISA-document ‘New reactor systems and fuel cycles for the future’ [4]. The topics discussed in this Round Table were:

1. Keep all the energy options open:
   - fission-fusion-fossil-renewables
2. Generation II, III, IV
3. Radioactive waste management
   - including participation and transmutation
4. Safety and security
5. General acceptability, stakeholder involvement
6. Position of Europe vs. the world
7. Financial research investment from Europe
   - fission-fusion-fossil-renewables

The 2008 SPERANSA course introduced two round tables. While the second one was devoted to the ethical aspects (see further), the first one was devoted to 'Nuclear Techniques and Sustainable Development' for which different topics were chosen by the organisers:
1. Fissile Resources and Breeding
2. New uses of Nuclear Plants
3. Passive safety systems of Nuclear Power Plants
4. Economy of nuclear power
5. Radioactive waste management
6. Non Proliferation Treaty: Best solution to an international problem?

For this Round Table the students had to prepare a paper before and give a presentation during the Round Table, and prepare several discussion points on each other paper for the discussion afterwards.

The lesson learned from this Round Tables was that for students (and maybe engineers and scientists in general) sustainable development as well as ethics are difficult concepts which use a different kind of mind, thinking and speaking far from their common everyday practices and functions. Technological aspects of the topics chosen were quite well introduced, but the link with sustainable development and ethics was hardly included and elaborated upon. A good technological solution was automatically considered as ‘sustainable’.

So in the next IP ICARO (Intensive Course on Accelerator and Reactor Operation) from 2009 onwards the Round Tables elaborated further on the same lines, starting under the name ‘Nuclear and Sustainable Development’ (2009) and evolving towards ‘Nuclear as part of Sustainable Development?’ (2011). The participants were introduced to the subject with an introductory paper: ‘Nuclear and Sustainable Development: an Introduction’[^5][^6].

The topics chosen by the organisers with more emphasis on sustainable development were:

1. The concept of sustainable development in general and the implication for the energy sector in particular in view of the nuclear renaissance
2. Comparison of nuclear energy and alternatives in view of sustainable development (excluding competitiveness)
3. Assessment of competitiveness based on comparisons of full costs to society including social and environmental costs
4. Radioactive waste management (including participation and transmutation) in view of sustainable development
5. Public participation, risk perception and stakeholder involvement in view of sustainable development
6. Fissile resources and nuclear energy development scenarios in view of sustainable development
7. New generation projects and non-energy applications (heat generation, hydrogen production, …) in view of sustainable development
8. Passive safety systems in view of sustainable development
9. Energy efficiency as main resource for energy supply in view of sustainable development
10. Proliferation of nuclear weapons as a treat to peaceful nuclear development

A conclusion from this Round Tables remains that most (engineering and science) students still have difficulties in contrasting technological and engineering solutions from their implications on sustainable development. Another conclusion was that the topics should be enlarged to include more fields of radiological and nuclear technology (not only nuclear energy).

The next IP SARA (Safe Application of RAdiation and radionuclides), with 10 participating CHERNE partners from 2012 onwards introduced an ALARA workshop, reducing
the topic of sustainable development to the implementation of the ALARA principle in practical situations, while enlarging the nuclear energy field towards the whole radiological and nuclear field (including medical nuclear techniques and natural radioactivity). An introductory paper ‘The ALARA approach as part of a radiation protection safety and security culture’ was made available beforehand [7,8].

The topics for the ALARA workshop in 2012 presented by the participants and chosen by themselves were [8]:

1. Too much safety?
2. Should ALARA be applied to natural sources?
3. Application of ALARA in case of natural sources: case study at the Czech radon Jachymov Spa
4. Training and procedure for hospital workers working with short-lived medical radionuclides. Concentration on the waste aspect
5. Alfa-beta alarms in a water treatment plant
6. Information and Radiation Protection for Out-patients, their Relatives and Health Care Staff During and After Nuclear Medicine Treatment
7. Management of Radiological Waste in Hospitals
8. Application of the ALARA principle to design and operate small gamma irradiation plants
9. Application of the ALARA principle to the design of a small neutron irradiator
10. ALARA Standard for the Radiation Protection at Laboratori Nazionali del Sud (Catania)
11. Preventive measures and actions for the radiological protection in the scrap yards in Spain
12. The ALARA approach and the environmental impact in the production of concrete

and for the ALARA workshop in 2013 [9]:

1. Interplay of ALARA and Dose Limits principles in Radiation Protection
2. Radon in a family house
3. Application of the ALARA Principle in the Design and Safe Operation of Particle Accelerators
4. The ALARA approach in the shielding design for proton therapy centres
5. The ALARA concept in the nuclear fuel assembly factory of Juzbado
6. Application of the ALARA principle in Cyclotron facilities for the production of radionuclides for Medical Diagnosis
7. Application of the ALARA principle to the design of a small neutron irradiator
8. An ALARA approach to radwaste monitoring and inspection
9. Application of ALARA method in high risk areas of radiation at Cofrentes NPP

From these workshops it could be learned that ALARA is a difficult and complex concept, with different interpretations (even among specialists working in the field). Not all of the initial papers included a clear ALARA approach, but after the workshop all participants admitted that they obtained a clearer view on the ALARA concept, the ALARA culture and the ALARA approach in practical situations, especially as a result of their discussions on the presentations.

Ethical Aspects

Ethical aspects were considered for the first time in SPERANSA-2008 with a Round Table ‘Discussion on ethical aspects of radiological and nuclear safety’.

The ethical justification of radiological and nuclear applications was introduced in ICA-RO 2009-2011. A Round Table was devoted to ‘Ethics and the Principle of Justification: Beyond the search for truth – what complicates the societal justification of nuclear technology?’.
From SARA-2013 onwards a conference-debate is organised on ‘The Ethics of Radiological Risk Governance’.

For these activities an external specialist was asked to introduce the subject and guide the discussion [10].

Conclusion

We have to acknowledge the fact that during the whole evolution of these Round Tables and Workshops on sustainable development, ALARA culture and ethics, not every participant, nor some organising partners were always convinced of the relevance of including aspects of ethics and sustainable development being included in engineering educational programmes. They remain difficult topics in an engineering environment (and most probably also in the professional field). Nevertheless the Round Tables and Workshops have given the students at least the opportunity to have a confrontation with sustainable development, ALARA culture and ethics.

We hope that our CHERNE experience can be an inspiration for likewise or other initiatives in educational programmes on radiological and nuclear technology.

References


Keywords: Sustainable development, ethics, nuclear and radiological technology, ALARA, education and training in radiation protection

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The future of education and training in radiation
INTERNATIONAL HIGH-SCHOOL STUDENT MEETINGS:
“RADIATION PROTECTION WORKSHOPS”

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ABSTRACT

Since 2007, international high school student meetings called “the Radiation Protection Workshops” involving French and European students have been set up by French institutions IRSN, CEPN, the center for scientific culture of Franche Comté and other partners (ASN, CEA/INSTN, Ecole des mines de Nantes…). High-schools students are coming from France, Belgium, Germany, Belarus, Ukraine, Romania, Moldavia and Italy and exchanges have already been established with the Lycée Français de Tokyo for their possible participation for the following school year.

These workshops are designed to engage high-school students in activities concerning the radiation protection culture.

The workshops are based on a pedagogical approach focused on:

- the importance of a multidisciplinary approach,
- the involvement of students on a voluntary basis,
- the identification of topics related to radiation protection according to local context (proximity to nuclear power plant), radon emanation, medical exposures or living conditions in contaminated area…)
- the collaboration with selected radiation protection experts in the relevant scientific disciplines who facilitates a technical visit or allows students to perform a practical experience completing the theoretical basis learned in courses.

The Radiation Protection Workshops are part of a process to spread out radiation protection Culture among young generation. These workshops allow to:

- Initiate a citizen approach with an appropriation of scientific and social issues related to ionizing radiation in the environment
- Contribute to enhance scientific and technical culture at high school level
- Enable discovery of the professional domain

To conclude this activity, "international high-school student meetings" are proposed during three days to allow students who participated in workshops (approx. 170 high schools students each year) to present their work by giving lectures and exchange information and opinions with other students and radiation protection professionals.

1. Introduction

Radiation Protection Workshops (les ateliers de la radioprotection in French) are intended to engage secondary school pupils (UK) / high school pupils (US) in activities concerning the practical radiological culture. The workshops build on important points that structure and ensure the quality and relevance of engaged actions.

- the importance of a multidisciplinary approach,
- the involvement of students on a voluntary basis,
- identifying scientific elements are discussed at workshops
- organisation of pedagogical path in each school in order to develop a citizen questioning approach on specific issues of radiation protection, thus expanding the strictly scientific approaches of addressed problems.

2. General objectives
Radiation Protection Workshops are part of a process of spread out radiation protection culture among young people. The majority of these are students aged 16 to 18 years and pursuing scientific stream, which in France is called “Premières and Terminales S”. These “workshops” are led by teachers in collaboration with radiation protection experts in the relevant scientific disciplines. The objective of this action is to involve students for an entire school year in multidisciplinary activities related to the radiation protection culture. The objectives of these high school international meetings can be broken down by:
- Initiate a citizen approach under an appropriation of scientific and social issues related to ionizing radiation in the environment
- Help to promote scientific and technical culture at high school
- Allow discovery of the world of work
- Lessons on teaching activities related to ionizing radiation and radiation protection

3. Context
The idea of these workshops was born in Ukraine in spring 2007, during meetings on Radiation Protection, organized by the CEPN in partnership with the Lycée du Bois d'Amour de Poitiers, the IRSN and the association CORE Ukraine, between French high school students, and Belarusian and Ukrainian pupils living in areas contaminated by the Chernobyl accident. This experience has shown the importance of fostering an exchange between students, teachers and scientific questions in order to develop a culture among young people on this issue from a practical and multidisciplinary approach.
Thus the idea of organizing these workshops and meetings, bringing together different schools of France was born. The project has generated strong motivation: five schools were involved in the process. Students and teachers have developed instead of weekly workshops, assisted by experts who advised them.
It was during the 2007-2008 school year, the CEPN, IRSN and the center for scientific culture of Franche Comté launched radiation protection workshops attended a hundred students from several French schools.
These workshops, led by professors from these institutions in partnership with the radiation protection experts, academics and researchers in the studied scientific disciplines, were designed to engage high school students in activities related to practical radiological culture. These meetings allowed the students to present their work and interact with other students and with radiation protection professionals.
The duration chosen for this event is 2.5 days. During these days, students shared their work done during the school year with their teachers, under the watchful eye of many experts in radiation protection.
The students make presentations of 20 minutes in groups of 4 to 6 in front of the entire audience. 3 mornings are devoted to presentations of the work of students. All presentations are in French. An afternoon is spent in workshops where each school presents experiences, posters, teaching methods they have developed and implemented. The other afternoon is devoted to visit nuclear facilities or in connection with physics.
Since 2007, every year in March, the meetings are held. They include an average of 170 high school students from France, Germany, Ukraine, Belarus, Italy (2008), Romania (2011), Moldavia (→ 2012), Morocco (expected in 2013) and Japan (expected in 2013).
4. Themes
Many themes were chosen by students. All students have discussed the radiation protection from local issues for example, near the Civaux NPP for Poitevin students or living in a contaminated area for Belarusians students. The theme of living in the contaminated territories and management of radiologically abnormal situations are often studied from the Fukushima accident. Medical applications of ionizing radiation are also studied.

The above list is not exhaustive but contains recurring themes of this event which concern the implementation of radiation protection and the assessment and management of risks related to exposure to ionizing radiations, for humans and the environment.

- Scientific and technical basis for radiation protection
- Management of radon exposure
- Radiation protection of workers and patients at the hospital
- Monitoring of radioactivity in the environment
- Biological effects of ionizing radiation
- Assessment of risk to humans and the environment
- Radioactive Waste Management
- Management of nuclear accidents

5. Methodological approach
In a context of scientific disciplines disaffection of the Y generation, radiation protection workshops are based on a combination of inductive / deductive approaches.

- Involve students in activities concerning practical radiation protection culture
- Multidisciplinary approach led by teams of teachers from each school (science, literature, philosophy, history, geography, arts, ...)
- Establishment of partnerships for each school with radiation protection experts (universities, expertise, research, ...) according to the work program adopted
- Development and follow-up of work program for each workshop with the radiation protection workshops steering committee

Implementation of radiation protection workshops during the school year is based on:

- The involvement of volunteer student and motivated classes.
- The discovery of radiation protection culture from a pedagogical approach bringing together students, experts and scientists involved (scientific and technical workshops, science club, options, ...)
- Coordination of activities within a network during the school year involving all schools and the steering committee (exchange of experiences and preparation of meetings based on the involvement of schools and experts)
- The presentation of the work done during workshops, deepening knowledge and exchanges during the radiation protection workshops.

In the framework of the work package #10 of ENETRAP II project, some notable achievements on attracting a new generation of radiation protection professionals are identified.

If one would like to address the human resource shortage in radiation protection and to reverse the trend of young students to turn away from science, it have to act in schools and high schools by supporting the targeted groups high school science teachers and students.

- development of a coordinated approach on attracting a new generation of radiation protection professionals,
- development of a RP action plan as a tool to support the targeted groups (high school science teachers and students, and early-stage researchers).
6. Conclusion and perspectives
In conclusion, this article attempts to show, from the feedback of five years, how these radiation protection workshops enable young people to develop a practical radiation protection culture. The success of this approach is illustrated by the acquisition of reference points from the radioactivity in the environment and concepts on how to measure it. Students have developed abilities to interpret measurements of external and internal exposure and also to understand the biological effects that may occur after exposure to ionizing radiation and also on risk assessment at low doses. In addition, students have acquired strong notions on environmental protection facing radioactivity. Finally, these students have developed their ability to discuss issues related to the protection against ionizing radiation and whatever industrial, medical or research domain concerned.
Due to this background, there is an increasing trend to involve stakeholders in radiation protection management. Some issues will be of particular importance in next years: radioactive waste management remains a sensitive issue, discharges from nuclear installations, medical exposure increases drastically, management of radon exposure needs to be improved, learning lessons from post-accidental situation (Chernobyl and Fukushima)… However, members of civil society need basic knowledge in radiation protection together with practical experimentation to be able to improve their level of protection regarding radiation exposures, to express their concerns and expectations on these issues and to play a role in the related decision making processes. In this perspective, the development of the radiation protection culture at high school through “Radiation Protection Workshops” can significantly contribute to open the debate and to improve the awareness of young generations on these different issues.

7. REFERENCES
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ABSTRACT

In 2009 a high-level expert group (HLEG) reported on the need for further research into the science underpinning protection from ionising radiation at low levels of exposure. The report (http://www.hleg.de/index.html) points out that:

"Many EU member states have lost key competences and are no longer capable of independently retaining their current research activities in radiation sciences, with implications for effectively fulfilling operational and policy needs and obligations."

They recommended “an integrated approach to E&T in radiation research in Europe. Particular consideration will be given to the better integration of research and teaching at Universities and at non-university research organisations.”

The FP7-Euratom funded Network of Excellence (NOE), DoReMi (“Low Dose Research towards Multidisciplinary Integration” http://www.doremi-noe.net) was formulated to develop the low-dose research platform MELODI (“Multidisciplinary European Low-Dose Initiative” http://www.melodi-online.eu) following the recommendations of the HLEG, and includes the task of setting up a support system for E&T in the field of risks from low-dose ionising radiation, both for students and new researchers in the field, and also to help integrate new disciplines and technologies into the research effort. The longer-term aim is to achieve a sustainable system that will integrate and provide support for the E&T of the next generation of students who will carry out the research needed to underpin a science-based system of radiation protection.

The work has identified 4 priority areas:

1. Promotion of the integration of multiple disciplines by hosting courses and training events on particular topics/disciplines: DoReMi sponsors 1- to 3-week courses, organised by partner institutions, on topics related to the expertise at each institution. This has been very successful and will continue for the term of the NOE. Planned future developments will widen the range of topics and institutions included in order to bring new disciplines and technologies into low-dose risk research.

2. Attracting students into the research area by facilitating the development of MSc courses that will be attractive to undergraduate science students: The European Masters course in radiobiology ended in 2012 after 20 years of introducing students into the discipline of radiobiology. Alternative courses are either in existence or being developed. It is important that access to these is promoted and facilitated. Further needs should be investigated.

3. Coordination and integration of E&T: The integration recommended by the HLEG is being addressed by the annual DoReMi/MELODI E&T Forum. Resolutions from the first such Forum will be discussed.

4. Development of sustainability: In collaboration with MELODI, the development of a sustainable E&T secretariat is needed to coordinate and integrate E&T resources and funding streams that will continue beyond DoReMi. The EC Framework Programme Horizon 2020 will see the transfer of funding responsibilities from the EC to technology platforms. It is essential that the E&T community engages in the planning for this.
1. Introduction: the need for support of E&T in radiation protection research

In January 2009 the Report of High Level and Expert Group on European Low Dose Risk Research was published (http://www.hleg.de/fr.pdf). The report highlighted the elements of the standard radiation protection system that still remain uncertain (Fig 1.). Among their conclusions were the following:

“Many EU member states have lost key competences and are no longer capable of independently retaining their current research activities in radiation sciences, with implications for effectively fulfilling operational and policy needs and obligations.”

“Programmes aiming at knowledge management across generations have to be designed in a way that they achieve sustainable results. Underlying scientific programmes have to address questions which are attractive for both young scientists, universities, or research organizations. Such programmes cannot be successful unless they do provide job opportunities to young scientists. Sustainability of such programmes can only be achieved by a long-term commitment of funding organizations.”

![Fig 1. Features of the standard radiation protection system that need to be questioned.](image)

2. DoReMi and MELODI

The recommendations of the HLEG report led to the formation in 2010 of the MELODI (Multidisciplinary European Low Dose Initiative) platform, by a group of European scientific and regulatory bodies dedicated to low-dose radiation risk research (http://www.melodi-online.eu), and also to the Euratom FP7-funded Network of Excellence, DoReMi (Low Dose Research towards Multidisciplinary Integration, http://www.doremi-noe.net)

DoReMi started on 01/01/2010 and runs for 6 years. The aim of the DoReMi is to promote sustainable integration of low dose risk research in Europe in order to more effectively resolve the key policy questions identified by the HLEG on Low Dose Risk Research. It also provides an operational tool for the further development of the MELODI platform. The relationship between MELODI and DoReMi is illustrated in Fig 2.
3. DoReMi Workpackage 3: Education and Training

3.1 Overall purpose
The HLEG recommendations call for a research programme that spans several decades, so it is essential to attract and support top-level well-trained research scientists who will spearhead the low-dose research community in the future. WP3 is designed to facilitate the networking of training and research institutions for this purpose in a way that will become self-sustaining after DoReMi ends. Maximal use is made of the centres of excellence in the DoReMi consortium by focusing on multi-centre E&T events and courses that exploit the individual research streams within each centre. The DoReMi E&T budget will be used in a way that maximally benefits both the DoReMi RTD programme and also the larger European research community in the longer term.

3.2 Specific tasks
WP3 used the first 12 months of the project to formulate a programme that would best respond to the perceived E&T needs of the community, using the resources available. The programme contains the following elements:

- Development of a programme of short courses at the MSc/PhD level in the topics of expertise of the DoReMi partners;
- Facilitating the development of MSc courses in radiobiology that will be attractive to undergraduate science students;
- Development of networking and collaboration within the radiation risk research E&T community; and
- Develop a structure that will provide sustainable leadership and support for E&T into the future.

4. DoReMi sponsored series of short courses
From 2011, each year a series of 1-week to 3-week courses has been held on topics including radiobiology, epidemiology, and radiation physics. The courses have been offered free to students, including accommodation, for up to a maximum of 15 students. The courses that have been held to date are given in Table 1.

There will be 2 more series of DoReMi short courses in 2014 and 2015. For more information see the DoReMi website:
http://www.doremi-noe.net/training_and_education.html
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Table 1. DoReMi sponsored short courses
5. European MSc in radiobiology

The MSc degree is the key level for attracting new students into the field of low-dose radiation research. From 1992 to 2012 a European MSc in Radiobiology was run by Klaus Trott at the University of London, incorporating teaching and project modules from a number of research centres in Europe. This was highly successful, and produced 137 graduates, many of whom now hold key positions in radiation risk research. However, this course was discontinued after 2012, and WP3 has been exploring options for a replacement course. There are several single-institution courses either currently available or starting shortly. Of particular note is a planned new MSc course in Radiation Biology in Munich. The course will be organised jointly by the Medical Faculty of the Technical University and the Helmholtz Centre Munich in cooperation with other academic institutions: Bundesamt für Strahlenschutz, Munich, Ludwig-Maximilian University Munich, and Medical Academy of the German Armed Forces Munich.

- All lectures and practicals will be in English
- DOREMI short courses will be incorporated
- The total time will be 2 years for bachelors, 1 year for medics
- The first course is expected to start in October 2014
- The course will be organised for 10 to 12 students per year initially.

6. DoReMi/MELODI – E&T Forum

The concept of an E&T Forum arose following the first 2 years of investigating the most effective means of networking and collaboration within the radiation risk research E&T community. The Forum is a working meeting for the purpose of:

- Discussing priorities for E&T
- Discussing the practicalities of networking, sharing resources and students
- Setting up working groups to develop courses, documents, etc.
- Discussion of funding possibilities, formation of lobby groups

The Forum has two fundamental themes:

**Theme 1: Financial support**

Funding is an essential support pillar of E&T. Research into the risks of low-dose radiation is a Public Good activity rather than RTD for commercial exploitation, so it is not possible to rely on private investment initiatives or user-pays. This is a theme common to all of the Technology Platforms, so the Forum is an opportunity for presentations from the other Euratom platforms, (Radioecology Alliance, NERIS, SNE-TP, and IGD-TP) in order to compare notes and develop strategies.

**Theme 2: Integration operations**

An essential function of the Forum is to provide an opportunity for dealing with all of the practical issues of integrating and supporting E&T for low-dose research. The issues addressed are:

- How do we take maximum advantage of existing E&T facilities, capacity, and resources?
- How can we achieve mutual recognition of courses and course modules so they can be integrated into MSc and PhD programmes, so that students can gain credits for their degrees?
- How can we strengthen networking and communication among members of the community?
- Other groups to be invited into the Forum: other platforms, EC projects with 5% E&T commitment, etc
- Feedback on the Forum: is it serving its purpose? How can we improve it?

The first DoReMi/MELODI E&T Forum was held in conjunction with the 4th MELODI Workshop in Helsinki, 2012. The next Forum will be held during the 5th MELODI Workshop
8-11 October 2013 organised by SCK•CEN in Belgium. The venue of this workshop will be the Royal Academy in the heart of Brussels.

7. Development of future sustainability
There are two essential ingredients for continuing support and coordination of E&T for radiation risk research. The first is an organisational structure to drive the programme. The second is a secure source of sponsorship. As already mentioned, this is not something that can be left to market forces. However, it is generally accepted that E&T is an essential intrinsic component in any research programme. There is a move to the incorporation of E&T into the formal structure of the Technology Platforms. In particular, following recommendations from the E&T Forum, MELODI is considering:

- Inclusion of the E&T Forum into the annual MELODI Workshop programme
- Formation of a Working Group to promote and coordinate E&T
- Making E&T a requirement in competitive research calls

A further development of interest, which is still at an early stage, is the Euratom FP7-funded OPERRA (Open Project for the European Radiation Research Area) project. The purpose of the project is the development of an umbrella structure to administer EC calls in the field of radiation research. It will develop the necessary structures to enable the management of the long-term European research programmes in radiation protection, embracing the following organisations:

- The MELODI Association in the field of low-dose risk research,
- The European Radioecology Alliance (Alliance) in the field of radioecology,
- The NERIS platform in the field of nuclear emergency management,
- The EURADOS group in the field of dosimetry,
- The EURAMET organisation in the field of metrology,
- The EUTERP organisation for fostering radiation protection education and training programmes.

Essential elements of the project for the continuing support of E&T are as follows:

- Identifying key partners involved in radiation protection research, as well as education & training, and joint programming of research activities in radiation protection
- Determining joint funding mechanisms for national & EU Fission R&D programmes which support a sustainable competence building in radiation protection for academic and vocational education & training.
- Exploring how to enhance radiation protection research activities related to the medical uses of ionising radiation. Strategies to optimise medical exposures will be developed by integrating knowledge from radiation protection and medical professionals and by identifying research, education and training priorities to improve radiation protection in medicine.
- Coordinating, integrating and further expanding existing education and training programmes in radiation protection and on health risks and ecological effects after low-dose radiation exposure.

The contract for OPERRA with the EC is still under negotiation. Once the project begins, work will start to prepare the organisation for a first competitive call by the end of 2013 for projects in low-dose risk research. There will be a second competitive call in 2014 for broader projects in radiation protection research, subject to the approval of EC services.
8. Conclusion
Following recommendations from the High-Level Expert Group (HLEG) the MELODI platform has been set up to coordinate the European research effort on low-dose radiation risk. The FP7 Network of Excellence DoReMi has been funded to implement MELODI. DoReMi has a workpackage dedicated to the support of Education and Training for the purpose of ensuring a continuing resource of top-level research personnel for the extended period envisaged by HLEG. This is sponsoring courses on topics fundamental to radiation protection through the lifespan of the project, and also working to achieve sustainable support for E&T beyond the project. MELODI will be a leading player in OPERRA, a new FP7 project which will develop an umbrella structure for administration of the coordination and EC funding of European radiation research in line with the EC Horizon 2020 plan. OPERRA will have a commitment to the support of E&T through the existing radiation protection platforms and other organisations.
THE SRP “YOUNG GENERATION“ INITIATIVE

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ABSTRACT

Concerns about potential skills shortages in the future in the field of radiation protection are well documented. At the root of this concern is a perception that insufficient young people pursue science, in particular physical science, in the course of their school or college careers. The consequence of this is dwindling numbers of appropriately educated – or interested – young people to “feed” into a radiation protection infrastructure.

This presentation outlines an imitative being taken forward by the Society of Radiological Protection (SRP) in the UK to try and promote interest and enthusiasm in school pupils (teenage) for careers in scientific disciplines. A brief summary of the “Schools Event” run by SRP at IRPA13 in Glasgow will be provided including discussion on the perceived outcomes of the event.

1. Introduction

One of the overarching objectives of the UK’s Society for Radiological Protection (SRP) is to encourage and promote education and learning in radiation protection. Over recent years SRP has become aware of a reduction in students following science-based courses at school and in further education with a consequent skills shortage in, not only radiation protection, but scientific disciplines in general. Work has been ongoing within SRP to try and scope what was already being, or could be, done to address the problem and to bring together the various initiatives into a coherent programme. This is still ongoing but one clear “task” that has been identified is to develop a central resource of material that would be available for SRP members and teachers to use in encouraging and developing pupils/students interests in science, including radiation protection.

In 2012, SRP was the host society for the IRPA13 International Congress in Glasgow. Building on the outcome of previous congresses, IRPA13 adopted as its theme “Living with Radiation – Engaging with Society” and this was reflected in a number of ways throughout the programme of the event, including a session on Teaching Radiation Protection in Schools.

In the build-up to IRPA13 the SRP and IRPA “threads” came together with the concept that the theme of IRPA13 could be given substance with an event that actively engaged with pupils and teachers from schools in Scotland. The event became known as “SRP Schools Event at IRPA13”, an Exhibition and Lecture attended by 1200 pupils and their teachers.

2. SRP Schools Event at IRPA13

2.1 The Planning

2.1.1 Timeframe
Although the concept of the Schools Event had been mooted by IRPA13 some two years prior to the event, there was little active progress until quite late in 2011 and even at this late stage only a vague outline of what was envisaged and no detail as to content.

SRP decided to move forward on the basis of the event being a “project” and identified a Project Manager, although it was not until the very end of 2011 before the first planning meeting was held. This short time frame undoubtedly helped to focus minds and generate momentum but in hindsight a timeframe of 9-12 months would have been better.

2.1.2 The Project Team

It was clear that in order for the project team to deliver effectively and on time, the composition of the team was critical. Local knowledge, experience of dealing with schools, experience in organising large-scale events and (perhaps most importantly) an innovative approach were considered to be the required key attributes.

In the event, the makeup of the 10-strong team was as follows:

1 x Project Manager - role was given to SRP’s strategic lead for schools/careers
4 x ICOC\(^i\) members - brought knowledge of Congress Arrangements, available facilities etc
2 x SRP Council - the SRP President and the Chair of the Scottish Regional Group
1 x SSERC\(^ii\) - brought knowledge of syllabus and school needs
1 x Guest Lecturer - an individual known for interesting, funny and innovative lectures.
1 x Admin - experience of organising events for SRP

Most of the work was undertaken/progressed via tele or video conference; two site visits we made as part of the planning process.

2.1.3 Evolution

The initial presumption had been that the event would be primarily targeted at 16-18 year olds – that is in the last stage of their school career - and that the event would consist of :-

- A lecture
- An exhibition of radiation protection artefacts and equipment
- A “meet the experts” forum.

The following points summarise the actual evolution and development of the event.

- It was quickly identified that the original target age group would be involved with state exams in May so it was decided to change the target audience to 14-15 year olds studying physics. It was felt that this was an age group that could still be
attracted to science although it posed implications and challenges for the level at which the lecture and other elements would need to be pitched.

- An ethos that evolved out of this (significant) change and the experience of those on the project team was that the optimum approach would be to entertain first in order to “hook” interest, while ensuring that there was relevant core science about radiation, how it is used, the benefits it brings and the careers that can be followed.
- There were difficulties in securing the appropriate space within the Congress venue. Once responses to the invitations started to come in it was clear that many hundreds of pupils would be attending; the logistics of managing high numbers and accommodating the exhibitors/demonstrators proved challenging.
- It became clear that not all schools would be able to be at the venue for exactly the same length of time (due to travel constraints etc). This, and the space difficulties mentioned above meant that the originally planned “sequential” event would not be the optimum use of time.
- There was a significant amount of juggling of the schedule in order to try and address the issues above; eventually, the agreed format was to have repeat morning and afternoon sessions for exhibition and presentations with the main lecture delivered once (for all) in the middle of the day.

2.2 The Event

2.2.1 The Exhibition

The project team put a good deal of work into identifying and inviting suitable exhibitors and in the end some 23 exhibitors provided stalls and/or displays (some has multiple displays). These included:

- 6 x Scottish Universities
- 6 x Professional bodies
- 5 x Government Agencies
- 6 x IRP13 Exhibitors (ie equipment exhibitors from the main Congress).

An eclectic range of radiation protection related topics was addressed at the exhibition including radon, transport, nuclear decommissioning, readiness of Emergency Responders, geological exhibits and simulated monitoring equipment. Some, although perhaps not as many as might have been desired, of the exhibits were interactive and very “hands-on” such as game of Radioactive Cluedo that required pupils to put on Tyvek suits and who killed a victim, where and with what by detecting simulated contamination with monitoring equipment. The full list of Exhibitors along with a brief description of their exhibit/demonstration can be found on the SRP web-site, WWW.srp-uk.org/news

Some of the exhibitors had previous experience of engaging with target audience age group and did ensure that exhibits were interactive and interesting. Several had no previous experience and requested guidance on what would be suitable.

2.2.2 The presentations

Three presentations were included in the programme in order to reduce the pressure on the exhibition. Each of these was about 25 minutes long and repeated a number of times, with pupils only going to one of the three.
Presentation 1 was focussed on the concept of Emergency Response, the key points made being –

- The wide variety of threats that society has to be prepared to deal with (radiation just being one of many)
- The UK common framework for dealing with all types of emergencies
- The importance of scientific advice in dealing with emergencies
- The amount of effort required for preparedness, including exercises

This presentation included many eye-catching photographs and video clips and touched on a broad spectrum of real events such as flooding in the North of England, the 7/7 London bombings and the Litvinenko polonium poisoning.

Presentation 2 was concerned with basic radiation physics with some good hands-on demonstrations.

Presentation 3 hinged round the consequences of Fukushima. The presenters or presentations 2 and 3 were from the French scientific and regulatory organisation, ISRN, who have a programme of work communicating with a variety of audiences, including school pupils.

2.2.3 The Lecture

The lecture (the John Dunster Memorial Lecture) was arguably the “headline act” of the Schools Event. Although aimed solely at the target age group it was also open to all IRPA13 congress delegates and to the public. The overall aim was to provide an overview of how radiation is used for the benefit of healthcare, with an objective of informing rather than educating. The emphasis was on how radiation is used for diagnosis and treatment rather than explaining the physics behind it. Underlying aims were to a) illustrate that radiation has beneficial effects and b) to inspire children as to possible career choices.

Although the speaker was an experienced presenter to adults (including students) he had no experience of presenting to this age group. This being the case a good deal of preparation went into how to gain/retain attention and getting the message across, including talking to physics teachers as well as to colleagues involved in outreach programmes for schools. Prior rehearsal at a local school proved invaluable as did the assistance of a stage manager on the day!

2.3.4 Posters

In the run up to the event it was felt that a set of posters covering factual material would be complementary to the hands-on nature of the Exhibition; a bank of posters would also absorb some of the pupil numbers thereby reducing the “loading” around individual exhibits. However, another significant driving force here was to produce a set of posters that could be a legacy from the event available for use by SRP Members and Teachers. Some 50 posters were produced; these are available to view at the SRP web site.

2.3.5 Fun and Games

The idea of including superhero/cartoon characters - although only those with a definite link to radiation – was suggested early on in the planning. Three volunteers agreed to dress up as “Radioactive Man”, “Homer Simpson” and “Mr Burns”, mingle
with the pupils and be included in group photographs. This seemed to go down well with the pupils and helped to promote the view that the event should not be boring; they also featured in the lecture supporting the premise that it was more of a “show” than an educational event.

With the intent of building on the day of the event two competitions were promoted, with a prize of £100 to each winning pupil. One competition was for the best school newsletter article on the event and the other for the best set of answers to a set of questions based on the posters. Not many entries were received for either competition, although those that were received were of good quality.

3. Review and Future Work

3.1 Feedback

The feedback received both on the day and afterwards for pupils and teaching staff that attended the event was very positive. Some of the comments are reproduced below:

“I thought I’d let you know how much our pupils (and staff !) enjoyed the SRP event last week. It was very well organised and very educational for the pupils. So much of it was directly related to the curriculum and they enjoyed the hands-on nature of the exhibits. It was the best school trip I have taken pupils on ...”

“Thank you very much for giving us the opportunity to be part of your great lecture yesterday. Everyone was buzzing all the way home on the bus...!”

“The students and staff thoroughly enjoyed your lecture! Thought the use of students from the audience to demonstrate the production of x-rays was spot-on for active learning... Your superhero helpers went down well too!”

Many of the exhibitors also found the experience rewarding and enjoyable and indicated support for SRP in future events.

3.2 SRP Experience

Overall the event was considered to be a great success by all involved in SRP and IRPA. It was felt that the key to the success was the underlying ethos of entertaining with science, illustrating that it can be both fun and rewarding. The value of the legacy material such as the posters and the DVDs of the lectures and the presentations is significant and SRP is seeking to progress how these may link into other strategic for careers information and informing the public.

3.3 Future Events

It is clear that such events have a future and, certainly, it is the intent of SRP to try and hold a similar event on an (ideally) an annual basis. SRP’s next Annual General Meeting and Conference will be held in Harrogate in May 2013 and will include a concurrent Schools
Event. Planning for the event is well underway with note being taken of the lessons learned from the Glasgow experience, particularly:-

- The cost of running such an event should not be underestimated; the budget for the 2013 event is approximately 30,000 Euros.
- Ideally exhibits/demonstration should be as interactive as possible with the exhibitors being clear about what they are trying to illustrate to the pupils and/or what message they are trying to get across. Early dialogue with exhibitors assists in this process.
- Although the event is hinged on radiation protection the objective is to try and encourage an interest in science that might spark an aspiration for a career in a scientific or engineering discipline; some of the most informed professionals in radiation protection have a solid background in industry. For the 2013 event a slightly wider range of exhibits/demonstration is being encouraged.
- Logistical difficulties - for example, how do you cope with 50 school buses turning up at the venue at the same time? - should not be underestimated!

4. Conclusion

The SRP Schools Event in Glasgow proved an excellent realisation of theme of IRPA13, “Engaging with Society” and was demonstrable delivery of one of the key objectives SRP, namely “to encourage and promote education and learning in Radiation Protection”.

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1 ICOC International Organising Committee of IRPA13
2 Scottish Schools Education Research Centre
Drivers and Enablers for Changes in Education & Training: all stakeholders involved under Euratom Horizon-2020

Georges Van Goethem

- Drivers for changes: scientific-technological and socio-economic requirements

The main “drivers” for changes in Education & Training (E&T) consist of “end-user requirements” of scientific-technological as well as socio-economic type. In the specific case of nuclear fission energy and radiation protection, most efforts world-wide are concentrating on a common nuclear safety culture based on the highest achievable standards, as this is also the main lesson learnt from the Fukushima accident. This high-level objective is naturally aligned with the Euratom Treaty (1957) \(^1\): remember that one of the main aims of Euratom is to contribute to the sustainability of nuclear energy by generating the appropriate knowledge (research) and developing the required competences (training).

Here is a (non-exhaustive) list of end-user requirements acting as "drivers" for changes in E&T in the specific case of nuclear fission and radiation protection:

(1) scientific-technological end-user requirements

- continuous improvements in (1) Sustainability (e.g. reduce the long term stewardship burden); (2) Safety (e.g. eliminate the “technical” need for offsite emergency response) / (1) and (2) are at the heart of Euratom Research and Training programmes
- continuous improvements in (3) Economics (e.g. have a life cycle cost advantage); (4) Proliferation resistance and physical protection (e.g. increase protection against acts of terrorism) / (3) and (4) are usually left to industry and governments, resp.
- development of a common nuclear safety culture, based on technical and organisational excellence (in synergy with IAEA and OECD/NEA); need to harmonise regulations in the EU (nuclear safety and radiation protection); need of basic research

(2) socio-economic end-user requirements

- possible shortage of nuclear skilled professionals and ageing population; new approaches for human resource development in a multicultural environment; high-level decisions needed over long time scales (up to 100 years)
- need for public debate (understanding, involvement, acceptance); increasingly multidisciplinary and international character of the nuclear energy sector; different national policies amongst EU Member States regarding nuclear fission technologies
- pan-European mobility in science and technology; towards a common language between the worlds of education and of work; impact of the new EU tools for E&T (ECVET policy - European Credit System for Vocational Education and Training).

- Enablers for changes: Technological Platforms to support Education & Training

\(^1\) EC DG Research and Innovation / Euratom - [http://ec.europa.eu/research/energy/euratom/index_en.cfm](http://ec.europa.eu/research/energy/euratom/index_en.cfm)
The European Technological Platforms and other authoritative bodies are “enablers” for changes in E&T. They play an increasingly important role in European programmes, be it as advisors for key decisions at EU level or as implementers of selected RTD programmes.

In the particular case of nuclear fission technologies, the Technological Platforms and a number of authoritative bodies represent the stakeholders from industry and public bodies:

- research organisations (e.g. public and private sectors, industrial and medical)
- systems suppliers (e.g. nuclear vendors, engineering companies, manufacturers)
- energy providers (e.g. electrical utilities, co-generation plants for process heat)
- nuclear regulatory authorities and associated technical safety organizations (TSOs)
- higher education and training institutions, in particular universities
- civil society (e.g. policy makers and opinion leaders), interest groups and NGOs.

In the future (Horizon 2020 (2014 – 2020), the successor of FP7), the EU policy is aiming at “externalising” a number of “indirect” actions. It is generally believed that progress would be facilitated if some initiatives are implemented by the Member States or by the organisations interested in them (see above stakeholders). In the specific case of Euratom, because of the very limited available EC funding, an even stronger coordination is required regarding governance and financing in order to ensure stability and stronger commitments from the parties involved. New implementation instruments – for example, P2Ps (Public Public Partnerships) and PPPs (Private Public Partnerships) - will replace gradually the current FP7 instruments for the implementation of EU (nuclear and non-nuclear) RTD programmes.

- **EC Framework to facilitate the interaction between Drivers and Enablers (“Knowledge Triangle” and "Flagship Initiatives")**

The European Commission launched in 2010 the general “Europe 2020 strategy for smart, sustainable and inclusive growth”, as a set of seven “Flagship Initiatives” ². Of particular interest in this context are the following EC Communications dealing with research, energy and education ("Knowledge Triangle"), respectively:

- **RESEARCH:** "Innovation Union - Turning ideas into jobs, green growth and social progress”
- **ENERGY:** “Resource-efficient Europe - Towards a resource-efficient, low-carbon economy” (three pillars: sustainability, security of supply, competitiveness)
- **EDUCATION:** “An agenda for new skills and jobs - Improving employability in a global economy at all education levels”.

The success of any energy E&T programme (in particular, in the case of nuclear fission energy and radiation protection) at EU level will depend on the synergy between:

- research: knowledge creation, usually in RTD organisations (public and private)
- innovation: technological applications usually in industry and services
- education and training: knowledge transfer and competence building across the EU.

Poster
"NATIONAL STRATEGY ON EDUCATION AND TRAINING IN RADIATION PROTECTION IN CUBA"

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ABSTRACT

The development of the nuclear applications in Cuba has been accompanied by a strong infrastructure of radiological protection, which includes the regulatory system and diverse scientific techniques services needed by the program. It is recognized the fact, that the preparation of the human resources has played an important role in safety levels reached in the practices accomplished. Presently, the processes of selection, training and authorization of the personnel working with ionizing radiations have been regulated. This paper aims at the development of a strategy to create a national system of sustainable education and training in the field of the radiological protection able to accomplish the demands of the regulatory organizations. Present necessities and the perspective of training were analyzed; in addition involved academic and non-academic institutions were identified. The design of the realistic-based national training program is described as well as the responsibility of each of the involved institutions.

1. INTRODUCTION

Nationwide nuclear techniques are implemented in almost all fields of the society, mainly in medicine and industry. The level of use has been accompanied by the implementation of a system of radiological safety, which has required the continuous preparation of the human resources in these topics. Despite the insufficiencies of the infrastructure, the country has a competence level that ensures safety in the applications. Two premises have contributed to this:

a). The Cuban nuclear program during the 80’s developed an important effort to ensure the education of many specialists in all the fields that such program demands. One of the first priorities was the formation of technicians in radiological safety and in related specialties.

b). Competent national organisms have understood that an important aspect in the radiological protection infrastructure is the maintenance of an adequate number of properly trained and competent persons. In the development programs of nuclear applications it is assumed that safety in practices largely depends in the preparation of persons working in them.

Indicators such as the limited occurrence of in incidents and accidents, the number of specialists and technicians who have granted the personal authorization and the existing safety infrastructure clearly show the advances in the field of human resources formation.
However, there is no an institutionalized system able to cover all the education and training needs on radiological protection.

2. PRESENT STATE OF THE EDUCATION AND TRAINING IN RADIOLOGICAL PROTECTION.

2.1 Programs and Institutions that presently are contributing in education and training

Today several institutions organize activities related to this topic. Some have a technical supervision of the content of the courses and therefore they are recognized by the competent authority. Most important institutions are described below:

- **Center for the Protection and Hygiene of Radiations (CPHR, acronym in Spanish).** It annually organizes, in collaboration with the national Center of Nuclear Safety (CNSN, acronym in Spanish), a national course mainly addressed to radiological protection officers that deals with basic topics. It mainly designs and implements specialized courses in radiological protection in those practices the users promote. In addition, it has developed regional courses co-sponsored by IAEA.

- **The National Center of Nuclear Safety (CNSN, acronym in Spanish) has organized national and regional courses for selected topics on radiological protection and on response to radiological emergencies, some of them in collaboration with IAEA. The CNSN develops together with CPHR the courses of higher academic figures such as diploma and post graduate specialties on radiological protection.**

- **The Higher Institute of Technology and Applied Sciences, (InSTEC, acronym in Spanish) has as part of the pre grade schedule of nuclear specialties, subjects on basics of dosimetry and radiological protection. It develops post graduate activities as part of the doctorate and master degree courses**

- **The Agency of Nuclear Energy and Advanced Technologies (AENTA, acronym in Spanish) has kept as priority the creation of capacities in education and training in the radiological protection field in the objectives of work and in the conception of branch research programs. It has promoted the topic in the relations with the IAEA. It co-sponsors and promotes advanced formation figures in radiological protection, like the newly organized diploma course.**

- **Institutions of the Ministry of Public Health (MINSAP, acronym in Spanish), such as the National Institute of Oncology and Radiobiology (INOR, acronym in Spanish), the Center for the State Control of Medical Equipments (CCEEM, acronym in Spanish), and the Program of Radiation Safety of the National Unit of Environmental Health (MINSAP), organize education and training activities that include topics of radiological protection. This is specially developed during post graduated formation and as part of the schedules of medical and medical physics specialties.**

The revision of the content and characteristics of the activities that are presently developed allow to conclude that:

1. The education activities are not organized on regular basis, except for the national course which includes the basic concepts of the radiological protection. This is an 80-hour course and it is mainly devoted to radiation protection officers. Since it is national one, matriculation is limited.
2. Training events are organized in specialized short courses. They are a response to some initiatives of user institutions or of ministerial programs of the human resources formation.

3. The development of regional training courses co sponsored with IAEA have allowed the formation of high level specialist, however its impact is limited, since matriculation is reduced.

4. Pre-grade subjects on radiological protection aspects are limited to nuclear specialties.

5. Trainings events addressed to trainers, in order to improve and enhance their expertise, have not been carried out.

6. Efforts are almost addressed to education as a mean to academically transfer the knowledge.

7. There is a great number of specialists who are regularly involved in education and training activities. That is why it is possible to structure a program with an adequate specialization that covers the formation requirements nationwide.

2.2 Regulatory framework

The Cuban legal frame has paid special attention to education and training of human resources. The main document that defines the policy of the country in relation to nuclear applications is the Government Decree 207 “On the use of nuclear energy”, it establishes this aspect as one of the main responsibilities of the licensees.

The “Regulation for the selection, training and authorization of the personnel working in practices related to the use of ionizing radiations” resulted from the importance given to technical competence and it aimed at achieving coherence with the international standards. It rules the activity and unequivocally defines the responsibilities of all the parts that contribute or guarantee the preparation of persons related to safety.

Soon, the Regulatory Body will enact the “Guide for competence recognition in the services of courses on radiological protection” so as to establish the specific requirements for competence recognition of the services of courses on radiological protection. This guide will permit the establishment of requirements concerning the documentation to present to request the competence recognition of the services of courses on radiological protection, the demands on the conception and development of courses and the materials for distant education, among others.

Presently, the Methodological Guide for the implementation of the integrated training system of the personnel from the National Center of Nuclear Safety is in process for the specific case of the personnel of the Regulatory Body. This guide also allows the identification of improvements in the training process, the definition of the types of formation and development the personnel require to have knowledge, abilities and necessary aptitudes to fulfill their institutional function in accordance with new tendencies in the regulation of radiological protection and nuclear safety and their own needs.

Requirements for the characteristics and volume of the required personnel and the specifications of the competence requirements to be met are established in the “Safety Guides” for the practices of Radiotherapy, Nuclear Medicine, Radiography and Nuclear Gauzes.
In general, the Cuban legal frame recognizes as priority the need of having qualified personnel that properly complies with its responsibilities and functions and that feel motivated to have a positive behavior towards safety in radioactive facilities.

2.3 Current education and training needs at short and medium terms

A great number of users of nuclear techniques have promoted the development of a safety culture in its practices. That is why; the continuous education and training of the human resources on radiological protection is one of the priorities. In addition, the impact of the implementation of the mentioned national regulation for the selection, training and authorization of the personnel has increased the demand of education activities as well.

The information obtained so far from the several meetings with the users and from the revision of documents supporting the authorization process drives to the following:

1. The demands of education and training activities are not cover at all. As it is expected, greater necessities are in medical practices.

2. Interestingly, the main demand deals with basic knowledge of radiological protection aiming at strengthening the preparation of the radiation protection officers

3. On-the-job training has not been fully used, though some limited applications have used this method. Users with solid and well-established radiological protection programs do not promote this kind of activities.

In addition, a detailed analysis of the training needs in radiological protection was carried out and has permitted to obtain valuable information to design both a strategy and a national training program on this subject.

2.4 International Cooperation

International cooperation can be differentiated from the one established with the International Atomic Energy Agency and the one kept with several foreign institutions and multilateral projects.

The IAEA, through its national and regional projects, has substantially contributed to the creation of the technical capacities the country has. This cooperation has been addressed to the formation of the officers of radiological protection of the more complex applications, like the specialized preparation of technicians in the area of services, regulatory activities and others. The post graduated courses in radiological protection (PEGC) that are organized by region has played an important role in passing on the IAEA standards on this topic.

The work that IAEA is developing nowadays in relation to its “Strategic plan for Education and Training in Radiation Protection and Waste Safety” has provided basic information for the conception of the technical programs of the courses that are delivered.

The international collaboration with regional institutions and projects is not big, however some activities with European programs have been promoted, specially the project to establish the “European Network on Education and Training in Radiological Protection”. The generalizing and integrating focus of all elements contributing to the development of a solid infrastructure for education and training, which characterizes this project, can be a worthy guide for the development of a national strategy.
3. DEVELOPMENT PERSPECTIVES.

The importance of this aspect has been recognized by the Agency of Nuclear Energy and Advanced Technologies. In its strategic program, it aims at developing a sustainable national system for the creation of technical competences in the field of radiological protection. That is why a long-term project has been started that aims at:

- Design and implement a mechanism that allows the identification of training needs and achieve the maintenance of a proper level of updating.

- Creating an effective institutional system that contributes to achieve the education and training system to cover national demands, including the definition of capacities for on-the-job trainings.

- Establishing a system that allows the harmonization of the content and scope of both basic and specialized courses, as well as its proper recognition by the regulatory authority. To define the role of technical societies in this system.

- Creating a program of information and visualization of topics, courses, professors, training capacities and other aspects that may lead to a better diffusion of the results and of available training capacities.

- Making the system to be applied compatible with IAEA education and training standards and platforms that have been presently developed in countries with high performance in the topic.

The development of actions has been the philosophy applied in this project. Even though these actions can be isolated, they tend to put into practices different variants and thus can prove their suitability in the national strategy. Apart from the activities regularly developed in the project, the ones mentioned below have been carried out so far:

1. Design and implementation of a course on basic elements of radiological protection for students from the Latin American Medical School of Havana. The course, with experimental character, was in the elective courses for second year students. The application of tools to evaluate the effectiveness of the course showed a very good acceptance and pointed out those elements that need to be improved.

2. Selection of a group of hospitals organized under a single government branch to which an education and training system will be designed and will include the adoption of application modules of “reference” techniques to develop on the job training in a centralized way for the personnel of this group of hospitals.

3. Proposal of creation a workgroup specialized in activities of education and training in radiological protection within the structure of technical support of the Ministry of Public Health, as main representative of the applications of ionizing radiations in the country. The group will promote an institutional view of the education and training actions in medical institutions in the country.

4. Implementation of a platform of virtual courses on Radiological Protection using a virtual environment of teaching/learning of open source.

5. Design and implementation of a television course “Nuclear technology at the service of life”, dealing with the main topics of nuclear energy in the energy branch and also in the applications in the industry, the medicine and other life areas. It can be assured that with the materials of the course, there is a new tool to promote the safety culture these applications require.
6. The pre graduate subject Radiobiology was included in the schedule of Faculty of Biology within the University of Havana. This subject has a marked focus towards the application of this science to support radiological protection. The higher education requirements for the presentation, approval and selection to organize and systematize the subject were met.

7. Design, approval and start of the first diploma in radiological protection and safety. This diploma course is the first academic figure that has been specifically developed to deal with radiological protection and safety topics. Experience in this field in the country and the need of continuing improving safety of our applications were important reasons to prepare this diploma. Firstly, it is an important motivation tool and a significant contribution to encourage the safety culture our applications need, and secondly it is the first step to implement the Post graduate specialty, which would complete the formation pyramid our system requires.

4. CONCLUSIONS

Currently, the situation of training in radiological protection in Cuba is characterized by an adequate professional level, mainly in the regulatory system and the institutions ensuring the specialized services. There is no an institutionalized system that permits to improve the existing infrastructure and cover the growing training requests. The development of a national strategy, formally supported by the main institutions involved or in charge of education and training in radiological protection, has been understood as the way to reach technical competence in the applications of ionizing radiations in the country. The model promoted by IAEA has been useful to build up the actions that have been carried out so far. Though there is no a formal strategy, the organizations and institutions related to this matter have shown commitment in the already performed activities.

5. REFERENCES


Education and Training in Radiation Protection at the University of Groningen – past, present and future

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ABSTRACT

The University of Groningen plays an important regional role in education and training in radiation protection in the northern part of the Netherlands. In this contribution we will give a concise analysis of the developments of the RP courses at our university over the past thirty-five years. The current range of RP training and education will be presented. Attention will be paid to internationalization. We will end our contribution with a discussion on future developments. In particular aspects of mutual recognition of certificates will be discussed.

1. Introduction - The Dutch System of Education and Training in Radiation Protection

In the Netherlands the official radiation protection courses range from the basic level 5 (radiological worker) to level 2 (radiation protection expert). A level 1 has never been implemented. The level 2 course is organized every 5 to 6 years at a centralized location in the western part of The Netherlands. Both lower levels are divided in a level for sealed sources & X-ray (A) and a level for open radioactive substances (B). The content of these courses, which are officially recognized by the competent authorities, is based on national guidelines from 1984.

For the medical professions the last decades special so called “M”-courses were developed (5AM, 4AM and 3M). Although these courses are also officially accredited, there are no specific guidelines for the content of these “M”-courses in Dutch legislation. The content of these courses is generally less advanced as the numbers suggests. The courses have only merit in the medical professions. They are generally based on EC Publication Radiation Protection 116.

A summary of the Dutch system is given in the next table[1].

1 Correspondence address: e.j.bunskoeke@rug.nl
Table 1. Summary of Dutch RP E&T system.

<table>
<thead>
<tr>
<th>Level of Expertise</th>
<th>Characteristics</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (A or B)</td>
<td>Low risk and few sources</td>
<td>X-ray (5A), sealed sources (5A&amp;5B), open sources (5B – only RWs)</td>
</tr>
<tr>
<td>5AM</td>
<td>Low risk</td>
<td>X-ray in dentistry</td>
</tr>
<tr>
<td>4 (A or B)</td>
<td>Moderate risk or low risk and more than ten sources</td>
<td>X-ray (4A), sealed sources (4A&amp;4B) and open sources (4B – only RWs)</td>
</tr>
<tr>
<td>4AM</td>
<td>Moderate risk</td>
<td>X-ray in Cardiology, Pulmonology, Gastro-Intestinal Disease and Orthopedy</td>
</tr>
<tr>
<td>3</td>
<td>Significant risk</td>
<td>small accelerators, X-ray, sealed and open sources</td>
</tr>
<tr>
<td>3M</td>
<td>Significant risk</td>
<td>X-ray in radiology and radiotherapy</td>
</tr>
<tr>
<td>2</td>
<td>High risk / complex licenses</td>
<td>All licenses</td>
</tr>
</tbody>
</table>

Table 1. Summary of Dutch RP E&T system.

2. Radiation Protection courses University of Groningen

Regional Importance

The University of Groningen has almost 40 years of experience with officially recognized radiation protection courses. The University of Groningen started in 1976 with the so-called C-course, which became later the level 3 course. Nowadays the university is the only accredited institution that offers the complete spectrum of level 5 (both 5A & 5B), level 4 (both 4A & 4B) and level 3 courses in the Northern part of the Netherlands. The “M”-courses are expected to be recognized by the end of 2013 as well. Fixed curriculum programs of other institutions sometimes include level 4 or 5 courses. The university is therefore one of the major locations in The Netherlands for radiation protection courses with a great regional importance. Participants of the courses are not only staff and students from the university and University Medical Center Groningen (UMCG) but also from different branches of industry and medical institutions.

As early as the seventies different isotopes course were organized within the university which were not connected with an official course level. These courses were for students and staff only. After the accreditation for level 5B (1995) these courses at e.g. the Chemistry, Pharmacy and Biology departments became official level 5B courses although the practical training was sometimes more extended than the basic level 5B-course. Mainly due to a lack of qualified supervisors for the practical training after 2007 all the practical training was concentrated in the Isotope Laboratory of the Biological Centre. Due to the transition to the more international bachelor/master (Ba/Ma) system the last old-style departmental isotope course was given in spring 2008. After the movement of the Isotope Laboratory from the Biological Centre to the new Life Sciences building the tradition of departmental isotope course was restored in September 2009 with the English master course Radioisotopes in Experimental Biology. The level 5B course is a mandatory part of this course.
Internationalization

Most people who attend a radiation protection course will do the basic level 5 (usually 5B, sometimes 5A) as instruction for radiation worker. Within our institution the level 5B for example is mandatory for someone to work without permanent supervision in an Isotope Laboratory. The PhD-students at the university are for a large part from outside The Netherlands. Due to the English master programs the number of non-Dutch students increased in the past years. This is also reflected in the participants of the level 5-courses. As for the level 3 course profound knowledge of Dutch legislation is required, most participants of this course remain of Dutch origin.

Nowadays most level 5(B)-courses are given in English and in 2012 the first level 5A was given in English. Since 1998 course certificates can also be provided in English. In fact also an increasing number of Dutch master) students prefer the certificate in English. Until 2012 already people born in 70 different countries outside The Netherlands have participated in the level 5 courses.
Table 2. Country of birth (The Netherlands not included) as mentioned on the course certificate level 5A/B 1995-2012

<table>
<thead>
<tr>
<th>Country</th>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>52</td>
<td>England</td>
<td>5</td>
<td>Norway</td>
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<td>5</td>
<td>Slovakia</td>
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<tr>
<td>India</td>
<td>35</td>
<td>Afghanistan</td>
<td>4</td>
<td>Syria</td>
<td>2</td>
</tr>
<tr>
<td>Iran</td>
<td>29</td>
<td>Brazil</td>
<td>4</td>
<td>United States (USA)</td>
<td>2</td>
</tr>
<tr>
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<td>South Korea</td>
<td>4</td>
<td>Colombia</td>
<td>1</td>
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<td>4</td>
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<tr>
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<td>4</td>
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<td>Gabon</td>
<td>1</td>
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<tr>
<td>Rumania</td>
<td>11</td>
<td>Canada</td>
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<td>Lebanon</td>
<td>1</td>
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<tr>
<td>Netherlands Antilles</td>
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<td>Finland</td>
<td>3</td>
<td>Nepal</td>
<td>1</td>
</tr>
<tr>
<td>France</td>
<td>9</td>
<td>Mexico</td>
<td>3</td>
<td>Ruanda</td>
<td>1</td>
</tr>
<tr>
<td>Belgium</td>
<td>8</td>
<td>Nigeria</td>
<td>3</td>
<td>Scotland</td>
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</tr>
<tr>
<td>Hungary</td>
<td>7</td>
<td>Peru</td>
<td>3</td>
<td>Soudan</td>
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<td>Japan</td>
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<td>Vietnam</td>
<td>3</td>
<td>Sri Lanka</td>
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<td>Austria</td>
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<td>Brunei</td>
<td>2</td>
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<tr>
<td>Surinam</td>
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<td>Bulgaria</td>
<td>2</td>
<td>Belarus</td>
<td>1</td>
</tr>
<tr>
<td>Switzerland</td>
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<td>Zaïre</td>
<td>1</td>
</tr>
<tr>
<td>Ghana</td>
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<td>Croatia</td>
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<td>1</td>
</tr>
<tr>
<td>Serbia</td>
<td>6</td>
<td>Liberia</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>6</td>
<td>Malaysia</td>
<td>2</td>
<td>Total</td>
<td>466</td>
</tr>
</tbody>
</table>
Here we present the percentage of people originating from Netherlands (NL) and outside the Netherlands (not NL) based on the countries of birth mentioned in the official course certificates. The data are grouped in periods of six years starting in 1995, the year that the University of Groningen was accredited for this course level.

Only the data of the level 5B course certificates are used for these charts. Reason for this is that this is the only course in the spectrum that is almost exclusively used as instruction for Radiation Workers. All other courses are mainly used as education for Radiation Protection Officers (RPOs) for which a good passive understanding of Dutch is obligatory. Level 4 and 3 are therefore only given in Dutch, with hardly students from outside The Netherlands. The same holds to almost the same extent for level 5A with mainly dentistry students. They will not only act as RPOs for their X-ray equipment but also be treating Dutch speaking patients.
3. Future

It is likely that the University of Groningen will be of major importance for the radiation protection courses especially in the Northern part of The Netherlands. As university and university hospital (UMCG) attract more and more people from outside The Netherlands the internationalization of the courses will continue.

New national legislation will be in place for the radiation protection courses in 2013 or 2014. This will not greatly influence the current system in The Netherlands[2]. Due to EUTERP, ETRAP and other international platforms the international value of the courses according to the Dutch system will become clearer as will the value from similar courses in other countries. It is expected that apart from certain basic modules also specific modules will be developed for at least the medical professions. Also more refresher courses have to be developed. The University of Groningen will participate in these developments together with its partners in Groningen (the UMCG and the Hanze University for Applied Sciences) and other accredited institutions in the Netherlands as with partners abroad. See e.g. the intended participation in the MoRaWo project aiming at mutual recognition of low level RP courses within the EU[1].

International cooperation will be important to ensure good quality courses also in the future. Dwindling knowledge of radiation protection and biological effects of radiation is a concern which can be coped with more international cooperation.

References

As in the former Isotope Laboratory in the Biological Centre, the Isotope Laboratory Life Sciences (in use since February 2011) has a special lab room for the isotope courses. Here a view of the room during a practical training of the level 3 course in February 2013.
Some manuals used for practical training in 2003 in the former Isotope Laboratory of the Biological Centre Haren (University of Groningen)

Practical training in 2003 of a level 5B course in the special lab room for the isotope courses in the former Isotope Laboratory Biological Centre Haren (University of Groningen)
ABSTRACT

The ISO 17025 accreditation is periodically checked by the Austrian National Accreditation Body by means of so-called audits. As the field (radioactivity measurements - self monitoring with regards to legal limits) of the accredited testing laboratory of the NES (Nuclear Engineering Seibersdorf) is rather small in Austria compared to other countries, special challenges arise as well for the laboratory staff as for the accreditation body, especially what training, education and the transfer of know-how is concerned. A system of training, both theoretical as hands-on, including independent testing of the staff, was established in order to ensure the quality of results as required by the accreditation as well as by the licensing authorities. A series of lessons learnt arose during the first year of the internal training system. This paper describes these lessons learnt as well as some ideas to improve internal training even more.

1 Introduction

Nuclear Engineering Seibersdorf (NES) is the sole radioactive waste processing company in Austria and is in charge of collecting, processing and storing all radioactive waste arising in Austria. Its facilities comprise an incinerator, a water treatment plant, a multi-purpose processing unit (which is currently in the stage of refurbishment and new-built) and several storage halls for interim storage. A hot cells laboratory was inherited from the previous nuclear research center Seibersdorf. It is currently used for the storage of highly active sealed sources and materials under safeguard control.

The operating licenses of the NES, one for each operating facility, all include the obligation to monitor the contamination status as well as the dose rates inside the facility. Outside the facilities, the gaseous and fluent releases have to be monitored in order to prove they are below the regulatory limits. All these data are summarized yearly in a so-called “Safety Report”.

All these measurements and controls are performed in the framework of an accredited system (“akkreditierte Prüfstelle”, PS ID 314). The accreditation thereof is controlled and audited internally every year, according to the international standard ISO 17025 [1]. External Audits are performed at a 15-month interval by the Austrian National Accreditation Body [2].

2 Competence management philosophy

Competences of the staff members are visualized in a matrix (“Prüfmatrix”). Every row is a measurement procedure, whereas every column represents a staff member. A ticked box together with a date means that the staff member is entitled to perform the particular measurement procedure in the accredited system, starting from this date (Figure 1). The yellow fields in the matrix mean that this particular staff member for this particular measurement procedure is a so-called authorised signatory (“Zeichnungsberechtigter”). Only after the signature of the authorised signatory, the reports can be published.
A series of criteria must be met before a staff member is entitled to perform a measurement procedure in the accredited system:

- Theoretical training
- Hands-on experience (3 stage training procedure: watch doing, do being watched, do)
- Tests

The final decision to accept a staff member in the matrix, is taken by the head of the testing laboratory (“Prüfstellenleiter”).

2.1 Theoretical training

The theoretical training courses in earlier stages were organized by external companies (Canberra, ORTEC, TÜV, etc.). As the experience showed that both the contents as the level of these courses did not match the needs and requirements of our testing laboratory, the decision to organize these courses in house was taken late 2012. The first course in gammaspectrometry is now being given by the head of the testing laboratory, resulting in 3 advantages:

- The contents can be tailored better to the practical needs in the testing laboratory. Real-life examples are given, feed-back between trainer and trainees is possible within the company. Hands-on training on company owned devices is possible.
- Trainees are colleagues, who you know better than an external trainer. Therefore, the atmosphere is less formal, it is easier for the trainer to estimate whether the trainees understand the lectures or not.
- Cost and time reduction for the trainees on the one hand, time increase for the trainer on the other. More flexible time management and planning of the training sessions.
2.2 Hands-on experience (3 stage training procedure: watch being done, do being watched, do)

Before employees can be accepted into the Prüfmatrix, they have to pass through a three stage training procedure: “watch being done”, “do being watched”, “do”.

A mentor is nominated for each procedure. The mentor is entitled to decide when the employee is experienced and skillful enough to pass to the next stage.

i. “Watch being done” comprises the phase of observing an experienced colleague, usually the mentor, the reading of the SOP (Standard Operating Procedure) as well as questions, answers and discussions.

ii. The “do being watched” phase inverts the roles. Possibility for feedback by the mentor, hands-on experience for the employee.

iii. The phase of “do"ing on an independent basis is the final stage and is completed by an informal test where the employee has to prove his or her skills and understanding.

The final decision of accepting the employee into the Prüfmatrix is taken by the head of the testing laboratory. Any change of the Prüfmatrix needs to be reported to the Austrian National Accreditation Body by proving the completed 3 stage training procedure.

2.3 Tests

Before 2012, hardly any tests and checks were foreseen inside the testing laboratory.

As operational experience showed that the knowledge transfer between staff members was not established reliably, both training efforts were intensified (s. above) as well as tests were introduced. The results of these tests, sometimes in the form of homework, are part of the yearly evaluation of the staff members. The tests are composed and evaluated by the head of the testing laboratory.

3 Lessons learnt

3.1 Theoretical training

The motivation of the staff for external training in the past was rather low. The management of the testing laboratory is convinced that training without motivation makes no sense. Moreover, it is a loss of time and money.

The new concept of internal trainings was welcomed with much more enthusiasm, as was shown by the big response on the first training session. Not only did all invited people show up, the group was doubled by other interested staff members, not working for the testing laboratory. The atmosphere was very open, discussions were initiated by participants, showing their interest. The feedback after the first training session was very positive and all participants had the feeling having learnt something new. The results of the homework were also very encouraging.

One disadvantage is the time consuming redaction of the course material: presentation, examples, hands-on training sessions, etc. It must be clear that starting such a training program from scratch is time consuming in the beginning, but the initially invested time will pay off in the future.

The time cost is being reduced to the maximum possible extent by using open source material (KIT, MIT, etc.).
3.2 Hands-on experience
The three stage system was established a couple of years ago and has brought more or less satisfactory results. It systemised the acquisition of practical skills by staff members.

One drawback of the system is that it doesn’t include a guarantee of the competence level of staff members who don't execute regularly the SOP. Therefore, a maximum time interval will be defined in the future, within which staff will have to prove their competence in the procedure concerned.

3.3 Tests
Tests leave us behind with mixed feelings: on the one hand, they are necessary to transfer the feeling of importance and relevance to the trainees. On the other hand, they make us all think a bit too much of school, exams and rigid educational systems.

The big challenge in a professional environment, with mainly young staff members, consists of motivating them to learn, to train, to study, to be curious (“stupid questions don’t exist”) without transforming the trainer in a first school teacher while still maintaining a minimum of discipline. Frankly, we haven’t found the perfect answer to this challenge so far.

3.4 Cooperation / Interaction with the accreditation body
Although we ourselves are convinced that training and skillful staff are key for a competent testing laboratory, delivering quality in their work, we are left behind with a feeling that training and knowledge management are not so essential topics during audits held by the accreditation body. Rather than verifying the contents’ level of training programs, more attention is dedicated to the fact whether participant lists are being kept and whether these are part of a QM system. Without wanting to minimize the importance of a high-performance QM system, we would prefer the main focus of attention to shift towards the contents, especially in training. If not, the risk exists that companies, above all those which are in heavy competition and under cost pressure, will organise training programs as part of their window dressing rather than to assure well trained and competent staff.

3.5 Errors and corrective actions – prevention
Up to a few years ago, errors were corrected in an informal way, without logging the solution implemented, without further research of which areas might be affected further. On the occasion of a QM audit, a system of how to implement corrective actions was established in the QM manual.

This step definitely improved the systematic reporting of errors and the implemented solutions. As this solution implementation reports are also sent to the higher management, a certain hesitation arose on the level of the operating staff to report errors found.

Having noticed that, the testing laboratory decided to implement a preventive, software-based system which checks the collected data for plausibility and warns the user as well as the head of the testing laboratory in the case of erroneous data input. Acting this way, tedious and sometimes painful a posteriori corrective actions can be avoided. Moreover, based on the feedback of experience, many small measures were implemented to reduce human error even more.

This system welcomed very positive response during the last audit by the Austrian National Accreditation Body and reduced the frequency of corrective actions drastically.
4 References
[1] ISO 17025 “General requirements for the competence of testing and calibration laboratories”, International Organization for Standardization
INTERDISCIPLINARY APPROACH TO NUCLEAR EDUCATION – TOWARDS SUSTAINABILITY

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ABSTRACT

Specific characteristics of nuclear energy and its management modes forces to develop advanced education – professional as well as public – nuclear education approaches, with the aim to solve two basic constituents of nuclear sustainability – 1) to maintain and develop reliable professional human resources, 2) to gain positive public attitude to existing as well as forthcoming novel nuclear facilities. There is proposed to develop a common interdisciplinary approach to nuclear education, taking into account that a) i) the public awareness and knowledge level about nuclear energy problems is different, ii) public perception of nuclear risks markedly differs from scientific assessment of these risks, iii) the inherent incompleteness in data on nuclear safety.

The key methodology of our interdisciplinary approach - the use of principles which could manage with the knowledge and information qualities: 1) a self-organization concept, 2) the principle of the requisite variety. As a primary source of growth of internal variety is proposed information and knowledge. Following actual issues are considered related to nuclear education a) nuclear risks and their perception, b) human resource development: c) advanced research and nuclear awareness improvement, e) multi-level confidence building to the nuclear power use.

We have shown: public education, social learning and the use of mass media and internet are efficient self-organization mechanisms, thereby forming a knowledge-creating community. Such a created knowledge could facilitate solution of key socio-technical nuclear issues as a) public acceptance of novel nuclear objects, b) promotion of adequate risk perception, and c) fostering of interest to nuclear energy being a key common factor of nuclear sustainability both in the personnel as well as in the public area. Comprehensive knowledge management and informational support firstly is needed in such issues as: a) general nuclear awareness, b) personnel education and training, c) reliable staff renascence, d) public education and involvement of all stakeholder categories in decision making, e).risk management.

1. Introduction

Sustainable development crucially depends on possibilities to manage a whole series of sustainability factors - ecologic, economic, energy supply and other ones. An efficient solution towards ecological, energetic and, finally, economic sustainability of our world – to increase the relative weight of nuclear power use, thereby requiring to ensure efficient management of this energy.

Specific characteristics of nuclear energy and its management modes forces to develop advanced education – professional as well as public – nuclear education approaches, with the aim to solve two basic constituents of nuclear sustainability – 1) to maintain and develop reliable professional human resources, 2) to gain positive public attitude to existing as well as forthcoming novel nuclear facilities.
Actually, nuclear energy brings real as well as imagine risks to global security and environmental safety, controversies of various nature emerged due to the use of nuclear energy in different peaceful and military purposes. Besides, huge complexity and specific characteristics of nuclear energy and its management modes leads to aggravated public perception of associated risks and such public perception of nuclear risks markedly differs from scientific assessment of these risks. Elsewhere, one of the main features of nuclear risks – a) low probability of accidents, b) their heavy global character of with long-term harm consequences. Such permanently growing public concern about possible nuclear risks and decision making policy in nuclear areas may endanger forthcoming development of novel advanced projects of efficient use of nuclear energy.

These real and imaginary nuclear risks and the growing complexity of nuclear energy management on the whole forces us to develop novel forms of complex problem solution, decision making and social communication approaches with the final aim to gain public confidence to find reliable and confident solutions of forthcoming use of nuclear energy, thereby, strengthening the basic conditions of sustainable development of mankind and assuring the global society in the safety of nuclear energy.

As a possible way towards solution of these problems one can propose to develop an interdisciplinary systemic approach to societal optimization aspects of nuclear energy management, including risk perception communication Recognizing a key role of education, communication and knowledge about nuclear energy issues in improving public attitude we propose a synergetic societal optimization approach based on the requisite variety principle.

2. Existing problems and threats in the peaceful use of nuclear energy

A set of fundamental problems and controversies of various nature emerged due to the use of nuclear energy in different peaceful and military purposes, including: a) political and environmental inter- and intra-national concerns about nuclear power plant safety, b) the threat of proliferation of weapons of mass destruction and to global security, c) environmental and security problems related to safe transport and disposal of radioactive waste, d) psycho-social problems of risk perception and acceptance of official nuclear energy management policy and projects.

2.1 Operational safety and accident prevention

The basic issue and aim of nuclear power plant (NPP) safety consists, first of all, prevention of nuclear accidents (Three Mile Island, Chernobyl and the quite recent Fukushima cases) and incidents, in order to ensure people life and health, environment and economics. They can have also significat transboundary effects (as in the Chernobyl case) and raise the concerns of the public about the safety of nuclear energy and the radiological effects on people and the environment [1]. Among the main components of the NPP operational safety failures one should accent following ones –

a) external disasters (earthquakes, tsunami, floods),
b) human factors: errors, human resources with the knowledge, skills and access to information that enables them to perform effectively, and
c) technical incompleteness and mistakes [2].

2.2 The nuclear terrorism threats

Nowadays he nuclear threats nowadays have following main constituents: a) a set of heavy hazards caused by the attack on, or sabotage of, nuclear facility or a transport vehicle; b) the acquisition of nuclear weapons by the theft; c) manufacturing explosive devices using stolen nuclear materials; and d) the use of radioactive sources in radiological dispersal devices ("dirty bombs") dispersing radioactive material when detonated.
Due to the increasing globalization tendencies, in particularly, global communication activities and the spread of secure nuclear information and technologies, a remarkable part of countries have potential capability to acquire nuclear material and technologies and, thereby, in future to become even a new nuclear proliferation centre to other new countries. Attacks on nuclear facilities (mainly - NPPs, also – research reactors, fuel processing and storage facilities) could bring about heavy damages and disruptions, large economic losses, and have potentially very significant health impacts. For example, an explosion or fire, or a crash into such a facility could lead to a giant release of radioactive material into environment. Besides, attacks on such objects as spent-fuel storage facilities endanger the nuclear safety and security also due to the fact that such storage areas are generally in a lesser extent protected against various attacks and impacts in comparison to NPPs.

2.3 Human Factors

The known NPP nuclear accidents emphasized the high importance of maintenance and developing also appropriate human resources in the nuclear safety and nuclear emergency preparedness. Only sufficiently qualified and properly trained personnel can ensure the performance of NPP operation without human errors. On the other hand, the growing public concern about possible nuclear risks manifesting in real risks and nuclear threats as well as imaginary risks nuclear fear originated due to inadequate risk perception - may endanger forthcoming acceptance and development of novel advanced projects of efficient use of nuclear energy. These items show our task – to develop the necessary human resources, to educate all relevant groups of society and to involve them in decision-making.

3. Societal optimization of nuclear energy management – key items of methodology

A huge practical experience accumulated in nuclear energy management and the studies on societal issues in this area show that nowadays there is difficult to perform main tasks of nuclear energy management and, especially – to develop and implement novel nuclear facilities (NPPs, radioactive waste (RW) repositories, etc.) without involving society. On this basis one can suppose predominance of societal factors in solving the nuclear energy issues, especially those related to siting of nuclear objects. Thus, as a key to modern governance of nuclear energy management could be considered stakeholder involvement, having been already recognized in international binding documents [3-5], forums and researches [6-8].

However, in parallel with implementation and observing legislative instruments – national and international – efficient involvement of various groups of stakeholders having different interests and, thus, development of socially favourable and technically advanced nuclear projects requires to promote approaches, based on stakeholder education, information, communication and interactions.

3.1 Stakeholder awareness level – the key parameter of societal optimization

Multidisciplinary complexity and special characteristics of nuclear energy management leads to aggravated public perception of associated risks and such public perception of nuclear risks markedly differs from scientific assessment of these risks. The important role of public education, distribution of all relevant information and development of communication options in the areas of the spent nuclear fuel and RW management safety has been underlined, in particular, via setting up a requirement to make information on the safety of nuclear objects available to public [3, 4].

Being aware of decisive role of public learning and informing as well as society participation, our approach to societal optimization of nuclear energy management is to analyze the role of
knowledge and information in the development of solutions to the complex socio-technical problems of the management safety. For our approach, let us take into account that: i) the public awareness and knowledge level about nuclear energy management problems is different, and ii) the inherent incompleteness in data on nuclear safety. On the basis of these premises, as the key principles in our approach we choose the principles which could manage with the qualities knowledge and information qualities: a self-organization (SO) concept, 2) the principle of the requisite variety.

3.2 Synergetic approach

As nuclear energy management problem nowadays has acquired a multidisciplinary nature, thus, can be considered as an object of an interdisciplinary science – synergetic [9] being a tool for description of complex system evolution. Due to growing social activity also in the nuclear area, there is swelling such global tendency of as a shift from relations based on separation, control and manipulation towards participation, appreciation and SO [10]. It is well known that development of qualitatively novel structures is associated with SO processes – spontaneous creation of a collective order out of the local interactions between initially independent components, and basic mechanisms of SO [11] can be attributed also to information phenomena [8]. Taking into account the decisive role of information and knowledge in the management of stakeholder involvement and participation, our task could be specified as to apply the synergetic concept, namely – SO – to information and knowledge aspects [12], with the aim to consider the key societal nuclear energy management issues.

3.3 Adaptation and the principle of requisite variety

For our aims we use also the relevant “principle of SO” [13] stating that „a dynamical system, independently of its type or composition, always tends to evolve towards a state of equilibrium“. Thus, the further step in our approach we will base also on the adaptation concept: „if we consider a particular part of the original, self-organized system as the new “system”, and the remainder as its “environment”, then the part will be necessarily adapted to the environment“ [13].

Taking such a self-organized nature of adaptation as a basic criterion of social optimization we choose the principle of requisite variety, stating: for successful development of a given system (e.g. human being(s)) in external environment its inherent variety should exceed the variety of its environment”. In such an approach enabling us to consider the problem of social optimization as a problem of social adaptation we should to specify a real content of the meanings of: i) external environment, ii) internal complexity, iii) a given system.

3.4 Self-organization of stakeholder community

Taking into account the drastic expansion of the problem area related to nuclear energy management, in particular, the marked changes in the societal environment for decision making in siting of nuclear facilities [14], let us define - in the analogy with the concept of human's three worlds [15] the concept “external environment” as an non-equilibrium creation including: (1) the natural environment, (2) the social world, (3) artificial environment – a set of objects and conditions emerged as the result of human activities. In such an extended definition the concept “external environment” includes a set of physical, ecological socio-economic and other factors. Thus, a necessary condition of successful adaptation to a changing external environment and optimization of interactions with such environment will be the predominance of humans’ internal complexity over the environmental complexity.

The growing complexity of the external environment markedly displayed in the decision-making on siting of facilities, demands to develop approaches to manage the societal requirements to the siting of new nuclear facilities. Emphasizing here two key factors -
information and knowledge - via which we relate to our environment by SO processes [16] and taking into account that the knowledge about the world contains possible interactions between subjects, we can propose to reveal relations between different stakeholder groups and their concerns and to find out possible forms of SO of such stakeholder groups into a harmonized stakeholder community having common strategic aims. Such a joint stakeholder community including all involved parts participating in decision making is considered as the given system.

4. Social learning and optimization of risk perception

4.1 Social learning via a self-organizing web

Thus, our task of optimization of stakeholder involvement can be formulated as the need to develop activities increasing the internal complexity of the joint stakeholder community. Viewing knowledge as a complexity factor, all available forms of stakeholder involvement, their education and mutual interactions can be classified as mechanisms of societal optimization, increasing the internal complexity. First of all, it can be achieved via social and mutual learning, thereby activating and diversifying interaction between stakeholders. A key mode of this interaction can be seen as the recognition by operators and regulators of the need to contact other stakeholder groups - to increase their knowledge level and to enhance mutual understanding. As the knowledge itself is able to self-organize [17], the whole process of mutual learning and educating of stakeholders can emerge in a *knowledge creating stakeholder community* able to use novel [18] communication and knowledge management forms, e.g., the Internet - a global socio-technical system, where humans renew the knowledge storage mechanism by producing new informational content [19].

Due to giant complexity, these global web networks have certain SO properties, including self-adaptation to changes in operating environment, to self-healing, and – just the internet will facilitate SO of a social community in a self-organized social network. Thus, Internet as a modern communication networks can be considered as an important case of SO, thereby facilitating [11] information retrieval. In particular, for the case of geological repository development such web-based approach, being an advanced way for all stakeholders to access permanently updated data, has already been developed and applied with the aim to provide socially informed decision making [18].

4.2 Optimization of risk perception

The role of social learning soundly appears in risk communication. So, importance of uncertainties management displays in: 1) confidence building for safety assessments, 2) in the decisive role of the unknown factors [20] in determining risk perception by the public, 3) in the social learning where the basic component of social learning can replenish – adaptation – by handling uncertainty [21] – deficiency in the necessary information. Thus, as the perceived risk of a nuclear facility could be regarded as a function of the knowledge of facility issues [20], the role of social learning in solving risk perception issues can be shown in the following way: the unknown factor of perceived risk can be diminished via social learning where affected communities become familiar with nuclear issues.

There is also another side of social learning: the ability to understand how the community perceives all possible as well as imaginary risks. To reach such understanding one could propose a program aimed to identify public and other stakeholder concerns. This could be achieved by increasing – via versatile communication and stakeholder involvement – the levels of such trust components [22] as openness, caring and competence enabling to include these items in the decision-making mechanism and raising the decision-making capacity of stakeholder community and public acceptance.
5. Development of human resources

5.1 General aspects

In line of the elaborated concept of information and knowledge role in optimization of risk management and finally – fostering safe management of nuclear energy, exclusively important task consists in preparing and preserving for NPP and other nuclear facilities highly professional personnel having advanced reliable knowledge and skills allowing the personnel to operate effectively.

This aim is to be realized mainly via [23]:

a) education at all levels, especially using modern international education networks (as ENEN (European Nuclear Education Network), ANENT (for Asia), WNU (World Nuclear University)) as well as a newly created European Nuclear Safety and Security School;

b) training – for all categories and ages of nuclear workers, in the frame of International Atomic Energy Agency (IAEA) training courses; besides, in Europe – in European Fission Training Schemes projects: for nuclear engineering, for radiation protection, for geological disposal of radioactive waste and for the nuclear safety culture;

c) research and knowledge management, using contemporary international databases, electronic communications portals and capabilities of specific projects, e.g., in the frame Euratom Framework Programmes, the Joint Research Center.

5.2 Basic challenges in nuclear education

In line of already ancient as well as contemporary experience and position regarding education of high-level professionals, it is important young-age pupils to attract and motivate to certain area of activities. In particularly, inclusion of basic nuclear knowledge in secondary level education could give such benefits as [24, 25]:

a) attraction of young people to professional nuclear education when they already have some basic nuclear knowledge;

b) a large percentage of students that decide their future career as they complete their secondary education. Exposure to nuclear technology could help them chose a nuclear related career.

Besides, acquisition of sufficient level of nuclear awareness already in the school will promote more reasonable perception of radiation and nuclear risks and improve attitude of population towards nuclear activities.

In turn, the university level education should stress the research as well as engineering aspects, including collaboration with universities, providing [25]:

i) scholarships for students of nuclear science, by motivating them to choose nuclear options and establishes early contact between students and the industry;

2i) acquisition of initial professional experience when accomplishing diploma and practical works at a nuclear licensed site, thereby finally promoting supply of nuclear industry with young generation of qualified professionals as well as preservation of specific nuclear knowledge, especially the tacit knowledge;

3i) possibility for professionals to participate in the development and delivering advanced education courses and lectures.

5.3 Development of research activities

Interdisciplinary approach using contemporary science concepts seems actually important in such a integral component of efficient education component as research, thereby providing the synergy of knowledge acquisition and generation of novel knowledge, which finally should elevate nuclear safety level and improve public attitude to nuclear industry.

Among the main research directions in the radiation and nuclear safety one should focus:
1) at the areas highlighted by the real and potential accident and to study and get safe solutions for critical situations;
2) to develop novel safe and efficient technologies, in particular, next generation reactors – in the frame of various international projects and forums - The Generation IV International Forum (GIF), Multinational Design Evaluation Program (MDEP), Innovative Nuclear Reactors and Fuel Cycles (INPRO);
3) to clarify possible impact of nuclear energetic practices on the people health and thereupon take relevant measures to minimize such impact, namely, such issues as: i) low-dose ionising radiation risks, ii) radiation effects on the molecular and genetic levels, iii) development of scientific monitoring system.

6. Nuclear education and awareness – the keystones of confidence building in nuclear energy management

Bearing in mind that one of basic goals of nuclear education – to reinstall public trust in nuclear energy, the world-wide scale of nuclear activities causes an actual the need to build confidence at all organizational levels
   1) global level, via
      a) United Nations activities aimed at reaching political settlement of controversies and discrepancies related to the use and proliferation of weapons of mass destruction, with a possible use of a novel approach – based on social self-organization – of minimization of controversies,
      b) IAEA activities aimed at reaching safety and security of the use of nuclear energy and materials, at assurance of international community of peaceful use of nuclear materials as well as at efficient interaction and feedback with society;
   2) regional level – seeking – via a two-way information exchange – for optimal solutions of safe management of nuclear power plant running, decommissioning and radioactive waste disposal, particular case studies being included in the Euratom Framework Programmes;
   3) national level.

In the area nuclear energy management, just the IAEA activities are aimed at reaching safety and security of the use of nuclear energy and materials, at assurance of international community of peaceful use of nuclear materials as well as at efficient interaction with society. Activities of various bodies established by IAEA, e.g, the International Nuclear Information System (INIS) highly succeed a) development of comprehensive network of education and training of nuclear professionals and personnel, as well as wide participation of stakeholders in the decision-making in nuclear matters, in order to maintain public confidence and to provide stability in decision-making, as well as b) the increase of the nuclear knowledge and "awareness" levels about the use, safety, security of nuclear energy.

7. Conclusions

On the basis of interdisciplinary science concepts, the decisive role of information and knowledge in the societal optimization of nuclear energy management area has been revealed. The following inferences about societal optimization in this area are developed:
   a) self-organized social learning, knowledge and risk management could promote adequate perception of risk and prevent, by diminishing uncertainties, social amplification of an imagined risk, as well as to increase the trust level and facilitate more adequate equity perception;
   b) knowledge management, social learning and self-organized communication of all stakeholders will provide a reliable basis for a new integral type of thinking being so actual for successful realization of advanced nuclear projects being keystones of sustainable development.
References

HOW WELL DO WE COPE WITH DIGITAL DETECTORS?
A VISUAL GRADING ANALYSIS OF ORTHOPEDIC RADIOGRAPHS.

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Warmeoesberg 26, 1000 Brussels - Belgium

ABSTRACT
Purpose: With the introduction and continuous improvement of digital detectors a dose reduction was predicted. Due to a larger dynamic range radiographs of sufficient quality can be produced with lower detector air kerma (DAK). However, this reduction was not observed. On the contrary, some authors indicate a creep towards higher DAK, explained by a better appreciation of the radiographs caused by a higher contrast-to-noise ratio. The authors investigated the relation between the DAK and the appreciation of image quality, described as ‘minimal detectable structures’ of MDS, by radiologists.

Methods and Materials: To investigate the relation mentioned above 172 anterior-posterior radiographs of the knee and 152 radiographs of the pelvis were collected randomly in 19 radiologic centers. A Visual Grading Analysis (VGA) with a five-point scale was used to judge the image quality of seven different anatomic structures. To simulate the evaluation of image quality during the installation of x-ray equipment, the mid-point of the scale was equalized to diagnostic quality. Six experienced radiologists scored all radiographs, in a controlled environment, with ViewDex®. Every observer received an instruction and a training dataset. To investigate intra-observer variability, twenty radiographs were repeated. The DAK was determined by the signal transfer properties of the detector.

Results: The knee AP (N=169) obtained an average VGA score of 3.92. A significant (p<0.01) difference between CR (VGAS 3.82 ± 0.38) and DR (VGAS 4.07 ± 0.32) was noted. The general VGA score for the pelvis AP (N=152) was equal to 3.71. The VGA score for CR (VGAS 3.4 ± 0.48) and DR (VGAS 3.9 ± 0.45) were significantly (p<0.01) different. The intra-observer variability was not significant (p>0.05) for both datasets. In both cases, the inter-observer correlations are high and significant. Only for the pelvis AP radiographs produced with computed radiography, a rather weak but significant (p<0.01) correlation (0.42) was found between the DAK (1.65µGy–5.29µGy) and the VGAS. A similar correlation wasn’t found for the knee AP on CR (DAK: 1.61µGy–5.48µGy) nor for radiographs produced with DR technology.

Conclusion: The VGA revealed an image quality higher than diagnostic necessary. The evaluation of image quality based on assessment of the MDS delivers a high correlation between observers. As such is it a reliable way to evaluate image quality. On the other hand, there was no significant correlation between the VGAS and the DAK. This supports the need for specific training of radiologist to understand digital image quality and describe MDS, in such a way radiographers can optimise their procedures to achieve an image quality, sufficient for the visibility of those MDS, with the lowest DAK possible.

Keywords: radiography, orthopaedic, digital detectors, image quality, dose management, VGA

1. INTRODUCTION

The phosphor-storage plates, the basis of Computed Radiography (CR) were the first ‘digital’ detectors. It was an asset and cheap conversion of conventional x-ray units into digital units. The second wave came with flat-panel detectors and dedicated digital systems or Digital Radiography. (1-4) These digital detectors are now the norm in the European Radiology Departments. (5) The introduction of digital detectors, justified by predicted improvement of image quality and lower patient doses was a major innovation and caused a paradigm shift. (4) Digital radiography system are characterised by detective quantum efficiency (DQE), dynamic range and post-processing. (1,6,13) The larger dynamic range tolerates a wider DAK range without an adverse effect on the image quality. This offers the possibility to further ‘tailor’ the patient dose and image quality for a specific task. (4) Based on those properties digital detectors may hold the opportunity to lower the patient dose. In contrast to this expectation, an increase was measured in many radiology departments after transition to digital radi-
ography. Higher DAKs lower the noise levels in radiography and result in a crisp and sharp appearance favoured by the radiologist. (4,6) The level of noise and the acceptability of digital images are ‘in theory’ inversely proportional. (9,14)

Many theories surround this ‘increase in dose’ or dose creep. (4,6,15) The origin is found in knowledge-based and procedure-based errors. Some authors claimed patients are unknowingly overexposed due to the appreciation of these low noise and sharp images. (1,6,14,16) Or operators may know that an overexposure can be resolved but an underexposed image needs a retake. (4) Because of the absence of detailed guidelines, the necessary DAK was increased, choosing the ‘safe’ side for obtaining a satisfying image quality. (4,5) In filmscreen radiography, the image density depends on a correct exposure and processing of the film. This fixed correlation between density and detector-air-kerma (DAK) has vanished in the digital world by disconnecting acquisition from presentation. The permanent a plain film radiography was, the manipulated a digital radiography can be. (1,4,6) The straightforward relation between dose and film density is replaced by a system that rewards an increase in DAK with a higher Signal-to-Noise Ratio (SNR), until the point of signal saturation of the detector is reached. Only at that point, due to the excessive dose, it will result in poor image quality and loss of diagnostic information. For digital detectors these saturations may occur at dose levels that are four to five times the reference dose. (4)

As ‘image quality is a quantity that is difficult to quantify’ not many authors tried to define the concept, notwithstanding the widespread use of the term. (7,8) Image quality is indeed a problematic concept in the digital world as many tools allow manipulation. So the quality can be improved with post-processing but it is a double-edged sword. If used inappropriately, it can decrease image quality or create artefacts and conceal pathology. (1) This shift from film to digital radiography demands new guidelines and illustrates the challenge for practitioners to regain control over the relation between dose and image quality. (4) Some authors illustrated hereby the need for adequate training and dose indicators. (1,4,9,14)

To define this ‘image quality’ the description of ‘minimal detectable structures’ or MDS seems a more transparent and unambiguous approach. Referral guidelines, defined within clinical pathways, are an excellent starting point to determine the needed anatomical structures and as such for defining the MDS. (1) In this manner, the MDS can also be linked to the clinical question, which opens further possibilities to correct the DAK. (1,4,8,9) This subtle difference in detectability can explain the relation between published dose reductions (compared to filmscreen techniques) and the diagnostic task ahead. Reductions between 33% and 50% or even up to 75% for orthopaedic measurements have been reported, when image quality is based on MDS. (4) Therefore, the purpose of this study is to invest the required MDS and ascertain the relationship between the DAK and the MDS. This relation can be studied with a visual grading (VG), whose validity is high due to the inclusion of clinically relevant structures and anatomical background. However if not clearly defined in a procedure, these clinically relevant structures, the anatomy needed to diagnose, depends on the experience of the radiologist. (10) This link is problematic for the operationalization of the term image quality. Variations in exposure, patient anatomy or ‘anatomical noise’ and technical factors will create variations in the experienced image quality. (9,10) To perform evaluations, based on the imaging task, well-defined criteria are essential. (4,8) The use of observer preference (“what image do you prefer?”) can easily be argued against since the observer is free to choose any criteria, even criteria not related to the clinical question. (10) Therefore well-defined clinical image quality criteria (anatomical region that need to be fulfilled) were developed for a given type of examination in the conventional radiology. (5,7,9-11) Some of them are still applicable for digital studies. (4,5) Others, like the level of contrast in the image, a still used ‘feedback loop’, is not longer relevant. (4,6)

A visual grading (VG) simplifies the problem of evaluating clinical information by evaluating the reproduction of (important) anatomical structures in the clinical image. The possibility to detect pathological structures correlates to the reproduction or the visibility of normal anatomy. This is the basic idea of visual grading and it has been shown to agree both with methods based on ROC analysis and with calculations of the physical image quality. (7,10) An important advantage of a VG is its workload, i.e. a few hours, which is a less laborious com-
pared to the time consuming ROC-based methods. This lowers the threshold for performing a VG in clinical routine. (7,10,12)

2. METHOD

2.1 Database Radiographs

To assemble a database of radiographs all Flemish radiology departments, collaborating with the radiographers training program at the Hogeschool-Universiteit Brussel where addressed by letter. In this letter the purpose of the study and the enrolment of second year students medical imaging for the data collection was explained. These students received clear instruction and training in data collection prior to their clinical placement.

To assess image quality in orthopaedic radiography two incidences were selected: the anterior-posterior (AP) radiograph of the knee and pelvis. Radiographs of the pelvis with lead protection or the presence of two hip prostheses were excluded. For the knee AP no prosthetic material was allowed.

The radiographs were anonymized and stored on optical carriers. Next to the radiograph also additional information on positioning, patient’s morphology and technique were recorded. Subgroups are defined based on detector technology. In total 320 radiographs were collected 168 for the knee AP and 152 for the pelvis in 17 radiologic centres across Flanders.

2.2 Evaluation of image quality

An absolute Visual Grading Analysis (VGA) was used to judge and quantify the degree in which different anatomic structures were visible. (10,12,17) The anatomic structures to evaluate the Pelvis AP radiograph where collected from the guidelines published by the European Commission and in radiography textbooks. (7,10,18-20) As these guidelines didn’t comprise any criteria for the Knee AP, criteria were collected from different publications with a similar purpose. (18-22) Five experienced radiologists reviewed the two criteria sets during structured interviews until saturation. (Table 1)

<table>
<thead>
<tr>
<th>Knee AP</th>
<th>Pelvis AP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Visualization of the patella</td>
<td>1. Visualization of sacroiliac joints</td>
</tr>
<tr>
<td>2. Visually sharp reproduction of the tibial plateau</td>
<td>2. Visualization of the middle third of the iliac crest</td>
</tr>
<tr>
<td>3. Visually sharp reproduction of the intercondylar eminence and fossa</td>
<td>3. Visualization of the pubic and ischial rami</td>
</tr>
<tr>
<td>5. Visually sharp reproduction of the capitatumfibulae</td>
<td>5. Visually sharp reproduction of the trochanters</td>
</tr>
<tr>
<td>6. Transition of cortical to trabecular bone</td>
<td>6. Visually sharp reproduction of the Shevon's line</td>
</tr>
</tbody>
</table>

Table 1: Minimal detectable structures for the evaluation of the radiographs

When performing a VGA, the observer should focus on the evaluation of the image. Using pen and paper for reporting moves the focus, mentally and physically, to the evaluation protocol on paper. The constant shift between the reporting and evaluation of the image can result in a lack of concentration. (12) Therefore, six experienced radiologists scored both datasets for the six MDS’s with the computer program ViewDex® (Version 2.0) on a five-point scale (from 1 ‘bad’ till 5 ‘excellent’) where the mid-point was equalized to diagnostic image quality or the image quality that would be expected routinely when imaging cooperative patients. Next to the six criteria of MDS’s also the general appreciation of the radiography was surveyed. (8,10,12,17) All observations took place in a controlled environment on a standard workstation (Window7-64bit) equipped with a Barco's® Coronis display and Barco® QAWeb. The display operated within the boundaries of the AAPM TG18. (4,23)

Every observer received the instruction to observe the radiographs as in the clinical situation. Therefore, options like window/level, pan and zoom were available.(4) Prior to the VGA, each observer received a training dataset. Moreover, twenty radiographs were repeated to determine intra-observer variability. Results from the training dataset were discarded.

For each image a VGA score (VGAS) was calculated using the equation:

$$VGA = \frac{\sum_{i=1}^{6} \sum_{j=1}^{5} \sum_{k=1}^{5} G_{ijk}}{I \times S \times D}$$

(1)
where $G_{i,s,o}$ is the grading for image $i$, structure $s$ and observer $o$. The denominator is formed by $I$, the total number of images, $S$ for the number of evaluated structures and $O$ the number of observers in the study. This numeric expression, the Visual Grading Analysis Score (VGAS), defines the mean score over all observers and structures. The DAK was specified using the Signal Transfer Properties (STP) of the detector. These calculations were performed conform the protocol defined by the IPEM. Statistical analyses of the VGAS were performed using SPSS 19.0. A $p$-value < 0.05 denotes a significant effect. To compare VGAS between groups, ANOVAs were performed, followed by post hoc tests with Bonferroni correction to prevent capitalization on error. To analyse intra-observer variability a Pearson correlation is used. The inter-observer reliability is calculated with a non-parametric, rank-invariant Spearman correlation ($\rho$). The relation between the VGAS and the general appreciation of the radiography is investigated with a Pearson correlation. To relate the appreciation of each MDS to the general judgement about the image quality of the observer, a regression analysis is performed per observer.

3. RESULTS

The complete dataset for the knee AP was scored by six radiologists with a minimum of five-year experience in judging digital radiographs. However, due to a technical failure, the results for observer 4 were not recorded. Subgroups of radiographs, based on detector technology, are comparable in composition: a similar distribution in sex and no significant difference in BMI were noted. For the other factors (Table 2) a significant difference ($p<0.01$) is observed.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
<th>BMI</th>
<th>Tube Voltage [kV]</th>
<th>Tube Load [mAs]</th>
<th>FRA [cm]</th>
<th>DAK [µGy]</th>
<th>VGAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>96</td>
<td></td>
<td>48</td>
<td>48</td>
<td>25.65 ± 4.8</td>
<td>69.63 ± 4.8</td>
<td>30.39 ± 62</td>
<td>103.44 ± 5.95</td>
<td>4.08 ± 1.47</td>
<td>3.82 ± 0.38</td>
</tr>
<tr>
<td>DR</td>
<td>72</td>
<td></td>
<td>38</td>
<td>34</td>
<td>25.73 ± 3.45</td>
<td>64.28 ± 2.58</td>
<td>8.82 ± 3.97</td>
<td>115.16 ± 4.5</td>
<td>2.99 ± 2.14</td>
<td>4.07 ± 0.32</td>
</tr>
<tr>
<td>Total</td>
<td>168</td>
<td></td>
<td>86</td>
<td>82</td>
<td>25.68 ± 4.23</td>
<td>67.33 ± 4.79</td>
<td>20.56 ± 47</td>
<td>108.46 ± 7.92</td>
<td>3.63 ± 1.85</td>
<td>3.91 ± 0.39</td>
</tr>
</tbody>
</table>

Table 2: Results for the Knee AP

The anterior-posterior radiograph of the knee obtained an average VGA score of 3.91. A significant ($p<0.01$) difference between CR (VGAS 3.82 ± 0.38) and DR (VGAS 4.07 ± 0.32) was noted. Based on the Spearman’s Rho scores of each observer correlated strongly and significant ($p<0.01$) with the total VGAS-score (inter-observer reliability). Only one observer, had a rather weak correlation, but still significant (0.394, $p<0.01$) with the total VGAS. The intra-observer variability was not significant ($p>0.05$). No significant correlation between the DAK and the VGAS was found, neither for CR (-0.005; 1.61µGy–5.48µGy) or DR (-0.109; 0.43µGy–6.18µGy).

The same radiologists evaluated the dataset for the Pelvis after ending the dataset of the knee AP. The subgroups are comparable in composition (no significant difference between groups for gender or BMI). No significant difference in tube voltage is noted. The other factors (Table 3) are significant different ($p<0.01$) between CR and DR. Only for radiographs produced with computed radiography, a rather weak but significant ($p<0.01$) correlation (0.42) was found between the DAK (1.65µGy–5.29µGy) and the VGAS.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
<th>BMI</th>
<th>Tube Voltage [kV]</th>
<th>Tube Load [mAs]</th>
<th>FRA [cm]</th>
<th>DAK [µGy]</th>
<th>VGAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>68</td>
<td></td>
<td>28</td>
<td>40</td>
<td>25.87 ± 4.57</td>
<td>78.63 ± 5.16</td>
<td>69.4 ± 61.99</td>
<td>104.02 ± 11.16</td>
<td>4.14 ± 1.56</td>
<td>3.49 ± 0.48</td>
</tr>
<tr>
<td>DR</td>
<td>84</td>
<td></td>
<td>35</td>
<td>42*</td>
<td>24.57 ± 3.29</td>
<td>77.17 ± 6.31</td>
<td>21.66 ± 15.3</td>
<td>128.07 ± 16.15</td>
<td>2.67 ± 2.03</td>
<td>2.67 ± 3.9</td>
</tr>
<tr>
<td>Total</td>
<td>152</td>
<td></td>
<td>63</td>
<td>82</td>
<td>25.18 ± 3.98</td>
<td>77.82 ± 5.84</td>
<td>42.85 ± 48.9</td>
<td>117.4 ± 18.51</td>
<td>3.34 ± 1.97</td>
<td>3.71 ± 0.51</td>
</tr>
</tbody>
</table>

Table 3: Results for the Pelvis AP

*7 cases didn’t report the sex of the patient
The general VGA score for the pelvis AP was equal to 3.71. The VGA score for CR (VGAS 3.4 ± 0.48) and DR (VGAS 3.9 ± 0.45) were significantly (p<0.01) different. The Spearman’s Rho indicates strong and significant (p<0.01) correlations between the general appreciation of the image quality by the observers and the VGAS. The intra-observer variability’s are not significant (p>0.05).

### Table 4 VGAS and mean general appreciation per observer and correlations between both

The majority of the observers succeeded to predict their VGAS to a significant degree, but the correlation between the VGAS and the question inquiring the general appreciation is not high enough to use it as a good indicator for the VGAS. Only two observers, for the knee AP, and one observer for the pelvis reached a strong and significantly correlation between both (r>.70). In addition, regression analyses shows that, for the knee AP, observers not only weight the criteria differently in relation to their general appreciation, but also base this judgement on a different subset of the presented criteria. The visualisation of the patella has (MDS1, see table 5) play the most important role in determining the general appreciation of the image. Similar regressions for the pelvis per observer shows that the visualisation of the sacroiliac joins, the middle third of the iliac crest and the trochanters play a considerable role in the general appreciation for most observers. However, also here important differences between radiologists are observed. Furthermore, the level of explained variance weakens for the pelvis, which may be linked to the higher anatomic noise in the image. Note here that observer 6 in both cases, had a negative, but non-significant, correlation.

### Table 5: Regression per observer of MDS on general appreciation of image quality: standardized regression weights and explained variance, Knee

<table>
<thead>
<tr>
<th>Observer</th>
<th>MDS1</th>
<th>MDS2</th>
<th>MDS3</th>
<th>MDS4</th>
<th>MDS5</th>
<th>MDS6</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.08</td>
<td>0.25</td>
<td>0.06</td>
<td>0.09</td>
<td>0.05</td>
<td>0.33</td>
<td>0.61</td>
</tr>
<tr>
<td>2</td>
<td>0.17</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.05</td>
<td>0.09</td>
<td>0.14</td>
</tr>
<tr>
<td>3</td>
<td>0.27</td>
<td>0.16</td>
<td>0.13</td>
<td>0.10</td>
<td>-0.19</td>
<td>0.16</td>
<td>0.29</td>
</tr>
<tr>
<td>5</td>
<td>0.07</td>
<td>0.17</td>
<td>0.14</td>
<td>0.43</td>
<td>-0.01</td>
<td>0.03</td>
<td>0.5</td>
</tr>
<tr>
<td>6</td>
<td>0.24</td>
<td>0.06</td>
<td>-0.06</td>
<td>0.22</td>
<td>0.06</td>
<td>-0.17</td>
<td>0.13</td>
</tr>
</tbody>
</table>

*p<.05, **p<.01*

### Table 6: regression per observer of MDS on general appreciation of image quality: Standardized regression weights and explained variance, Pelvis

<table>
<thead>
<tr>
<th>Observer</th>
<th>MDS1</th>
<th>MDS2</th>
<th>MDS3</th>
<th>MDS4</th>
<th>MDS5</th>
<th>MDS6</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.14</td>
<td>0.08</td>
<td>0.04</td>
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*p<.05, **p<.01*
4. DISCUSSION

The general VGA Score of all observers for the both datasets is higher than 3, i.e. higher than 'appropriate for diagnostic purposes'. When correlating the image quality with the signal-to-noise ratio and therefore with the patient dose, we can suspect an overexposure of most of the patients. Though the strong correlation between the VGA Score of the observers for both group, indicates that the criteria that are setup for both image groups are clearly defined and unambiguous for the observers. Meaning that the MDS-approach results in for a more stable and reliable evaluation of image quality between different observers.

When the observers score the 'image quality' defined as 'General Appreciation' there is much smaller correlation between them. Regressions analysis and the correlations indicate that the apparition of the image quality is generally judged based on the visualisation of 1 to 3 structures like the patella, the sacroiliac joints or the middle third of the iliac crest. All of these structures are characterized by a high level of anatomic noise due to the superposition with bone or large amounts of soft tissue, in comparison to the other evaluated structures of MDS. As expected, observers use their own intuitive combination of self-chosen criteria to define 'image quality'. Hence, their judgement is based on different anatomical structures and imaging limits.

Optimising image quality based on a general judgement can therefore easily result in an increased DAK to satisfy the noise levels in these regions and to satisfy individual preferences of the evaluating radiologists.

The design of optimisation strategies demands a common language between the three actors: the radiologist, physicist and radiographer. The use of MDS encourages a better communication between radiographer and radiologist. Recoding the ‘to deliver image quality’ (visualisation, sharp reproduction) in the evaluation of specific MDS stimulates an output-management of radiographers. As such, the use of MDS promotes not only a better communication but also a common baseline needed for clear quantification of image quality by physicist in order to be able to design of new optimisation protocols.

5. CONCLUSIONS

The VGA revealed an image quality higher than diagnostic necessary in both datasets. The evaluation of image quality based on assessment of the MDS delivers a high correlation between observers. As described in the literature the overall question inquiring the general appreciation of the radiograph, is not conclusive. As expected, a significant difference in VGAS rated image quality between the CR and DR was noted for both datasets. This proofs that a ‘paint by the numbers’ approach, like the systematic evaluation of MDS, is more reliable to evaluate image quality. On the other hand, there was no significant correlation between the VGAS and the DAK within these subgroups. Based on the absence of a correlation with the DAK an overexposure is suspected. This supports the need for specific training of radiologist to understand digital image quality and describe MDS, in such a way radiographers can optimise the procedure to achieve this level of image quality with a minimal patient dose. Here for radiologist need to have knowledge of technical foundations of digital radiography and possible optimisation strategies. These findings also illustrate the need for multidisciplinary collaboration between radiologist, physicist and radiographers to achieve optimal clinical use of digital detectors.

REFERENCES


TOWARDS THE SUSTAINABLE SYSTEM OF EDUCATION AND TRAINING FOR BUILDING COMPETENCE IN NUCLEAR AND RADIATION SAFETY IN BELARUS

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ABSTRACT

The new vision on the system of education and training in nuclear and radiation safety in Belarus is under working out. Launched in 2008 the undergraduate education and training programme on Nuclear and radiation safety is subjected to the revision now. The duration of training is changed from 5,5 years to 5, the new content is to be included into the syllabus and training – many of issues have become much more clear to trainers after a series of education and training events donated by the Belarus Government and IAEA. There is the new two year Master programme authorized in 2012 to be started in 2013. The renovation of PGEC course on radiation, transport and waste safety is on practical way to be finished in 2013. That is why the harmonization of the educational content at all levels and between all parts of the education and training system on radiation protection in Belarus is required in accordance to up-to-date international approach and real demand at national and regional level. One of the most urgent and important things to do is to adjust the appropriate re-training and professional updating of specialists for regulatory authority and its technical organization – Joint institute of energy and nuclear research – “Sosny” of Belarus national academy of sciences. The approach to the training content in compliance to the requirements to knowledge and skills for different kinds of professional training in nuclear and radiation safety is considered.

1. Introduction

Education and training on radiation safety was carrying out in Belarus for dozens of years, first of all, in the form of short time courses (1-2 weeks) and within the different re-training programmes in favour to support, first of all, radiation protection services. After Chernobyl accident the problem of education and training professionals who would be able to assist to the government in its efforts to mitigate the consequences of Chernobyl affects had been raised. The reaction on this challenge was the foundation of the International Sakharov College on Radioecology in 1992. The college in short time was rapidly developed into the institute and then into the International Sakharov Environmental University (ISEU). During 20 years ISEU has trained more than 800 specialists in radioecology, radiobiology and radiation medicine. It becomes one of the leading institutions in Belarus that supervises the major part of training in the field of environmental science and technologies and technical support to the human health as well.
The new step in developing education and training in the field of radiation safety and related activities is having pushed forward in Belarus by growing demand to use radiation sources especially in medical applications and by decision of the Belarus government to introduce the nuclear power. Owing the system of education and training in the field of radioecology and radiation protection developed earlier manly to mitigate the Chernobyl accident consequences, the country is changing the paradigm of that going along the road of establishing (renovating) education and training for nuclear power. Since 2007 the State Programme on the human resources development for nuclear power is functioning. This Programme comprises 4 higher institutions (Belarus State University, Belarus National Technical University, International Sakharov Environmental University, Belarus State University of Electronics and Computer Science – see Fig. 1) and the number of special secondary colleges of the Ministry of Education, Joint Institute on Power Engineering and Nuclear Research of the National Academy of Sciences of Belarus, Ministry of Power Engineering, Ministry of Health. Main radiation protection issues are given to all the trainees but the specific focus is allocated within the specialty “Nuclear and radiation safety” established at the 1st stage (undergraduate higher education), the 2nd stage (master courses) and the post-graduate re-training course on “Radiation protection and safety of radiation sources”. The last one is mainly conducting in co-operation with IAEA whose contribution to the course is crucial and sufficient.

Fig. 1. Four main institutions of Belarus involved in education and training for nuclear energy

The “center of mass” of education and training in nuclear, radiation, transport and waster safety in Belarus is concentrated in International Sakharov Environmental University. There is the capacity to cover training demand of neighboring countries and countries where radiation protection staff uses Russian. First of all they are former Soviet union countries: Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Ukraine, Uzbekistan, Tajikistan, and also some countries of the Eastern Europe like Bulgaria and countries of former Yugoslavia.

The role of ISEU is strengthening by the recent decision to introduce the education and training of radiation medical physicists in Belarus. The decision was caused by growing use of radiation sources in medicine challenged by increasing number of cancer events discovered by medical institutions among population of the country. ISEU possesses academic staff well experienced in different fields from physics and
engineering to biology and medicine. That is why it was committed to establish the undergraduate programme on medical physics that is reported in another publication. The problems to be solved within the system of education and training on nuclear and radiation safety and medical physics were not met before in Belarus. One of them is to create the entire system of education and training in the field in which at each level including re-training and professional updating the education and training should be tightly connected with previous levels and their syllabi should be developed at the new basis [1,2] and harmonized with each other. This problem should be solved within the current legal basis (look at, for example, [3-7]) taking into account up-to-date achievements in the field of nuclear and radiation safety [1,2]. Document [6] is issued very recently, in the end of 2012, is recalling the GSR-3 [2] and is adopted to the national peculiarities. So existing educational standards must be reconsidered and adjusted to the new requirements correspondent to the basic IAEA documents [1,2] in the nearest future. Thus, there is the big challenge to build up the renovated structure of education and training system on nuclear and radiation safety in Belarus. It should be done via establishing a consistent national strategy that due to experience gained by Belarus takes into account, among other things, the regional needs.

2. The experience of Belarus in education and training on nuclear and radiation safety

Up to 2008 education and training specialists on radiation safety was carrying out mainly in ISEU within the specialty «Radioecology» and also within special blocks «Radiobiology», «Radiation epidemiology» of the specialty «Medical ecology». Some elements of professional education in radiation safety are given in the specialty «Environmental agriculture», that is hosted in Belarus state agriculture academy and in the number of specialties within the medical training and re-training. The current situation in the field of education and training on nuclear and radiation safety in Belarus is shown below.

a. Training in nuclear and radiation safety

The specialty “Nuclear and radiation safety” with qualification “engineer” awarding to graduates was designed in Belarus in the beginning of 2008 and aimed to train specialists with higher education that will be able to work both in nuclear safety and radiation safety and in case of radiation safety not only at nuclear power plants but also in any other applications of ionizing radiation sources, radiation monitoring and radioactive waste management. The total duration of studying is 5 years since 2013.

At the second level of higher education, for the Master’s course we have 2 options.
1) The student can enter the so called ‘scientific and pedagogical’ 1 year course on Nuclear and radiation safety.
2) Very recently, the justification of special 2-year Master programme that oriented to train specialists for regulatory authorities, definite institutions where more deep professional training is required.

The second programme is built in accordance with IAEA recommendations work out for Master courses on nuclear and radiation technologies.

b. Post-graduate educational and training course on radiation protection and safety of radiation sources

The Post-graduate educational and training course on radiation protection and safety
of radiation sources (PGEC) is made upon the Standard Syllabus worked out by IAEA and lasts 5.5 months for the full time education. There are also options of evening and even correspondent education at the course with extended duration. At the end of the course participants defend the project work for specific area of radiation protection and according to the decision of the State commission are awarded by the diploma on re-training with qualification "Radiation protection specialist". This qualification is higher than Radiation protection officer qualification but intermediate between it and regulatory authority specialist.

c. Establishing education and training in medical physics
The draft of academic plan on "Medical physics" is described in [10]. It anticipates the synergism of the university training in physics and major issues related to life sciences and health studies like physiology, genetics, biophysics and biochemistry, internal diseases, basic oncology, physical methods of diagnostics of diseases etc. Special radiation medical physics programme can be, probably, start only at the 4th year. The special clinics will be as the base for practice of students. At the end of studies graduates will defend the diploma work and will be awarded by the diploma with qualification "Medical physicist".

d. Short courses available
There are several short time (1-2 weeks) training courses available for professional updating in the field of radiation protection providing not only by ISEU but by some other institutions. They are:
- professional training courses for different radiation protection workers and specialists:
  - in industry (National Institute on Higher Education – NIHE, ISEU, Belarus – Russian University – BRU, and also the «Institute of re-training and professional updating» of the Ministry of Emergency of the Republic of Belarus);
  - in public health (NIHE, Belarus Medical Academy of Post-Graduate Education – BelMAPO).
Moreover, the knowledge on elements of radiation safety are included in:
- discipline «Civil protection in emergences. Radiation safety» for all higher educational specialties in the Republic of Belarus;
- programmes of professional updating of labor safety specialists, lecturers of higher education institutes and secondary colleges (NIHE),
- agriculture specialists (Belarus Academy of Agriculture, Belarus State Agriculture Technical University);
- medical specialists including nurses (BelMAPO).
ISEU staff is attracted to take part in many of the courses on radiation protection.

e. Physical infrastructures and human resources
ISEU has good facilities to conduct many kinds of training courses on radiation protection. They are:
- laboratories equipped by up-to-date radiation measuring equipment (Semiconductor gamma-spectrometers – 4, liquid scintillation spectrometer, scintillation beta-gamma-spectrometers and radiometers, gaseous counters, alpha-spectrometer, dosimeters of different kinds, equipped radiochemistry lab, etc.);
- lecturing and computer rooms
- field station in radioactively contaminated area
- training materials in Russian
- educated and skilled personnel for training and organizing training course.
About 120 local lecturers and instructors are usually attracted to perform the PGEC. Many of specialists in specific topics are attracted from other institutions in Minsk and Gomel (regional center of Belarus). They are:

- Institute of Physics, laboratory of nuclear physics
- Institute of Power Engineering and Nuclear Problems (reprocessing spent fuel, neutron generator, industrial accelerators and other irradiators, etc.)
- Radioactive Waste Storage Facility “Ecores”
- Institute of Radiobiology
- Institute of Radiology
- Centre of Radiation Medicine and Human Ecology
- Centre of Oncology and Medical Radiology
- BELSTANDART – office for standard radiation measurements
- Central Laboratory for Environmental Radiation Monitoring of hydrometeorological service
- ATOMTECH – the leading enterprise producing radiation measuring equipment
- ATOMNADSOR – regulatory authority of Belarus in radiation protection and safe use of radiation sources
- laboratories of Polessky Radioecological Reservation
- Radiation laboratory of the Ministry of Forestry
- Centre for Emergency Response of the Ministry of Emergency
- Border Guard Centre for illicit traffic control.

f. Some highlights

There were 7 PGEC courses held since 2001 (2001: 9 weeks, 2002: 18 weeks, 2004 – 2005: 21 weeks, 2005 – 2006, 2006 – 2007, 2008, 2009 – 2010: 22 – 23 weeks). 141 of participants from 19 countries finished them successfully. There is the 8th PGEC going on now for 13 specialists from 9 countries. Collaborating Centres and Institutions count 22 organizations and enterprises which specialists and facilities are involved in the PGEC. There is one week field practice in exclusion zone in Khoiniki nearby the Chernobyl nuclear power plant.

32 participants finished the short course (2 weeks) on emergency monitoring.

g. Master courses

There is Master course on nuclear and radiation safety started in 2006. In 2012 the separation of the Master level of education onto two types had happened:

- master courses for scientific and pedagogical activities (1 year);
- master courses for innovative activities (1-2 years).

For this occasion together with the Master course on nuclear and radiation safety (scientific-pedagogical profile) the new specialty for two year education at the Master level “Safety of nuclear and radiation technologies” is introduced that is within the new Code of education [3].

The preparation of new syllabi for these specialties is in progress now. It is carried out within the principles and considerations described in the Section 3. The main concepts and findings in this way are considered in the Section 4.

3. To sustainability of education and training system for nuclear and radiation safety in Belarus

Building up the new system of education and training in nuclear and radiation safety in Belarus the following principles that are referent to the analogous basic principles of radiation safety are put in place:

- justification of content of forms of training that is based on strong analysis
of training needs including tacit needs of particular branches and activities related to
the nuclear and radiation safety;

- optimization of forms and methodologies of training with respect to
  competences and internal logic of the subjects to be studied to minimize the time of
  training and harmonise theoretical knowledge with practical skills to be gained;

- systematic approach to education and training to sustain interconnection,
  continuity and necessary completeness of education and training at each level of
  education.

These principles reflect basic elements of the strategic approach to education and
training work our by the IAEA [8,9].

According to these principles the main flow to educate and train specialists on
nuclear and radiation safety and related topics for the Republic of Belarus can be
realised within the scheme shown at the Fig. 2.

![Fig. 2. Provisional flow of education and training in nuclear and radiation safety and related topics.](image)

At the level of specialized training courses there two of them might be the most
important: «Control and non-proliferation of nuclear materials», and «Radiation
medical physics».

The access to the radiation safety branch should not be forbidden for specialists from
other branches jobs of that may be interfered with use of radiation sources or with
work in regulatory authorities, in analytical laboratories that control the situation in
environment of the radioactive pollution of food, health surveillance, etc.
This scheme is not finished yet. Many of different professional updating courses are not included in it. There are also some difficulties to realise this scheme because of some lacks of Belarus legal system. For instance, people, who are occupied the positions of technical staff in clinics can not go to re-training to become medical physicists because they will lost their salary for rather long period (1,5 year). The same assumptions should be taken into account while designing any master level course for some target group of professionals needed to enhance their knowledge and skills to occupy higher positions in the future. Correspondent and evening forms of study do not assist to acquire appropriate knowledge and skills.

4. New academic plans and educational standards for different courses on nuclear and radiation safety and related topics

As it was mentioned above there are 3 major directions now in Belarus to work out academic plans and appropriate educational standards in nuclear and radiation safety and related topics:

- specialties of the undergraduate level:
  - “Nuclear and Radiation Safety” – to be renovated in accordance to new safety requirements [1,2,6];
  - “Medical Physics” – to be developed (see ref. [10]);
- specialty of the post-graduate level “Radiation protection and safety of radiation sources” – to be renovated in accordance to new safety requirements as recommended and drafted by IAEA;
- specialty of the Master level “Safety of nuclear and radiation technologies” – to be developed.

The main content of the syllabi for undergraduate specialties mentioned above is formed. It is done at the same firm basis of deep training in higher mathematic, basic computer science, general physics and chemistry that demonstrated in [10]. In opposite to medical physicists specialists in nuclear and radiation safety should be engineers and must study many of engineering subjects like computer design, mechanic of continuous media, applied mechanics, power engineering, nuclear reactors, nuclear safety, exposure situations, emergency preparedness and response etc. The specialty “Safety of nuclear and radiation technologies” is designed close to the IAEA recommendations done by IAEA advisory group worked out the appropriate draft material to harmonize approaches of different countries at the tertiary level.

The programme briefed above will be realised during forthcoming two years.

5. Towards to establishing the national strategy

There are several elements of the national strategy on education and training in radiation protection in Belarus. Thus there is the State programme of education and training for nuclear energy, in place since 2008, including the specialty «Nuclear and radiation safety» aimed not only for nuclear energy but also for other radiation applications.

The system of professional education (secondary and tertiary levels) is governed by educational standards and academic plans endorsed by the Ministry of Education (second generation).

There are only academic plans authorized by the Ministry of Education and profiled Ministries in the system of re-training and professional updating for now. The procedure of establishing educational standards and new academic plans related to
them for the field of re-training and professional updating has been started recently and will be finished this year.

Quality control of the education and training is traditionally carried out by the established procedure of appraisal and accreditation (1 time in 5 years). There is the special body in the Ministry of Education for this purpose – the Department of the quality control of education and training. During a week or two weeks special commission headed by an officer of the Department together with specialists invited from other institutions and professional bodies assess the following:

- the quality of academic process (organizing flow, documentation, quality of knowledge of trainees – by written examination of students, questionnaires for students and teachers, etc.);
- the state of art in carrying out research, use of the research findings in education and training;
- the education and training infrastructure (premises, equipment, their sufficiency, conditions of use, etc.);
- effectiveness of the administration management, including organization chart, sharing responsibilities, interaction between the chart blocks and elements, logistic flows, internal quality control system, etc.

The Quality Management System (QMS) and control according to ISO 9001 is introducing since 2009 in all the higher education institutions and organizations providing re-training and professional updating. All leading universities and organizations providing training in radiation protection are certified now within the QMS.

Belarus via ISEU can play a co-ordination role in the process of finding consensus in solution of these problems. Those countries that needs the consultancy and advise for establishing their national education and training programmes in radiation protection can apply for advise to the ISEU.

The analysis made shows that there is the need to develop the education and training system in the field of nuclear and radiation safety and related topics and there is some starting background for that. Meanwhile, she existing system and the future scheme designed on the Fig. 2 can not work in sustainable way without allocation of money through a state programme and attraction of foreign students and participants. That is why IAEA recommendations in building national strategy on education and training [11,12] are crucial to reach this goal.

The following elements of the national strategy important to be recognised that the strategy is in place can be extracted from [1,11,12] and listed in the following:

1) *publishing President or Government Bill on adherence* to the policy of establishment and maintenance of the education and training system in the field of nuclear and radiation safety with respect to all up-to-date achievements and requirements;

2) *creation of legal and organisational infrastructure* (mechanisms) to functioning of the cycle education and training process [12];

3) support of international co-operation of national organizations, taking part in the process of maintaining competences, with appropriate counterparts from other countries and IAEA;

4) allocation resources necessary for long-term functioning of the system taking into account possible changes in the country.

The item 1) is not realised in Belarus yet, but other requirements 2) – 4) are not fully reached.

The key problem to implement the position 2) is the absence of clear and well defined system of assessment of the training needs in the country. According to [3],
Article 57. the order to define training needs must be established by the Government. But the Government recently committed to do this work to the Ministry of education and the Ministry translated this commitment to higher institutions. But the institutions have not enough competence to apply to organisations directly especially in the field of nuclear and radiation safety. Their ministries or other relevant leading bodies should give them the clear order and help to assess their real needs.

The tool proposed by the IAEA in [11] by completing the table with indication how many qualified experts, radiation protection officers, qualified operators should be trained in forthcoming 5 years for each particular activity provides only the clear structure of data to be collected. But data collection mechanism is remained the same endpoint: to collect official answers from official representatives of organisations on how many specialists of different kinds their organisations need. There is a risk to get a judgment taken ‘looking to a ceiling’ not based on real analysis of the situation in the organisation. It is desirable to have an independent tools to reveal real needs and even tacit needs applicable in each organisation.

Such a tool if it really exists could be discovered only by a group of experts. Despite of that special advisory group on education and training in nuclear and radiation safety and related topics subordinated directly to the government is needed to:

1) work out the draft of declaration of adherence of Belarus authorities to establishing nuclear and radiation safety education system;
2) prepare proposals how to change the national legislation to strengthen implementation of basic safety principles including the policy in education and training;
3) develop and carry out appropriate databases on real demand of different sectors of economy in specialists on nuclear and radiation safety;
4) monitor the situation in the system of education and training on nuclear and radiation safety and
5) develop proposals to enhance the system of education and training;
6) collect and refresh the information about Belarus for Radiation Safety Information Management System of IAEA;
7) assist international co-operation of Belarus with other countries and IAEA in the field of nuclear energy, nuclear and radiation sciences and applications, nuclear and radiation safety.

6. Conclusions

There are many of elements of national education and training system for nuclear and radiation safety and related topics in Belarus. To finalise the forming the sustainable system of education and training the activities decribed in section 5 should be entertained. For this purpose the creation of good acting advisory group subordinated directly to the Government of Belarus is desirable.

References


IMPLEMENTATION OF ISO 29990:2010 MANAGEMENT SYSTEM FOR PROVIDERS OF LEARNING SERVICES IN NON-FORMAL E&T ON RADIATION PROTECTION

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\textbf{ABSTRACT}

An effective national strategy on Education and Training (E&T) in radiation protection presupposes that the organization providing the E&T, has a well established Quality Management System (QMS). Recently, the Department of E&T of the Greek Atomic Energy Commission has been focused on the accreditation of its management system based upon the ISO 29990:2010. This quality system specifies basic requirements for providers of learning services in non-formal education and training. This demands the involvement of scientific personnel, expert tutors, external experts in quality and auditing, under the supervision, guidance and financial support of the departments' administration.

The management system mainly focuses on: (a) Learning Services and (b) Management of the Department of E&T as a learning service provider. Concerning the learning services the system focuses on: determining learning needs, as well as, design, provision, monitoring delivery and evaluation of the learning services. The management of the Department of E&T also supports and is supported by the developing management system of GAEC, (ISO 9001:2008 and IAEA GS-R-3). A fully customized management system was developed and implemented, ensuring that all the personnel involved is the best suited, the services delivered meet the high standards set by the department's administration regardless of the personnel involved and that all aspects of the department's operations are fully documented, regularly reviewed and all the necessary adjustments and improvements are met. The work being done could be also used as a stepping stone in the transition to a formal system (within Greek official education structure).

The experience gained from the development and implementation of the QMS is presented in this work.

1. Introduction

The need for the implementation of a management system derives directly from the responsibilities of a regulatory body according to the [1]. The regulatory body, among other crucial responsibilities has to establish, implement, assess and strive to continually improve a management system that is aligned with the goals of the regulatory body and that contributes to the achievement of those goals. According to the [1] the term ‘management system’ reflects and includes the concept of ‘quality control’ (controlling the quality of products – learning services in our case) and its evolution through ‘quality assurance’ (the system for ensuring the quality of products) and ‘quality management’ system (the system for managing quality).

The requirements for establishing, implementing, assessing and continually improving a management system are described in the IAEA Safety Requirements Publication [2].

At the moment the Greek Atomic Energy Commission (GAEC) does not implement an integrated documented management system, as it is defined in [2]. For that purpose, GAEC has initiated actions for the certification of all its activities according to ISO 9001:2008 [3]. However, a quality management system based on ISO accreditation has been established in
GAEC for some of the services provided, since 2003. More specifically, its services that are accredited under the terms of ISO/IEC 17025 [4] are the following:

- individual monitoring;
- calibration of equipment;
- gamma spectrometry measurements and
- non-ionising radiation measurements

Moreover the GAEC inspection activities have achieved an accreditation according to the terms of ISO/IEC 17020 [5], in 2011. The GAEC department of education and training was recently certified under the terms of ISO 29990:2010 [6].

All CAEC activities for which a quality management system exists will be brought together in a coherent manner, since the basic regulations, standards and documents of relevance are common or based on the same principles. In this context the management system of the education and training department, supports and is supported by the GAEC management system.

In this work the implementation of ISO 29990:2010 management system in GAEC department of education and training is described.

2. The ISO 29990:2010 standard

The specific standard was selected due to the fact that provides a generic model for quality professional practice and performance and a common reference for learning service providers in the design, development and delivery of non-formal education, training and development. According to this standard, the vocational training, life-long learning, in-company training (either outsourced or in-house) could be considered examples of non-formal education.

The scope of this standard is in agreement with the mission, the vision and the policy of the GAEC’s department of education and training, as a learning service provider. As far as the policy of the department is referred, it is noted that the department is fully committed to ensure professional competence on radiation protection for people involved with facilities and activities, promoting at the same time professional success of its learners. The department, therefore, develops, provides and continuously improves its educational programs in order to satisfy changing needs of the learners, employers and community.

The implementation of the system consists of procedures and documents which focus on two main aspects of the department:

(a) the learning services provided and
(b) the management of the department

In each procedure the responsibilities of individuals or group of individuals are defined. Indicatively it is referred that responsibilities for the head of the department, the scientific and the administrative personnel are clearly defined. Moreover, in the frame of this management system, a learning services committee and a quality committee have been organized and their responsibilities are clearly defined, as well.

3. Learning services

The management system established provides the following steps for the design, provision and evaluation of the learning services:

(a) determining learning needs;
(b) design of the learning services;
(c) provision of the learning services;
(d) monitoring the delivery and evaluation of the learning services which form a Plan-Do-Check-Act (PDCA) cycle [6].

3.1 Determining learning needs

Prior to the learning services offering, and in order to orientate these effectively, a learning needs analysis is conducted.
The analysis is performed by the scientific personnel of the department in collaboration with the GAEC’s scientific personnel. The learning needs are defined either on the basis of an established national strategy for education and training in radiation protection [7] or independently as a result of the technological innovations, legislative reformation, industry orientation, extraordinary or emergency situations. Learning needs can also derive from requests of third parties.

In any case, a comparison between the knowledge and the experience level of the learners and the legislative demands or the desired levels is performed. Figure 1, schematically presents this procedure-comparison.

![Diagram of the learning needs analysis process](image)

**Fig 1.** The procedure of the learning needs analysis in the frame of the management system of the department of education and training.

### 3.2 Design of the learning services

After having determined the learning needs, the procedure of designing the learning services is initiated. With this procedure the department ensures that the learning content and process take into account the predefined needs, while the learning methods and materials to be used are appropriate, accurate and sufficient to meet the stated goals.

To this end, different model learning services appropriate for the needs of different ‘target groups’ (e.g. medical radiological / nuclear medicine technologists, industrial radiographers, workers in transfer of radioactive materials etc) are prepared. For each model learning service a curriculum is developed by the scientific personnel of the department and is approved by the head of the department. The curriculum consists of:

(a) A syllabus of the learning service.
(b) Lesson plans in which the methods to be used are defined. The methods respond to the aims and requirements of the curriculum and are different for each group (e.g. presentations, laboratory exercises, on the job training).
(c) Training material – material for the trainers and the trainees.
(d) A list of the approved trainers.
(e) Evaluation methods (e.g. exams material, anonymous questionnaires).
(f) Administrative documents (e.g. attendance certificates, certificates, cost lists).

### 3.3 Provision of the learning services

The communication of the learning services to all the involved parties (trainees, trainers, third parties) as part of their provision, as shown in Figure 2, occupies an important position in the management system of the GAEC’s department of education and training.

Responsible for that procedure is the administrative personnel of the department, which ensures that all parties have understood their responsibilities, the purpose, the format and
content of the learning service including the means of evaluation. The administrative personnel is also responsible for ensuring that all resources defined in the curriculum are available and can be accessed by the learners.

Documents with the status and the working or scientific background of the participants are always filled before the delivery of the learning services with responsibility of the administrative personnel.

Fig 2. The procedure of providing the learning services.

3.4 Monitoring the delivery and evaluation of the learning services

Responsible for monitoring the delivery of a learning service is a representative of the department and might be a scientific member of the department or a scientific member of the GAEC. In this way, the department ensures that feedback is requested from the learners and the trainers on the methods and resources used, as well as their effectiveness in achieving the predetermined aims.

The results of the evaluation procedure, which are elaborated by the scientific personnel of the department with the supervision of the head of the department has two main aims:
(a) To measure and analyze the extent to which the individual learners are achieving, or have achieved, the learning outcomes of the learning service.
(b) To measure the effectiveness and quality of the learning service itself.

For performing the first analysis, the results of the learners’ exams are used, while for the second analysis the answers in the questionnaires.

It is important to note that for each learning service, the department has also installed a system for handling complaints and appeals. All participants and third parties are informed for the existence of such a system.

4. Management of the department of education and training

According to the international standard that was adopted the management system established should be documented and should be ensured that it is understood, implemented, maintained and reviewed.

The management system developed in the GAEC department of education and training satisfies this condition via a series of documented procedures that are developed and implemented using the ISO 9001:2008 [3] ‘culture’. A member of the administrative
personnel is defined to be responsible for keeping the system up to date and for communicating it to all relevant personnel, according to the existing procedures.

The management system implemented consists of procedures for:

(a) The document and record control. In this way the transparency, accuracy, relevance, circulation and security of the documentation is ensured.

(b) Communicating (informing, consulting and training) the management system to all the involved parties (internal and external).

(c) The review of the system, at least once per year in meetings with the participation of all the members of the department. In this way the management system continuing suitability, adequacy and effectiveness, including the stated policies and objectives related to the fulfillment of the aims of the department and the GAEC. Motivations of such a meeting could be: the results of internal and external audits, the feedback from interested parties, the results of evaluation of the learning services, the status of preventive actions and corrective actions, follow-up actions from previous management reviews, any changes that could affect the management system, any appeals and complaints, as well as the handling of them.

(d) The identification and management of nonconformities. Their root causes are analyzed in order to prevent recurrence and to organize preventive and corrective actions.

(e) Internal and external audits. The existence and implementation of internal audits ensures that the management system is being effectively implemented and maintained. Internal audits are conducted by suitably qualified persons, while auditors do not audit their own work.

(f) Handling complaints and appeals as mentioned above in section 3.4.

5. Conclusions

The appropriate international standards, a lot of hard work, insight and a clear vision in regards of the future of non-formal education, has led to the development and implementation of a fully customized management system ensuring the identification of learning needs, the design of learning content and processes, the provision and evaluation of the learning services. At the same time the management system makes certain that all services delivered meet the high standards set by the administration of the department, regardless of the personnel involved. The existing processes guarantee that all personnel involved is the best suited and that all the department operations are fully documented, regularly reviewed and all needed adjustments and improvements are met.

Important steps for the proper development and implementation of a management system that meets the requirements of ISO 29990:2010 may include:

- Determination of a management representative
- Establishment of processes and documentation of the management system
- Provision of learning services in accordance with the established processes
- Measurement of the efficiency of the provider and the compliance with the procedures
- Identification of opportunities for improvement
- Internal and external audits and identification of non-conformities
- Management review meetings
- Maintenance and continuous improvement of the management system

Finally it is referred that the development, implementation and certification of the management system meeting the requirements of the ISO 29990:2010, places the GAEC department of education among the few organizations worldwide certified as such (31 by
January 2013 according to the World Register of ISO 29990:2010 Certificates), while it should be noted that the work performed and the experience gained could be used as a stepping stone in the transition to a formal system, within the official education structure of Greece.

6. References
1. IAEA Safety Standards Series No. GSR Part 3 (Interim), Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA, Vienna 2011
4. ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories
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6. ISO 22990:2010, Learning services for non-formal education and training – Basic requirements for service providers
DESIGN FACTORS WITH ICT TOOLS IN COURSES TO TRAIN THE TRAINERS

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ABSTRACT

The need for continuous training in a no-formal way or getting proficiency in a formal way over a lifetime about any particular subject, the technological development, the increased social demand for education, have introduced critical issues that require comprehensive responses more flexible than conventional training. As a result of these, now a days, it is possible the coexistence of different modalities and strategies of teaching and learning with the incorporation of information and communication technology (ICT). Some possible options for training, in special in higher educational levels, are: virtual campus, blended education systems, networking designed content materials, several ways of communication modes, distance students assessment in order to create meaningful learning contexts.

In particular, in this paper, some design factors are presented to be considered in developing a course to train the trainers in order that it can be an interesting alternative to the participants, to promote autonomous learning and to note different rates of learning and previous difficulties. This report tries to account the actions for promoting joint developments between different institutions concerned with a society more aware of the need for radioprotection and safety of radiation sources. Pursuant to maintain a methodology that integrates educational structures ways that make it possible a suitable middle level of dialogue and management autonomy that is required in the learning process.

The factors that are addressed in the actual design include: the justification and description of the application context, the technological environment and its functionalities, the course management, the interactivity types selection, some development tools and materials introduction, the participant evaluation and the definition of indicators for assessing the quality of the course. Also it is briefly described, as a higher learning institution is mobilized to adopt ICT, in order to support teaching and learning processes, which contributes to its international reach with the promotion of an specific virtual education unit. They are added comments and suggestions by the authors in reference to the grade and graduate training in science and technology issues through virtual classrooms at the university.

Keyword: Tools and resources, methods of delivery, introduction of modern learning tools.

1. Introduction (12 pt, bold)

The need for lifelong formal and informal continuing instruction, technological innovation, as well as the increased social demand for education have introduced critical issues that require
comprehensive and more flexible responses than the ones conventional education provides. Consequently, it is now possible the coexistence of different teaching/learning modalities and strategies with the incorporation of the information and communication technologies (ICT). Different instructional settings in higher education are: virtual campuses blended learning systems, collaborative material design, various communication means, and e-students assessment in order to create meaningful learning contexts.

The new emerging contexts, in relation to the new labour market demands and the crisis of values are affecting the educational work. For professional development more and different skills are required, especially the ability to use knowledge creatively and in particular the one linked to technology. Regarding the crisis of values, there is a lack of socialization and “the ethics of personal development and individual success is the most powerful trend in modern society” (Brunner, 2003, p.32). The differentiating factor of societies will be the degree to which they integrate or exclude people, groups and nations. Education systems in developing countries now face the challenge of responding not only to the demand for universal access to education, but also to cultural diversity and development needs (Gutiérrez Martínez, 2003).

The information and communication technologies, especially the Internet, allow new and remote social bonds, thus creating new virtual communities. In this context, there are two strategies that countries are pursuing in order to adapt education to these changes: a) continuing and lifelong education for all through institutionalized networks, b) distance education and distributed learning (Brunner, 2003).

UNESCO Virtual University affirms that as higher education communities adopted ICT to support their teaching and learning function and international marketplace appears to be taking shape, a variety of institutional models have begun to emerge. Various classifications have been proposed, but for the purpose of this work, the focus was placed on four main institutional types:

- a newly created institution operating as a virtual university;
- an evolution of an existing institution, with a unit or section offering virtual education;
- a consortium of partners constituted to develop and/or offer virtual education;
- a commercial enterprise offering online education.

The creation and management of virtual communities for learning involves thinking not only in content distribution, but also in the design of various communication spaces (García Blázquez, 2006; Jimenez Esteller et al., 2006). Many questions arise about this issue: How can valuable educational communications for the construction of knowledge be built? What are the characteristics of a comprehensive model for continuing education to take full advantage of ICT? What are the conceptions underlying these teaching and learning strategies? How can current professionalization problems be addressed in these virtual environments?, At what extent can the topics be related to participants’ interests and prior knowledge?

The design of an e-learning project still implies a cultural innovation in the educational context which introduces questions about effective educational practices. The implementation of an innovative project affects on culture and business practices as "it is easier to introduce materials and technologies than achieve change of beliefs" (J. Sancho and others, 1988). It is a process whose management is learned by doing, producing a specific change, and consolidating as continuous improvement.

In particular, in this paper, design factors to be considered when developing a course to train the trainers are presented, which may imply an interesting alternative to participants and
which may promote independent learning and consider different learning styles, learning pace as well as prior background.

2. **Characteristics of the Radiation Program**

The specialization program in Radiation Protection is certified by the School of Engineering of the University of Buenos Aires in agreement with the Nuclear Regulatory Authority which reports to Argentina Presidency and sponsored by the International Atomic Energy Agency (OIEA) which provides scholarships to different Latin American and the Caribbean Region students.

The program aims at training specialists in radiation protection and safe use of radiation sources; it provides theoretical and practical instruction and promotes the development of the necessary skills to perform effectively by controlling the risks associated with the multiple activities involved in the use of ionizing radiation. It is aimed specifically at graduates in the fields of engineering, natural sciences, biochemistry, pharmacy, medicine and other health sciences from accredited national and international universities with equivalent qualifications.

This program is strongly committed to security in defence of life in the workplace and it has the following characteristics:

- Varied background and profile of students (generally university graduates) that have to be taken into account;
- General consensus among all participants on the objectives that transcend the program, that is to say their future function in their workplaces as mentors and disseminators of the risks of radiation and the methodology to prevent dangerous situations and attitudes;
- Awareness of the program organizers about the relationship between the learners’ autonomy in the learning process, the educational material structure and the participants’ capacity for collaborative/cooperative learning and open communication. Hence, the need for the introduction of other teaching and learning modalities and methods to reach more professionals and countries.

Considering this context, in the case of an e-learning project, it is necessary to anticipate potential problems or difficulties and develop strategies to face them.

3. **Design Factors of the Online Module**

Through the online modality, it is intended to:

- Contextualize the learning proposal based on anticipation, search, exploration and practice steps in order to expand and strengthen self-paced instruction, deep understanding and meaningful learning.
- Increase the capacity of institutions and individuals to create new contexts for real and virtual interaction so as to encourage participation as a social activity and anticipation as individual intellectual activity (that is to say, ability to cope with the future, anticipate events, invent, create, etc...).
- Personalize instruction in order to adjust the participants’ level, to flexibilize learning and time-space variables, thus preparing students to reach the professional profile currently required by society (Beatriz Fainholc, 1999; Aveleyra 2006).

3.1 **Characteristics of the Design**

Some design factors are proposed to be considered when designing a program to train future trainers by answering the following questions (Mena M. et al., 2005):
---|---|---|---|---
A pilot e-learning project to train future trainers on ionizing radiation. | To train different professional with heterogeneous background and profiles in Latin America. | 1. Because it is necessary to have more professional specialized in the area. 2. Because it provides the possibility of personalized and alternative learning paths. | Professionals working with radiation emitting materials and devices | E-learning and B-learning strategies. The idea is to enhance teaching since ICT environments are effective when they are properly implemented through collaborative, problem solving and task-based learning. (Aveleyra, 2009)

The design models proposed in this paper are based on the strategies and methodologies used in coaching and mentoring, and the interactivity in distributed learning. In the last decade, the search for comprehensive quality within organizations has fostered and encouraged the use and application of these techniques that implement the skills approach. Coaching can be considered as a dialogue between a tutor (coach) and a student (coachee) in a productive and result-oriented context. Coaching involves individual's access what they know; it is about asking the right questions rather than providing the answers. It is a journey where the process of learning is as important as the knowledge and skills it is closely related to learning because it involves learning (Zeus & Skiffington, 2002). Moreover, coaching is closely related to change and transformation, it is connected with the identification and modification of unsuitable behaviour by learning and applying new behaviour in which the emotional component is involved. (J. Technol. Manag. Innov., 2006, Volume 1, Issue 3).

In summary, the following characteristics of coaching are present in the design approach:

- Developing and promoting the best in each person.
- Providing the person new opportunities for growth and development.
- Identifying and facilitating the change of thoughts or beliefs that may limit the development of an individual.

Mentoring is a natural form of transmission of knowledge, skills and experiences by someone who has the specific knowledge and a broader experience. Mentoring is generally confused with coaching or it is considered a synonym of coaching, but the most important differences are that: mentoring is based on experience and knowledge of a third party, while coaching is based on the potential of each individual. Therefore, when designing a program, both concepts are taken into account: the potential and difficulties of students and the experience and knowledge of teachers/coaches.

The technology and the Internet have favoured the emergence of two new concepts: e-mentoring and e-coaching which are based on the use of electronic media as the primary communication channel such as chat, instant messaging, email, etc. (Hamilton & Scandura, 2002).

The other aspect of the design is related to the potential pedagogic strategy, that is to say, related to the objectives, content, resources, teaching activities and strategies. The design should emphasize two fundamental issues: support in the learning process since “teaching is fundamentally helping somebody learn” (constructivist approach) and technology components which can provide opportunities and/or offer restrictions on the learning activities implementation (Coll, Mauri, Onrubia, 2008; Litwin, 2000).

a) Interactivity in Distance Learning is based on three key elements: materials development, tutoring and collaborative and personal work with other students.

b) The tutor’s profile involves different functions to facilitate the understanding and application of contents, the acquisition of study and communication skills, and the evaluation of students.
through permanent monitoring, academic literature advising, and learning management improvement and particularly through motivational support.
c) The educational materials are mediators in the training process. They are guides for knowledge construction and learning orientation.

3.2. One relevant tool: Diagnosis Test

How the diagnosis test was designed based on the items listed in 3.1 and the flexibility of native Moodle quiz?
Using applets and authoring tools to provide examples of evaluation and contents. The test was designed with:

- Videos, movies and the ICT tool Geogebra to provide an initial impact of contents.
- Applets to encourage reflection on learning.
- Examples and self-assessment to identify prior knowledge and adjust participant’s level initially on basic Mathematics and Physics

3.3 Quality indicators

The basic principles of university education are considered in the definition of quality indicators: (Rubio 2003, Indiana University Centre for Research on Learning and Technology)
1) Contact between teacher and student. Clear rules should be established with the student, defining communication channels and response times.
2) Cooperation among students. Forums are designed in order to facilitate communication among students (focusing on controversial issues, preparation of reports of practical works).
3) Active learning by encouraging respects the diversity of levels and needs by offering variety of on-line and on-site activities. Therefore, individual work is planned and encouraged.
4) Prompt feedback of information and participation recognition.
5) Emphasis on programming teacher-student joint activities on the platform.

The design of interactivity among teachers and students in the learning process in a virtual environment is also considered to establish the following dimensions: teacher-student joint activity (interactivity teacher-student and among students, mediation through different means and ends, forums, chats, reports, etc.), and potential teaching support (considering prior knowledge, self-pace learning, motivation, etc), knowledge construction (continuous and sensible assistance, active and meaningful learning, etc.) (Aveleyra, Chiabrando, 2012) and evaluation (qualitative model, time on task, immediate feedback) (Rubio, 2003; Fernandez, 2005; Marchisio 1997-1998; Gomez, 2005; Muñoz Cantero, 2002; Santoveña Casal, 2005).

4 Learning Management System

Regarding e-learning quality standards, Moodle was chosen since it supports content design Standard IMS, specially the standard QTI when referring to Questions and Test Operativity and the standard SCORM/AICC for activities design.

Moodle is the free and open-source Learning Management System that FIUBA adopted in 2009 to deliver its courses due to the advantages it presents compared to other commercial or even free LMS as well as to its functionalities in alignment with e-learning quality standards mostly used by thousands of higher education institutions and research communities around the world as a collaborative environment.
Moodle is appropriate as a support tool to on-site and online teaching since it promotes social constructivism (including collaboration, task-based learning, critical thinking, interaction and collaborative work through forum, etc.).

Among the functionalities of the LMS are 1) Content distribution, 2) Communication and collaboration tools, 3) assessment tools and 4) Course and Group management.

<table>
<thead>
<tr>
<th>CONTENT DISTRIBUTION</th>
<th>COMMUNICATION &amp; COLLABORATION</th>
<th>ASSESSMENT</th>
<th>COURSE &amp; GROUP MANAGEMENT</th>
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<td>File repository</td>
<td>Among students &amp; teacher</td>
<td>Gradebook</td>
<td>Personal Information</td>
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<td>Resources</td>
<td>Forum</td>
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<td>Agenda</td>
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<td>Last threads</td>
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4. **Final Comment**

It is recommended to implement more flexible teaching and learning modalities, due to the relevance of the training to future trainers in radiation protection and the impact of future dissemination to their communities of origin. Hence, current learning designs can be supplemented and improved.

According to the experience of the trainers and of the institution FIUBA itself, the use of a virtual learning environments can facilitate more personalized support to students and a wide variety of customized resources both throughout the learning process and in the initial stages when previous knowledge of the participants is revised.

A course of this type can be adapted to different contexts and professions, taking into account cultural diversity and linguistic differences.

Works of action research made in the field of educational technology confirm that well implemented ICT tools in virtual learning environments improve synchronous and asynchronous communication (i.e. via videoconferencing and forums) and encourage the socialization among participants even after finishing instruction. Thus, communities with members from different countries can be developed and collaborative work can promote the appropriate and responsible use of radiation sources.
5. References


UNESCO Virtual University. www.unesco.org/iiep/virtualuniversity

ABSTRACT

The Greek Atomic Energy Commission (GAEC) is the national authority in the country responsible for matters related to radiological protection from ionizing radiation. The legal framework in force, determines GAEC responsibilities in the provision of E&T, as well as, in the certification of the competence on radiation protection of the occupationally exposed workers. GAEC provides E&T on radiation protection since 1960. Nowadays, it has a range of activities, in providing post-graduate and continuing E&T on radiation protection, at national and regional level.

At national level and in the particular field of medical exposure, GAEC is a participant and a major contributor to the Inter-University Post-Graduate Program on Medical Radiation Physics, running under the administration of Athens University in co-operation with the Medical Schools of five Greek Universities and the Research Centre “Demokritos”. GAEC’s participation in this Program aims at the provision of a number of highly qualified Medical Physicists who may also act as Radiation Protection Experts in the hospital environment. It also aims at producing a pool of trainers who can play an important role in the implementation of E&T programmes on radiation protection - locally in the hospitals - addressed to occupationally exposed workers. Recently, GAEC organised and accomplished a nationwide E&T project, dealing with several cycles of three days courses on radiation protection in medicine, addressed to medical radiological technologists, which was implemented in collaboration with academic institutions and locally with the Medical Physics Departments of Universities and major General Hospitals.

Since 2003, GAEC is the IAEA’s Regional Training Centre (RTC) for the European Region in the English language and through IAEA TC Programmes organizes and hosts in Athens the 22 weeks Post graduate Educational Course on “Radiation Protection and the Safety of Radiation Sources”, based on the relevant IAEA Standard Syllabus and other specialized training courses. A Long Term Agreement (LTA) was signed, in 2011, between the Government of Greece and the IAEA, supporting GAEC as RTC in Europe. The LTA was ratified by the Greek Parliament in October 2012.

In this paper, the involvement of GAEC in E&T on Radiation Protection will be presented and discussed.

1. Introduction

The establishment of a national strategy for building radiation protection competence through E&T is of crucial importance for the development of the safety culture. International organizations (IAEA, ICRP) emphasize this importance and issue guidelines for the implementation of E&T programmes (e.g. EC, IAEA).

An efficient radiation protection system is an ongoing procedure based on the experience and the knowledge of the individuals participating in this effort. Therefore, it is undoubtedly necessary that the people involved occupationally in procedures using ionizing radiation to have appropriate education and training on radiation protection issues. This necessity is clearly stated in the Greek Radiation Protection Regulations (GRPR) [1].

The Greek Atomic Energy Commission (GAEC), as the competent national authority for radiation protection and nuclear safety in Greece, is responsible for ensuring the proper
implementation of the GRPR. According to these Regulations, GAEC’s responsibilities involve the provision of education and training on radiation protection issues to occupationally exposed workers through specialized courses and the certification of their competence on RP.

GAEC has a central role in E&T in both radiation protection and medical physics in Greece. The beginning of GAEC’s educational work coincided with the Hospital Physicists’ post graduate School foundation in the beginning of 1960. Since that time GAEC has organized and hosted hundreds of national and international seminars and educational events, addressed to occupationally exposed workers in the medical, industrial and research applications of ionizing radiation to workers in radioactive material transport, in customs offices and airport, where audits for illicit trafficking of radioactive sources are performed, as well as to people involved in emergency response plans.

In order to fulfill the educational needs in radiation protection, GAEC has established partnerships with other international and national educational institutions and professional bodies. GAEC’s educational activities are fully supported by its experienced scientific personnel, its state of the art technical infrastructure and supplementary by that of the collaborative educational and research centers.

GAEC attaches great importance to its educational and training activities, so recently proceeded to two significant initiatives. The establishment of a national strategy for education and training and the certification of the department of education in accordance with ISO 29990:2010.

2. Education and training at national level

At national level and in the particular field of medical exposures, GAEC, since 1994, is a participant and a major contributor to the Inter-University Post-Graduate Course on Medical Radiation Physics [2]. This course is organized by the Universities of Athens, Ioannina, Thessaloniki, Crete and Thrace in collaboration with GAEC and NCSR “Demokritos”, aiming to a specialised training of physicists in Medical - Radiation Physics. The course is attended annually by 10 to 15 students, depending on the national needs. This course is leading to a Master’s Degree which is a prerequisite qualification for the candidates along with the one-year on the job training in order to get the relevant professional license, issued by the Ministry of Health. The GAEC invests on production of highly qualified Medical Physicists who can play an important role in the implementation of E&T programmes on radiation protection - locally in the hospitals - addressed to occupationally exposed workers. These Medical Physicists should be capable of acting as Medical Physics Experts in the field of medical exposures according to MED 97/43 Euratom Directive [3] and to provide high standard services within the medical radiation laboratories. In addition, following a specialized training, they can act as Qualified Experts according to the BSS 96/29 Euratom Directive [4], in radiation protection and safety of radiation sources in fields other than medical, covering relevant needs of the country.

Recently, GAEC organised and accomplished a nationwide extensive E&T project, dealing with several cycles of three days courses on radiation protection in medicine, addressed to medical technologists, which was implemented in collaboration with academic institutions and locally with the Medical Physics Departments of Universities and major General Hospitals. In total, 2,425 medical technologists attended these courses. Following successful examinations, they obtained a certificate of knowledge competency on radiation protection. For the purposes of these courses, special educational material has been developed (textbook and presentations files). GAEC’s goal is to extend this kind of training to other groups of occupationally exposed workers such as in the field of interventional radiology and veterinary.
Although the industrial sector consists only a small fraction of the overall ionizing radiation applications (less than 10%) in Greece, GAEC enhance through E&T, the development of the safety culture on radiation protection, due to the fact that many accidents are reported internationally especially in industrial radiography where high dose rate sources are used. In the name of this effort, last autumn a series of 2-days courses on radiation protection in industrial radiography was implemented in three main cities of Greece. In total 100 radiographers and assistant radiographers attended these courses.

Moreover, GAEC participates in the training of the safety advisors in the safe transport of dangerous goods and in particular for class 7. This training is a mandatory prerequisite by the transport modal regulations in order for the safety advisors to receive the relevant certificate after examinations to the designated examination body by the Ministry of Infrastructure, Transport and Networks. This training refers to one day seminar 4 times per year.

As far as the nuclear safety is concerned due to the high requirements demanded for the safe conduct of the Athens 2004 Olympic Games, a nuclear security programme was established and the nuclear security infrastructure of the country was upgraded [5]. Under this framework, GAEC provided training on radiation protection, prevention, detection, emergency preparedness and response to hundreds of persons working for several national organizations involved in the national emergency plan (military forces, police, coast guards, fire brigade, first line officers, etc.). This mechanism has to be maintained and improved through continuous training and knowledge dissemination on the new techniques and methodologies. Therefore GAEC continues to organize seminars frequently addressed to the personnel of these organizations involved in the emergency plan, in order to assure the sustainability of national operational capability on preparedness and response [6]. In particular, this year, a refresher training program to customs all around Greece will be implemented in order to maintain and strengthen the skills and knowledge of the customs officers on the detection equipment, how to undertake preliminary surveys and to identify radionuclides encountered so as to be able to make an initial assessment and determine whether additional support is required from GAEC.

A new initiative was launched in 2012, concerning the training of the staff of the external companies (e.g. companies for installation, maintenance, repair of medical equipment for the production or the detection of ionizing radiations) who are employed in radiation areas. Two daily seminars were organized in November and were attended by 50 external workers.

Depending on the objectives of the national training courses organised by GAEC appropriate curricula and educational material have been developed based on the recommendations of international organizations (IAEA, EC, ICRP) [7], [8], [9], [10], [11] taking into account the national specificities.

### 3. Education and training at regional and international level

GAEC’s significant educational work is acknowledged internationally, which is mostly proved by the fact that GAEC is the IAEA’s Regional Training Centre (RTC) in English language in Europe on radiation protection and the safety of radiation sources since 2003, as well as on nuclear/radiological security since 2005. After the successful completion of the IAEA Education and Training Appraisal (EduTA) mission of Greece in 2008, a Long Term Agreement (LTA) between the Government of Greece and the IAEA, to support GAEC as the RTC in Europe for radiation, transport and waste safety was signed in July 2011. The LTA was ratified by the Greek Parliament in October 2012. Furthermore, the team of the Integrated Regulatory Review Service (IRRS) mission [12] which was conducted in Greece in May 2012 identified as a ‘good practice’ the E&T provided by GAEC on radiation protection.

In this framework

a) Hosts, since 2003, the Postgraduate Educational Course on Radiation Protection and the Safety of Radiation Sources [7], co-organised and co-funded by IAEA. The Course provides education and training to young scientists pursuing to acquire a
sound basis in radiation protection and knowledge of related safety fundamentals in order to become, in the course of time, qualified experts in countries of Eastern Europe. The purpose of this course is to meet the initial educational requirements on a postgraduate level for staff earmarked for positions in radiation protection and on the safe use of radiation sources in different fields of ionizing radiation, in order to cover the relevant national and regional needs. The Course lasts for 22 weeks and is conducted every two years in the English language. The Course follows the IAEA’s Standard Syllabus and is supported by the relevant educational material. It is supported in terms of experienced lecturers and technical infrastructure by the Nuclear Engineering Department of the National Technical University of Athens, the Physics Department and the Medical Physics Laboratory of the University of Athens, the Medical Physics Laboratory of the University of Ioannina, the National Centre for Scientific Research “Demokritos” and many hospitals in Athens. The scientists participating in this Course are European citizens and are chosen by IAEA. The Course is supported by local and external lecturers.

b) Organizes regional and international seminars in specialised fields of radiation protection, as well as in Nuclear Security such as:

Regional training courses on:
- gamma spectrometry for monitoring of radionuclides in air
- assessment of occupational exposure due to intakes of radionuclides
- radiological emergencies for first responders

and International Training Courses on:
- detection and response – techniques and coordination for Front Line Officers (FLOs) and Mobile Expert Support Teams (MESTs)
- data networking, remote monitoring and sustainability of border radiation detection equipment for FLOs and MESTs
- authorization and inspection of radiation sources for regulators

c) Offers on the job training to scientists proposed by IAEA, in the fields of radiation protection, regulations and regulatory control, dosimetry, ionizing radiation calibration and environmental radioactivity control.

4. Conclusions

GAEC, as it is reflected in this work, has a range of activities, in providing post-graduate and lifelong E&T on radiation protection and nuclear safety, at national and international level. It has a strong commitment to building competence on radiation protection through E&T which is acknowledged internationally. It places a great effort to the provision of regular education, training and retraining courses and knowledge dissemination on the new techniques and methodologies, addressed to the staff involved with ionising radiation since this is a key element in order to provide competence and ensure expertise in the field of radiation protection. This is further strengthened with the established national strategy and quality management system for E&T which give the appropriate provisions needed for an effective E&T program.

5. References
This work presents the activities of the Medical Physics Laboratory (MPL) of the University of Athens (UoA) concerning the provision of Education and Training (E&T) in Medical Radiation Protection (MRP).

Several University Departments in Greece offer E&T in MRP. The MPL of the Faculty of Medicine of the UoA is one of the main Academic E&T providers in MRP at both pre- and post-graduate level. At pre-graduate level, MRP forms an integral part of obligatory courses in Medical Physics included in the curricula of the Medical, Dentistry and Nursery Schools of the University. In example, Medical Physics is offered in the first two semesters of the Medical School and E&T in MRP is encouraged by the regulatory authority according to Article 7 of the 97/43 MED EURATOM Directive. The syllabus includes Radiation Physics, Dosimetry, Instrumentation, Biological effects, and Radiation Protection (legislative framework, medical, occupational and public exposures including emergency exposures). In addition, elements of MRP are incorporated in various elective courses with learning objectives relevant to the applications of radiation in medicine.

At post-graduate level an inter–University PostGraduate Program in Medical Radiation Physics (PGPMRP) is conducted since 1993. The PGPMRP is running under the administration and co-ordination of the Medical Physics Department of the UoA, in collaboration with the Physics and Biology Departments of the UOA and the Medical Physics Departments of the Universities of Ioannina, Thessaloniki, Crete and Thrace, as well as, the National Centre for Science Research (NCSR) “Demokritos”, and the Greek Atomic Energy Commission (GaEC). An extensive part of the syllabus is dedicated to MRP. The PGPMRP leads to an MSc degree in Medical Physics and, optionally, to a PhD. After a one year residency period in hospital radiation facilities MSc graduates with a first academic degree (BSc) in Physics, are entitled to participate in the examinations given by a Committee of the Ministry of Health in order to obtain a professional license of a Medical Radiation Physicist. Medical radiation physicists mainly staff the existing medical facilities in the country, and they can also act as Radiation Protection Experts in the medical setting.

Continuing, lifelong education and training on radiation protection is also provided by the Medical Physics Department to the medical and paramedical staff of medical radiation facilities in collaboration with medical societies and professional bodies.

1. Introduction
The MPL was established in the Faculty of Medicine of the UoA in 1979. Its main educational activity is to offer compulsory education in Medical Physics to the undergraduate medical students of the University’s Medical, Dental, and Nursery Schools. It also provides elective courses on Medical Informatics to the above mentioned students. Since 1996, MPL is the coordinator for the Inter-University Medical Radiation Physics postgraduate course organized jointly by five Greek Universities and two Research Centers. The MPL also participates in three other postgraduate courses. Maintaining high standards in fulfilling such diverse and intensive educational responsibilities necessitates adherence to strict quality assurance policies and MPL maintains ISO 9001: 2008 certification for the provision of E&T services, the design and implementation of educational programs, as well as the provision of E&T through e-learning.
Within the framework of its aforementioned activities, the MPL is one of the main Academic E&T providers in Medical Radiation Protection (MRP), conducting relevant courses at pre- and post-graduate level. It also supports residency based, continuing and lifelong E&T, addressed to health professionals involved in the practical aspects of medical exposures to ionizing radiation.

In the present work, the activities of the MPL, with emphasis to the provision of E&T in MRP to medical students, medical radiological practitioners, medical physicists and other health professionals, are presented and discussed.

2. **MRP courses at under-graduate level**

At pre-graduate level the MRP courses are addressed to the students of the Medical, Dentistry, and Nursery Schools of the UoA, as an integral part of their basic curriculum. For the students of the Medical School, the MRP course is part of the obligatory two semester’s course in Medical Physics during the first year of studies. The first semester (45 lecture hours) covers the issue of Medical Radiation Physics. The relevant syllabus includes elements of Atomic and Nuclear Physics, Sources of ionizing radiation, Interaction of Radiation with matter, Detection of radiation, Radiation Dosimetry, Instrumentation, Biological effects of Radiation, and Radiation Protection (legislative framework, medical, occupational and public exposures including emergency exposures). Specific topics dealing with the medical applications of ionizing radiation (radiodiagnosis, radiotherapy and nuclear medicine), along with the particular radiation protection issues which are also included in the syllabus. For the students of the School of Dentistry the MRP course is part of the obligatory one semester course in Medical Physics offered in the first year. The syllabus on MRP is similar to that of the Medical students, but tailored and more focused to dental applications of radiation. Elements of MRP are also included in the syllabus of an elective course on biophysics offered in the first semester of the Nursery School.

A textbook on Medical Physics entitled “Medical Physics: Diagnostic and Therapeutic Applications of Radiation”, written by the staff of the MPL in 2008 is distributed to the students of Medical, Dentistry and Nursery Schools, and covers the learning objectives of the aforementioned syllabus. This textbook is also provided and used by Medical students of other Greek Universities, as well as Physics students attending elective courses in the medical applications of radiation. The educational material is complemented with power point presentations and lecture notes made available through the web site of the MPL (http://mpl.med.uoa.gr/) as well as the University platform for asynchronous tele-education (http://eclass.uoa.gr/).

3. **MRP courses at post graduate level**

One of the main activities of the MPL on E&T in MRP is the coordination and administration of the inter–University PostGraduate Program in Medical Radiation Physics (PGPMRP).

Medical Radiation Physics is a statutory professional specialization for Physicists in the field of Healthcare defined by the national legislation [1]. The relative recognition requirements have been recently reviewed and are currently provided by a new Law [2]. In this context the national legislation concerning E&T requirements is consistent with the EURATOM Directives BSS 96/29 [3] and MED 97/43 [4], as well as the new IAEA BSS [5]. The Medical Radiation Physicist professional license is awarded by the Ministry of Health and Welfare upon successful participation in examinations held in Radiation Protection, Radiation Therapy, Radiodiagnosis and Nuclear Medicine. A first academic degree (BSc) in Physics and a Master Degree (MSc) in Medical Radiation Physics are considered preconditions for eligibility to participate in the above mentioned exams. The award of this MSc degree is the object of the inter–University PGPMRP. This course was established in 1993 and is currently running under the administration of the Medical Physics Department of the University of Athens. The participating institutes in the Course are: the Department of
Physics and Biology of the University of Athens and the Medical Physics Departments of the Universities of Thessaloniki, Ioannina, Thrace and Crete, as well as, the Greek Atomic Energy Commission (GAEC) and the NCSR “Democritos”. Teaching is provided by the academic staff of the collaborating Universities, the GAEC’s specialized scientists (regulators and inspectors) and researchers of the NCSR “Demokritos”. The PGPMRP runs in a yearly basis, and is attended by 10 to 15 students.

The mission of the PGPMRP, is to provide graduates with high level education enabling them, after their residency based specialization, to function as Medical Physics Experts in the field of Medical exposures [4], as well as Radiation Protection Experts in the hospital environment, dealing with occupational and public exposures [3]. The Program lasts three semesters (30 Credit Units per semester). Within the first two semesters, students are provided with theoretical education and laboratory/practical exercises in the facilities of the GAEC and the MPL. Practical exercises are also carried out in the facilities of NCSR “Demokritos” and public hospitals. The third semester is dedicated to the preparation of the students’ thesis, which, according to its subject, is performed in the laboratories of the participating institutions. Optionally, the Course may lead to a Ph.D degree in Medical Radiation Physics. The Curriculum of the MSc Course, the stipulated work load in full weeks (including laboratory exercises), the number of class hours and corresponding credit units per topic, are summarized in Table 1 (also available at: http://mpl.med.uoa.gr/)

<table>
<thead>
<tr>
<th>1st Semester</th>
<th>Hours</th>
<th>Credit Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Physics</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Radiation Sources</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Interaction of ionizing radiation with matter</td>
<td>65</td>
<td>5</td>
</tr>
<tr>
<td>Detection &amp; Measurement of radiation</td>
<td>52</td>
<td>4</td>
</tr>
<tr>
<td>Statistics, Computing &amp; Image processing</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Parts of Biology, Anatomy, Physiology &amp; Physics of the body</td>
<td>39</td>
<td>3</td>
</tr>
<tr>
<td>Radiation Dosimetry</td>
<td>65</td>
<td>5</td>
</tr>
<tr>
<td>Biological effects of radiation</td>
<td>52</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2nd Semester</th>
<th>Hours</th>
<th>Credit Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic &amp; Interventional Radiology</td>
<td>52</td>
<td>4</td>
</tr>
<tr>
<td>Nuclear Medicine (Diagnosis &amp; Treatment)</td>
<td>65</td>
<td>5</td>
</tr>
<tr>
<td>Radiotherapy &amp; Brachytherapy</td>
<td>91</td>
<td>7</td>
</tr>
<tr>
<td>Physical Principals &amp; Applications of non-ionizing radiation</td>
<td>52</td>
<td>4</td>
</tr>
<tr>
<td>Radiation Protection</td>
<td>78</td>
<td>6</td>
</tr>
<tr>
<td>Parts of Nuclear Technology &amp; Nuclear Safety</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>Effects - Protection of non-ionizing radiation</td>
<td>26</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3rd semester</th>
<th>Weeks</th>
<th>Credit Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSc Thesis</td>
<td>18 weeks</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>3 semesters</td>
<td>90</td>
</tr>
</tbody>
</table>

Tab 1: Summary of Curriculum and Credits of the Medical Radiation Physics Inter- University Postgraduate Course coordinated by the MPL

4. Continuing and lifelong education and training on MRP

Continuing, lifelong education and training on MRP, is also provided by the MPL to the medical and paramedical staff of medical radiation facilities. The relevant courses are organized and realized either under the sole auspice of the MPL, or in collaboration with fellow University Departments, the GAEC, NHS Hospital Departments and Professional/Scientific Societies. The curricula of the courses provided on MRP, are based on International and European relevant Guidelines [6], [7], and are tailored, by means of depth of knowledge and duration, on the E&T needs of the audience under consideration.
The target audience of these courses is inter alia, Medical Doctors (Radiologists, Dentists, interventional radiologists and cardiologists, Nuclear medicine practitioners), Medical Physicists, Radiological Technologists, and Nurses. These courses are conducted on demand, on a regular basis (i.e. the MPL provides a 2 day course on MRP to resident nuclear medicine physicians on a regular basis), or in partial fulfillment of according to the policy.

Key elements of the curricula for the above MRP courses include: Basic concepts of nuclear physics, Principles of radiation detection and measurement, Dosimetric quantities and units, Biological effects of ionizing radiation, Principles of radiation protection, Radiation protection of workers, patients and the public in radiology, nuclear medicine & radiotherapy applications.

Recently the MPL has participated in the implementation of an extensive program of training in MRP addressed to the auxiliary staff of medical ionizing radiation laboratories. This program, organized and financially supported by the GAEC, was carried out in the form of a series of intensive 3-days MRP refresher courses for radiological technologists. The staff of the MPL was the main contributor to the drafting of a booklet entitled “Lessons on Radiation Protection for operators of medical radiological equipments”, which was published by the GAEC and used as the reference educational and exam material for the participants.

5. Discussion

The MPL of the Faculty of Medicine of the University of Athens, is one of the main Academic E&T providers in MRP in Greece, conducting relevant courses at pre- and post-graduate level. At pre-graduate level, the courses provided on MRP, are addressed to the students of the Medical, Dentistry and Nursery Schools and are included in their basic curriculum. The aim of the courses is that the students acquire a sound basis in radiation protection as well as a preliminary knowledge of the risk related to the different types of radiodiagnostic procedures, in line with Article 7 of the 97/43 MED EURATOM, which states that “Member States shall encourage the introduction of a course on RP in the basic curriculum of medical and dental schools”. Moreover, the courses provided are also consistent with the stricter provisions of the new draft EU BSS Directive, where “Member States shall ensure that a RP course is included in the basic curriculum of medical, paramedical, and dental, and veterinary schools”.

The MPL, along with its collaborating institutions, have a long-standing tradition in providing post graduate education in medical radiation physics. The PGPMRP curriculum is based on the International and European relevant guidelines [8]-[11]. However, work to attain consistency with the new EU “Guidelines on Medical Physics Expert” [12], and MEDRAPET EC project under preparation [13], will be required in the future. The preparation of highly qualified Medical Physicists is key to the successful implementation of an RP programme at a national level. In this regard the contribution of the PGPMRP is noteworthy given that the role of Medical Physicists in establishing a safety culture for the country is of paramount importance. Medical Physicists staff the existing medical radiological facilities and their responsibilities include the on-site provision of education and training on MRP to the radiation workers.

As far as the provision of continuing and lifelong E&T on MRP is concerned, it is understandable that the level of knowledge required is highly depended on the staff's specialty, experience, tasks and responsibilities. Therefore, it is among the perspectives of the MPL, to provide more extensive and specialized courses to the personnel involved in practices resulting to high doses, such as CT and interventional radiology and cardiology. To this end, the forthcoming publication of the MEDRAPET report will be of great help in the revision of the existing MRP curricula.

In conclusion, the activities of the MPL in conducting MRP courses addressed to students, medical practitioners, medical physicists and other health professionals, conduce to the establishment of a robust and sustainable system of E&T on MRP in the country. As the medical sector represents 90% of ionizing radiation applications in Greece, the long
standing operation of the PGPMRP has contributed to the establishment of a safety culture in the field.

6. References


Abstract

Since 2010 a training programme is established in Germany to finish as a master craftsman in radiation protection. This graduation is comparable with the RP technician in other countries (like Switzerland) and permits to work as a highly competent RP supervisor in nuclear or research facilities with a broad variety of RP functions. To advance the qualification of RP technician at the RP School at the Paul Scherrer Institute in Switzerland the course was established similar to master craftsman courses in other fields of power plants at the Kraftwerksschule Essen. The course takes totally around 30 weeks and comprises 6 modules between 2 and 8 weeks each. The examination regulations are recognised by competent authority of Nordrhein-Westfalen in Germany (Industrie und Handelskammer Essen). In this report details on the training programme, learning targets, acquired skills and prospective function of course participants will be shown.

1. Introduction

The operation – as well as the decommissioning - of nuclear power plants requires thousands of different tasks in radiation protection to be done in a professional manner. Therefore the licensee has to employ a stipulated amount of radiation protection professionals and to appoint them with duties and competences. These radiation protection professionals have to prove different qualification levels to enable the realization of tasks derived out of the duties.

2. Qualification levels in RP of nuclear facilities in Germany and Switzerland

First of all there is the appointed Radiation Protection Manager (Strahlenschutz-Beauftragter, RPM), mostly chief of the internal RP organisation, who is responsible for the conversion of legal rules and regulatory demands to internal directives of the company and for the supervision of the compliance. The RPM has the qualification level of a radiation protection expert (RPE) and acts as the upper responsible radiation protection officer (RPO). Additional there are several other RPE per facility who are appointed as substitutes of the RPM, especially in the emergency response organisation.

Further more, depending on the size and the complexity of the facility as well as on the phase of operation (power operation, outage, decommissioning) in the order of 10 to 100 RPO take care on RP in the facility in general and especially in the particular workplaces. In
nuclear facilities in Germany as well as in Switzerland the responsibility for radiation protection of the occupational exposed staff (radiation workers) is confined to the self-protection and to fulfil the internal instructions. The radiation workers do not need to look for the preparation of protection measures or the monitoring of the radiological situation. This is the job of the RPO.

The RP assistants (Strahlenschutz-Werker) represent the lowest level of RPO, who are responsible for routine RP jobs without any harmful risk for other staff, e.g. the standard periodical monitoring.

The PR practitioners (Strahlenschutz-Fachkraft) act as RPO with a qualification level, which allows for example for determination of simple protection measures for certain planned jobs and to clear material in non–radioactive and radioactive at the exit of the controlled area.

Because of the huge amount of different tasks, which have to be coordinated and controlled by the RPM, it would be useful, to depute some of the elaborate tasks to RPO who have a broad and interdisciplinary knowledge and capability additionally to a profound qualification and experience in RP. The education and training program for RP master craftsman (Strahlenschutz-Meister) satisfies exactly these demands. The RP master craftsman acts as a connector between the practical loads on the workfloor (therefor craftsman) and the strategic aims of the RP program determined by the appointed RPM (therefor master).

3. Typical tasks, derived capabilities and skills of RP master craftsman

The RP master craftsman has

- to plan and coordinate big projects as construction, replacements or decommissioning of mean components of NPP, at least to contribute RP demands to such projects
- to compile RP plans for complex and high risk radiological jobs to achieve and maintain an optimized level of protection,
- to constitute protection measures as well as radiation survey methods,
- to survey equipment and procedures for protection and monitoring the exposure of radiation workers and members of the public
- to instruct workers about risk, safe working procedures and behaviour during and after an event,
- to lead a group of radiation protection officers as assistants or practitioners and radiation workers,
- to act as a leading person within an emergency response team responsible for RP in the field,
- to overtake partially the responsibilities of RP Manager on the work floor

The capabilities of the RP master craftsman enabling to overtake these tasks, may be sorted to categories as

- a consolidation of competence in RP additional to several years of experience in RP,
- a broad and interdisciplinary knowledge of business management and administration,
- a general survey of techniques, processes and systems especially used for construction, refurbishment, replacements and decommissioning of NPP

Furthermore the RP master craftsman has to show skills like:

- Ability to settle different aspects from totally new and sometimes unknown projects in- to the right order (Thinking in the big picture)
- Taking a decision by considering in a commensurate way
- Looking for synergies
- Working in modern organization with interdisciplinary scope
- Thinking and acting in a task oriented way
- Tackling a problem and resolving new demands
• Capability to communicate and report
  • Charismatic leadership

4. Development of the education and training program

Achieving these competences and skills an expert group of the VGB-PowerTech (Verband europäischer Großkraftwerksbetreiber, an european association of companies of power plant operators and manufacturers) developed a professional education and training program (ET program) according to a training course for RP technicians in Switzerland. This RP specific course, which is given by the Paul Scherrer Institute, is successful since more than 20 years and is recognised by the Swiss Federal Nuclear Safety Inspectorat.

The ET-program has the same structure as the formations of power plant master craftmen of other disciplines, which are developed from the Chamber of Commerce and Industry Ruhr (IHK Ruhr) and KRAFTWERKSSCHULE E.V.

5. Requirements on the education and training program

As a prerequisite to start with the RP master craftman education and training program, the candidate should either show at least 2 years of experience on the job e.g. as a RP practitioner or alternative an occupational history which ensures the equivalent experience.

The program of the continuing education and advanced training RP master craftman looks like:

<table>
<thead>
<tr>
<th>Module</th>
<th>Duration</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor Training</td>
<td>2 weeks</td>
<td>local IHK</td>
</tr>
<tr>
<td>Module 0: Preparation</td>
<td>1 week</td>
<td>KWS</td>
</tr>
<tr>
<td>Module 1 A: Interdiscipli-</td>
<td>8 weeks</td>
<td>KWS</td>
</tr>
<tr>
<td>Examination Preparation</td>
<td>2 weeks</td>
<td>KWS</td>
</tr>
<tr>
<td>Examination</td>
<td>2 days</td>
<td>IHK-Essen</td>
</tr>
<tr>
<td>Module 2 B/C: Core</td>
<td>8 weeks</td>
<td>PSI or KWS</td>
</tr>
<tr>
<td>Project Work with</td>
<td>2 weeks</td>
<td>PSI or KWS</td>
</tr>
<tr>
<td>Module 3 B/C: Core</td>
<td>6 weeks</td>
<td>KWS</td>
</tr>
<tr>
<td>Module 4: Examination</td>
<td>2 weeks</td>
<td>KWS</td>
</tr>
<tr>
<td>Examination of &quot;job-related aspects&quot;</td>
<td>2 days</td>
<td>IHK-Essen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IHK-Essen</td>
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For further information please visit www.vgb.org/pss.html or www.kraftwerksschule.de.

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H. Baschnagel NPP Biblis
H. Prehn NPP Brunsbüttel
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ON-LINE TRAINING IN RADIOLOGICAL PROTECTION: 
MASTER’S DEGREE IN RADIOLOGICAL PROTECTION IN 
RADIOACTIVE AND NUCLEAR INSTALLATIONS

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ABSTRACT

The companies that are working in decontamination, dismantling and assessment in nuclear power plants, usually have their employees in different facilities far from its central offices. When there is a training in radiological protection applied to the nuclear field, it is difficult for these people the attendance to the course because of different reasons as the location of the formation centres which sometimes are not near from the nuclear facilities, so they usually cannot attend their daily work with the same effectiveness.

In this work we present a postgraduate training in radiological protection supervised by Polytechnical University of Valencia (Spain) applied to nuclear and radioactive facilities by a technological platform developed in collaboration with the university. This platform is adapted and designed to different high level contents and applications in different areas and sections, related to a general part, radioactive facilities, nuclear facilities and advanced concepts. When the student finishes an area, an evaluation has to be done to prove the understanding of the lessons. We have included films of different activities as decontamination devices, radiation detectors..etc with the contents to make the explanations more understandable to the student.
The course is complemented with a final review and exam that are not online to guarantee that the training is well finished. In addition the student has some practice related with different items explained during the training as the use of equipment in radiological protection tasks. This type of training is more flexitime and can be adapted to the necessities of each user, avoiding high costs and unnecessary displacements.

1. Introduction

The workers of a large number of companies, such as those carrying out maintenance tasks and giving advice in nuclear power stations, are generally stationed at various nuclear and radioactive installations. When a formative need arises, it is difficult for them to attend classroom courses given in a specific place, as this involves their abandoning work for days or even weeks for however long the training lasts. Furthermore, the centres where this specific training is taught are not generally near the places where nuclear installations are located, which increases travel time and costs.

For this reason, in this type of work the objective is to provide training in radiological protection and nuclear security in a telematic manner applicable to various specific generic modes of nuclear power stations and industrial radioactive installations, research and teaching institutions, and X-ray diagnosis installations.

Telematic training allows an on-line training system designed to suit the person following the course, with greater flexibility and convenience as to making use of his/her time, for instance saving on travel and facilitating a follow-up tailored to the needs of the individual. This allows a more successful combination of work and training, as most people following this type of course are working and it is hard for them to fit training in with their daily job routine. Because of this, the flexibility of having the use of a training mode in which the pace is set by the person following the course, so as to combine work and training, is more efficient. The clearest advantage of on-line training is that of having a personalised learning system that can be adapted at all times to the formative needs of the worker regardless of his/her physical location.

It is for this reason that telematic training or that achieved by platforms designed on Internet mediums and known as e-learning [1] has numerous followers in different countries, as all teaching methods are instantly available for a suitable level of training, with a personalised follow-up in which the person following it sets his/her own study periods and personal work pace under the guidance of a tutor.

This idea is therefore to develop a telematic tool consisting of a technological platform adapted to the designing of measures for the efficient follow-up of various course types on radiological protection and nuclear security. In this way, these courses are followed up in a manner guaranteeing satisfactory learning, and include tools that allow efficient continuous assessment by various means of controlling this follow-up.

The course “Master in Radiation Protection in Radioactive and Nuclear Installations” has been designed for people interested in this field with at least a University Degree, Master Degree, etc. This course qualifies its students to carry out surveillance tasks focussing on:

- Functions as Radiation Protection Technician (IS-03 content: RPTU or Radiation Protection Service Head) [2].
- Occupational Health and Safety technicians (Industrial Hygienist).

The qualification is a result of the collaboration of Titania Servicios Tecnológicos (henceforth Titania) and Logística y Acondicionamientos Industriales (henceforth Lainsa) for the Grupo Dominguis and the Chemical and Nuclear Engineering Department, Institute for Industrial,
Radiophysical and Environmental Safety (ISIRYM), and the Postgraduate Learning Centre (CFP) of the Universitat Politècnica de València (henceforth UPV). Moreover, various entities collaborate in the teaching of some parts of the qualification, allowing the use of their installations for carrying out classroom practice sessions, such as Hospitals (Hospital Universitari La Fe, Hospital Clínic Universitari), Research Centres (Centro de Investigación Príncipe Felipe) and other entities (Consejo de Seguridad Nuclear, Enresa, Iberdrola, Central Nuclear de Cofrentes, Centro Nacional de Dosimetria, Oncovisión, Sección de Seguridad Radiológica Conselleria de Governació...).

2. Material and Methods

In order to implement on-line training with a guarantee of success, we have tackled this work with skills reflecting experience in the necessary field:

The company Titania, which belongs to the Grupo Dominguis, is an entity based on spin-off technology of UPV. Within this framework, Titania is the organisation responsible for developing the training, as it adapts the platform to the characteristics of the courses and carry out a follow-up so as to guarantee efficient learning. In its turn Titania coordinates the various phases of the implementation of the training, which is guaranteed by its experience in the coordination and follow-up of technological projects. The essential tasks carried out by Titania are the following:

- The development and adaptation of the specific material of the various courses in a self-explanatory manner for on-line training.
- The adaptation of the Poliformat platform for following up the courses proposed.

The company Lainsa, which also belongs to the Grupo Dominguis, has considerable experience in the nuclear field in various nuclear and radioactive installations. Moreover, it has a Technical Radiological Protection Unit that has been officially approved by the Nuclear Security Council and which gives courses on radiological protection in nuclear and radioactive installations (research, industrial and health installations). The main tasks carried out by Lainsa are the following:

- Gathering material for each of the course modes as to contents, transparencies, videos, animation…
- Providing teachers for tutorials and on-line follow-up and for classroom teaching (practical sessions and assessment in accordance with each course mode taught).

When improving and adapting the teaching of these courses to the training needs of the applicants, advanced technological methods will be available such as the use of technological platforms especially designed for distance training, such as the Poliformat platform of UPV.

UPV has considerable experience in the designing and development of telematic on-line training follow-up platforms, such as the Poliformat platform, in order to manage on-line university and postgraduate training in various master courses. Poliformat is part of the “Sakai Project”, an international scheme that aims to develop open-code educational software. It must be emphasised that the solidity of the platform has been thoroughly tested by the 42,000 members of UPV university community.

The overall objectives of the project concentrate on the development of telematic resources that guarantee suitable training and the detailed follow-up of each course so that it is taught in such a way that it is well controlled by the teaching institution. On-line training in radiological protection, which consists of various blocks of different subjects according to the
type of course taught, will be complemented with classroom practical sessions to guarantee complete quality training and a classroom assessment examination as a check operated by the organisation organising it, i.e. Titania, and by the entity collaborating with the teaching, i.e. Lainsa, to ensure that the course has been assimilated satisfactorily and that the assessment is favourable.

Following the methodology explained above, the course “Master in Radiological Protection in Radioactive and Nuclear Installations” has been implemented as part of the Poliformat platform of UPV.

3. Results and Discussion

The characteristics of the “Master in Radiological Protection in Radioactive and Nuclear Installations” are described below. The various options of the Poliformat tool will also be described, and various captures of the latter will be shown:

The “Master in Radiological Protection in Radioactive and Nuclear Installations” has a duration of 60 ECTS (1500 hours. 1 ECTS (European Credit Transfer System) = 10 hours of teaching + 15 hours of student work), lasts for a whole academic year and is divided into 4 modules, one general, two specific and one advanced. In the general module the student sees a general picture of the basic concepts of radiation and its effects and of radiological protection. The specific modules are that of “Radioactive Installations”, which is divided into industrial installations, nuclear medicine, radiotherapy, radiodiagnosis, and research; and the module of “Nuclear Installations and Fuel Cycle”. For each type of installation, attention is given to their general characteristics, operational radiological protection, and specific legislation. The “Nuclear Installations and the Fuel Cycle” module also includes a Nuclear Safety block. The last module is the Advanced Module, in which the student receives advanced concepts of radiation and radiological protection.

The didactic methodology of the course is blended learning. So, most of the course is online through Poliformat platform of the UPV (the Poliformat platform is described below in greater detail). Also, there are planned several sessions of remote reviews of each area using specific software (named Policonecta) to be able to contact the students wherever they are. The student will only need a computer connected to the Internet, a webcam, and a microphone. Finally, at the end of each module the student must complete his/her training by attending a classroom seminar, helping to revise the course and resolving any queries, and also includes practical sessions, visits to installations, and a classroom examination to check the students’ knowledge.

The environment of the Poliformat platform is friendly and intuitive, which makes it easy to use. It has various tools with different functions depending on whether one is an administrator (for instance a course teacher), when the management capacity is wider, or whether one is a student, in which case permission is restricted to those authorised by the administrators. For this reason the existence of control tools is important; they guarantee efficient follow-up and control by the entity providing the course.

Students have access to the course by means of a main menu such as that shown in Figure 1.
Fig 1. Main screen of the course of Master in Radiological Protection in Radioactive and Nuclear Installations.

On the left of the said start screen there is a menu with various possible options, which are: Calendario, where you can see the course timetable and important dates such as those of classroom examinations; and Anuncios, where you can view the latest news on the progress of the course. In the Programa option you can see the index of the material that will be followed during the course; in Contenidos, the main material available to the student by areas with the presentations, explanatory videos, interactive tasks, etc. that cover the major objectives of the course. In Recursos you can view the complementary material as extra information for those students who wish to go deeper into the subject. In the Exámenes options you can find the self-assessments corresponding to each learning block so as to check the student is assimilating the contents satisfactorily. Other options are: Chat, Foro (Forum), among others. Moreover, as can be appreciated in Figure 1, this screen contains a brief explanation of the course accompanied by images.

The course’s contents have been adapted to make them more interactive by means of presentations and on occasion by videos; they can be popped from hyper-links. A “Polimedia” teaching video is shown in Figure 2.
Once the thematic block has been defined, when the student pops it he/she accesses both theoretical and practical contents of the tasks and resources of the complementary material in the Recursos menu, which can be seen in Figure 3 as to websites, links, complementary videos, etc.

The pace when following the course is set by the student his/herself, as he/she learns the contents and then passes the self-assessments. In this way he/she can learn the thematic blocks by following the material available in them, and assess him/herself as to whether he/she is evolving favourably. In order to so he/she is also assisted by the teachers in the resolving queries and by their comments depending on the results obtained by the student, owing to which course feedback is quick and effective.

Figure 4 includes the self-assessments that can be carried out from the platform. In this case the examination is temporised; when it starts time begins to run. It consists of several multiple choice questions, although examinations can also be created with other question types (short-answer questions, true or false, linking two columns, filling in gaps, etc.). Once he/she has sat the examination, the student will be able to appreciate his/her correct answers and view comments on his/her incorrect ones.

By means of the Statistics tool, the administrator can simply and quickly follow up the steps that each student takes on the platform; in order to do so he/she has at his/her disposal a multitude of automatic reports. Figure 5 shows an example of this.
Fig 3. Screen of the Recursos option in which we will find complementary and course material and other elements to facilitate following the course.

Fig 4. Self-assessment of a thematic block generated by the Poliformat platform that has been drawn up for self-correction.
Fig 5. Screens in which can be appreciated a visits report and an events report. In the former we can see the visits that have been made by the different users over a period of time. In the latter, we can see the number of times each person has accessed each option during those visits.

4. Conclusions

The designing and the teaching of adapted on-line training on radiological protection and nuclear security is interesting because of how it can benefit society in the achieving of a flexible and balanced training system which is convenient and personalised for each individual. The development and designing of this on-line follow-up platform and the fact of having a powerful and robust tool for following up and controlling the course effectively makes the application of this project very interesting both for internal training of personnel from the Group and for client companies, which have been requesting this type of training for some time.

The advantages of this distance training are as follows: employees do not need to leave their workplaces in order to receive specific training as the amount of travel necessary to receive the training is reduced, and the company in charge of the training also reduces costs by using fewer teachers.

In this way flexible quality training is achieved, in which the pace of the follow-up time is set by the person following the course and is adaptable to the internal and external training of the companies requesting it.

The implementation of the course “Master in Radiation Protection in Radioactive and Nuclear Installations” provides training in radiological protection and nuclear security in a telematic way applicable to various specific generic modes of nuclear power stations and industrial radioactive installations, research and teaching institutions, and X-ray diagnosis installations.

5. References

FIRST PATAGONIAN COURSE
“DIAGNOSIS AND TREATMENT OF IONIZING RADIATION INDUCED INJURIES”

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ABSTRACT

Because of the wide variety of nuclear techniques involved in medicine and industry and the consistent increase of occurrence probability of accidents related to human mistakes, stating an effective medical response is a top priority need.

Early diagnosis and treatment of patients undergone irradiation exposures, such as diagnosis, therapy or accidents, must be only done by a qualified medical staff due to the special characteristics of the etiologic agent and the evolution of radiation induced pathologies.

In Patagonia there are universities, industries and hospitals using ionizing radiation in their daily routine. However there are not any protocol available fulfilling local needs. This is why a training course was hosted at Centro Atómico Bariloche from 5th October to 10th November 2012. There were physicians, nurses and radiology technicians among the participants.

Topics included were: dosimetry magnitudes, types of ionizing radiation, internal contamination, triage in radiological emergencies, biological effects, biological dosimetry, radiation acute syndrome, radiation-induced skin syndrome, among others. Lectures were in charge of national experts with an important background and experience in their fields of knowledge.

The course provided a theoretical/practical guide about how to recognise and deal with a patient exposed to ionizing radiation, guidelines for radiological emergencies and a clear perception of psychosocial impact of radiological accidents.

As a result, a pocket notebook was designed including the most important aspects that medical staff should keep in mind when dealing with patients undergoing radiation induced injuries.

Due to the importance and the social sensitivity of the topics scheduled, the National House of Representatives of Argentina stated the course to be of national interest.

1. INTRODUCTION
The use of different techniques applying ionizing radiation has been considerably increased during the last years, such as those in medicine as well as in industry. Therefore, an increase in the probability of accidental situations has been observed due to diagnosis (individual vulnerability to radiation, wrong calibration of radiation
detectors), therapy (safety margins defined inappropriately) or accidental situations. Most of these scenarios are strongly related to human errors.

Because of this increase in accidental probability, an efficient medical response by the health staff is necessary. This group of professionals must be trained and should be able to do an early diagnosis, and when necessary, give proper treatment to the irradiated patient.

There are currently many institutions working with ionizing radiation in Patagonia, such as Balseiro Institute (where the RA-6 Research Reactor is located), industrial facilities (mainly in the oil industry), and several hospitals with nuclear medicine and radiotherapy services. However there are no protocols satisfying local needs.

Due to this necessity and the medical staff concern, a training course for health personnel was carried out at Bariloche Atomic Centre and Balseiro Institute. There were physicians, biochemists, nurses, radiologists, medical physics students, among the participants. The lectures were in charge of national experts with a vast experience and career in their fields of knowledge. The particular characteristics of the etiological agent, the evolution of radiation induced patologies and, when possible, its relation with physics and engineering, were strongly emphasized.

The course has set the following objectives:

- To identify and diagnose radiation induced patologies.
- To provide a practical guide about how to deal with people exposed to radiation, making special emphasis in early actions to be done in case of an incident or an accident, and in a second level, actions to be taken in first aids centre or local hospital.
- To provide a practical guide about the public health in radiological emergencies, including radiation effects, countermeasures, and side effects in the long term, as a decision-making platform about protection and promotion of public health.
- To provide the participants with a new understanding of the mechanisms and significance about the vast psycho-social impact of radiological accidents, which involve people exposure, and of the aspects that should be kept in mind in order to minimize these effects.
- To provide the participants with a new perception about the necessary medical requirements to assist during radiological emergencies and how they should have kept in mind during the emergency response planning.

2. METHODS
The course took place, from 5th October to 10th November 2012. Every lecture but one (a video-conference) was an in-person class.

The programme included a visit to the RA-6 Research Reactor, where the facility chief brought on different possible accidental situations, and a visit to the Nuclear Medicine Service at the local hospital. In the latter, participants could be in touch with a working service and they also analyzed what kind of situations might derive in an overexposure both patients and workers.

Finally, participants took a written exam. They were asked to solve real cases. These exams were thought as another learning step, whose goal was to approach students to possible scenarios where radiation exposure could take place (as much in normal as accidental situations).
Afterwards, members of the organizing committee analyzed the results. This analysis tried to identify common issues and check the answers. Every participant received a personal feedback, which was done by the expert physician committee member.

### 2.1. PARTICIPANTS PROFILE

Thirty-three people signed up, and there was an average attendance of twenty participants per class, among professionals and postgraduate students. The difference between registered people and attendees was because the course schedule overlapped working hours of participants sometimes.

Passing the course implied to have an 80% compliance and the written exam had to be approved.

Figure 1 shows the academic profile of participants. Most of the physicians were labor medicine specialists. The group of radiologists consisted of technicians in radiology and bio-images production.

![Academic profile of participants](image)

Figure 1. Academic profile of participants

Although the course was addressed to health professionals, medical physics master students were present in some classes. Topics developed during this lectures were biological effects of radiation, internal contamination and decontamination, which also correspond to the Radiation Protection subject.

A couple of nuclear engineers and physicists attended the course. However, their performance was not computed since they were not member of the health system to whom the course was addressed.

### 3. RESULTS

An anonymous survey was done the last class. The participants were asked to evaluate the course and its contents. 87% of people said that this kind of activities should be done once a year, and 17% thought that a biannual frequency would be ideal.

On the other hand, 100% of participants believe that these activities are a very good opportunity to exchange experience and to upgrade their knowledge.
Participants were also asked to opine about different aspects of the organization and about the topics included in the programme. The results are shown below.

### Table 1. Organization qualified by participants

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Very Good [%]</th>
<th>Good [%]</th>
<th>Regular [%]</th>
<th>Bad [%]</th>
<th>NC [%]</th>
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<td>Lecturers</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Class length</td>
<td>67</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Time for discussion</td>
<td>53</td>
<td>47</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Schedule compliance</td>
<td>80</td>
<td>13</td>
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<td>Classrooms</td>
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<td>33</td>
<td>-</td>
<td>-</td>
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</table>

### Table 2. Course contents qualified by participants

(5: Very interesting – 1: Not interesting at all)

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<th>4 [%]</th>
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<td>7</td>
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<td>27</td>
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<td>-</td>
<td>7</td>
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<tr>
<td>Cell - Cell death</td>
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<td>-</td>
<td>-</td>
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<td>DNA and radiation</td>
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<td>-</td>
<td>-</td>
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<tr>
<td>Biological effects</td>
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<td>7</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Radiobiology of health tissues</td>
<td>53</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>7</td>
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<td>Radiation induced skin syndrome</td>
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<td>-</td>
<td>-</td>
<td>7</td>
</tr>
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<td>Pregnancy and radiation</td>
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<td>-</td>
<td>13</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>7</td>
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<td>Real case resolutions</td>
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<td>7</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>Site Visit</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>13</td>
</tr>
</tbody>
</table>

The following graph represents how many participants passed the course.
4. CONCLUSIONS
As the main conclusion, participants were trained to use a practical guide which allowed them identify and treat a patient undergoing ionizing radiation, and think about him/her as a whole, meaning, his/her physical and psychological aspects and his/her insertion into society.

Spread this training activity is of fundamental relevance because the same situation as it is presented in our Patagonia occurs in other regions of our country.

Due to the importance and the social sensitivity of the topics scheduled, the National House of Representatives of Argentina stated the course to be of national interest.

Finally, this course was a link between different characters involved in the local health system who were inserted in an emergent issue as the radiation-induced injuries are.

5. ACKNOWLEDGEMENTS
The authors would like to thank: National Commission of Atomic Energy, Bariloche Atomic Centre, Balseiro Institute, Nuclear Regulatory Authority, Argentine Society of Radiation Protection, Association of Balseiro Institute of ex-Students, INVAP SE, Swiss Medical Private Medicine, Bariloche Chocolate Chamber.

The authors would also like to thank the lecturers, who had to travel thousands of miles to be part of this activity.

6. REFERENCES
A SURVEY ON THE AWARENESS OF THE RADIATION PROTECTION IN MEDICAL SECTOR IN ISTANBUL, TURKEY

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ÖZGE ECE KARA
Yildiz Technical University, Institute of Science, Istanbul

ABSTRACT

This study presents the preliminary results of a survey conducted on patients and practitioners exposed to ionizing radiation in some hospitals in Istanbul, Turkey. Questionnaires consisting of common and particular questions related to basic radiation knowledge, radiation protection awareness and professional responsibilities were asked for the target audience. Results of the survey were analyzed by using Statistical Product and Service Solutions, SPSS program.

1. Introduction

Ionizing radiation has been used in medicine for both diagnosis and treatment of disease for many years. In recent years, the use of more developed devices delivering much higher radiation exposure doses in medical imaging have caused a significant increase in patient doses and the collective dose to the population [1]. Therefore, radiation protection and healthcare authorities in each country are reminded to make regular assessments of the magnitude and distribution of this large and increasing source of population exposure [2].

To ensure good practice and to deliver a safe and effective radiation dose to the patient in medical applications, medical staff having a sufficient academic education reinforced with a clinical training are required. Appropriate facilities and radiation protection infrastructure for monitoring and regulatory control are also needed [3].

The lack of well-educated and trained technical staff in radiological applications is a serious problem because their professional knowledge is essential for a successful diagnosis or treatment. Surveys have been conducted for determining the inadequacy in practice [4-9]. Such surveys are very important for determining the needs of education and training.

Although there is an increase in the number of master level courses in medical physics offered by the universities in Turkey, the need for qualified and capable professional staff is growing faster because of the development in medical sector. Due to such concern, a survey has been conducted at the various hospitals in Istanbul to determine the current situation and preliminary results were presented in this paper.

2. Survey Details

Questionnaires consisting of 20-30 questions were separately prepared for the doctors, technical staff (technicians and medical physicists) and for the patients exposed to ionizing radiation. Some common and particular questions related to basic radiation knowledge, radiation protection awareness and professional responsibilities were asked for all target audience. Results of the survey were analyzed by using Statistical Product and Service Solutions, SPSS program.
3. Results

3.1 Profile of the Target Audience

**Number of Participant**

<table>
<thead>
<tr>
<th>Number of Participants</th>
<th>Patients</th>
<th>Technical Staff</th>
<th>Physicians</th>
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<tbody>
<tr>
<td>Patients</td>
<td>396</td>
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<td></td>
</tr>
<tr>
<td>Technical Staff</td>
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<tr>
<td>Physicians</td>
<td>396</td>
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**Age**

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<td>31-40</td>
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<td>51-60</td>
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<tr>
<td>61 and above</td>
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**Professions of the Patients**

<table>
<thead>
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</thead>
<tbody>
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<td>Unemployment</td>
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<td>Teacher</td>
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<tr>
<td>Student</td>
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<td>10%</td>
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</tr>
<tr>
<td>Officer</td>
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<td>5%</td>
<td>5%</td>
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<td>Worker</td>
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<td>Retired</td>
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<tr>
<td>Shopkeeper</td>
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<td>Administrator</td>
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**Professions of the Physician**

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<tr>
<td>Internist</td>
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<tr>
<td>Orthopedics and Traumatology</td>
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<td>Obstetric and Gynecologist</td>
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<tr>
<td>Emergency medical specialist</td>
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<tr>
<td>Otolaryngologist</td>
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<td>Other</td>
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**Experience**

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<td>2 years and below</td>
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<td>20%</td>
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<tr>
<td>3-5 years</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>6-9 years</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>10-13 years</td>
<td>20%</td>
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<tr>
<td>14-17 years</td>
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<tr>
<td>18-25 years</td>
<td>10%</td>
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<tr>
<td>26-29 years</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Education**

<table>
<thead>
<tr>
<th>Education</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliterate</td>
<td>10%</td>
</tr>
<tr>
<td>Literate</td>
<td>5%</td>
</tr>
<tr>
<td>Primary School</td>
<td>10%</td>
</tr>
<tr>
<td>High School</td>
<td>15%</td>
</tr>
<tr>
<td>University</td>
<td>20%</td>
</tr>
<tr>
<td>Post Graduate</td>
<td>10%</td>
</tr>
</tbody>
</table>
3.2 Common questions directed to the target audience

Do you have any information about ionizing radiation?

Which of the following examinations do you think include radiation?

- CHEST X-RAY
- ABDOMINAL ULTRASONOGRAPHY
- MAMMOGRAPHY
- BONE DENSITOMETRY
- ABDOMINAL CT
- ABDOMINAL MRI
3.3 Common questions directed to patients and technical staff

- Do you think the occurrence of the following diseases/symptoms is connected with the radiation?
  - LEUKEMIA
  - INFERTILITY
3.4 Common questions directed to technical staff and physician

- Do you have any idea about the “ALARA Principle”?
- Which of the following explains the ALARA principle?
3.5 Particular questions directed to only patients

- Are you informing the patients about dose delivery before examinations?
- What can you say about the doses received in an Abdominal CT and (PA) Chest X-Ray?
- What can you say about the contribution of the medical exposure to the annual effective dose? (based on NCRP 160)
- What is the annual effective dose for public? (based on ICRP 103)

- Do you have any information about radiation?
- What is the radiation?
- Why do you need for this radiological examination?
- Who requested this radiological examination: you or your doctor?
- Which of the following radiological examinations is more harmful on the basis of radiation?
- Do you request any information about the risk and benefit of the examination from your doctor? or Do you research yourself before application?
- Do you think the given answers are satisfactory?
- What is the reason if you are not researching or requesting any information about the examination?
3.6 Particular questions directed to only technical staff

- **How did you obtain your knowledge of radiation protection?**
- **Which of the following protection tools are available at your work?**
- Do you request the missing protection tools at work?
- Which protection tools do you use at work?
- What kind of protection precautions do you apply for the radiation safety of the patient?
- What are you doing for radiation protection at work?
- Do you ask about the pregnancy of a woman patient before radiological application?
- Have QC and QA tests of the equipment being regularly made in your department?
- If you have ever repeated because of any reason, what is your repeating frequency in a year?

- Do you use a radiation dosemeter?

- What is the checking frequency of your dosimeter?

- Do you think the checking result of your dosemeter is reliable?

- What is the annual effective dose for radiation worker? (based on ICRP 103)
### 3.7 Particular questions directed to only physicians

<table>
<thead>
<tr>
<th>Question</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you have any training on radiation protection?</td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Do you follow the recent developments related to radiation protection?</td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Do you asked about the past radiological history of your patient in the case of ordering a new radiological examination for the same situation?</td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Do you pay attention to choose a non-ionizing alternative method instead of a radiological examination?</td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>What is the unit for using to measure the absorbed dose?</td>
<td><img src="image" alt="Graph" /></td>
</tr>
<tr>
<td>Do you make estimation about the effective dose to patient undergoing PA chest X-Ray for an adult?</td>
<td><img src="image" alt="Graph" /></td>
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</tbody>
</table>
4. Discussion

This is an ongoing survey and the data obtained so far is presented here. These limited data of course is not enough to make a correct interpretation. Completed data would be presented in the future studies.

Acknowledgement

This study is supported by the Scientific Research Projects Coordinator of Yıldız Technical University (BAPK, YTÜ). Authors would like to thank to the Scientific Research Projects Coordinator of Yıldız Technical University for their support.

References


TRAINING COURSES ON RADIATION PROTECTION FOR THE EMERGING NUCLEAR STATES IN THE CENTRAL INSTITUTE FOR CONTINUING EDUCATION&TRAINING

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ABSTRACT

Central Institute for Continuing Education and Training (CICE&T) has acquired wide experience of training in the field of radiation protection during its more than 45 years history of operation. We developed programme packages for various target groups, including nuclear operators and regulatory bodies, oil and gas industry, medicine, research and development organizations. Some programmes were developed jointly with foreign partners and aimed at forming and maintaining nuclear safety and radiation protection competencies both for countries already having nuclear industry and emerging nuclear states. The proposed report contains samples of content and lessons learned from implementation of these programs.

After the Fukushima accident in the CICE&T special emphasis is made on the development of safety related courses for the countries embarking on the nuclear power programme. These courses are focused on the Russian computer codes used for safety analysis and capable of severe accidents modelling starting from the core melting, through hydrogen accumulation in the containment building to radioactivity release and its transport in the environment. These courses were successfully piloted in 2012 for regulatory body of Vietnam.

1. System of continuous education and training in Russia

Continuing education and training is a key resource for advancement of efficiency of business processes. According to the Russian legislation, personnel training and qualification is the responsibility of the utility organisation, the utility may contract other organisations for the fulfilment of this function. For many years, this function has been delegated to training centres and industry institutes of continuing education and training.

Russian System of Continuing Education& Training in nuclear sector has a long enough history, that comes back to the decree of the Council of Ministers in 1967 which, in compliance with the special decree of MinSredMash (the predecessor of ROSATOM), established Institute for Continuing Education&Training (CICE&T) in Obninsk.

The over 45 years of experience accumulated by the Central Institute for Continuing Education and Training in the nuclear industry, that is most demanding to the quality of education and training, has helped to develop a comprehensive educational model.

Main mission of the institute is to enhance professionalism and competence of the nuclear industry employees for its safe sustainable development and competitiveness at the world market of nuclear technologies. Main activities of the institute are: education and training, professional retraining, advanced training of all kinds of specialists working for the Rosatom State Corporation and other industries. Our Institute is the main educational institution for continuing professional education in nuclear industry.

CICE&T plays important role in the implementation of the Rosatom State Corporation strategy, realizing this role through the following activities:

- Organizing and holding of the annual strategic sessions, scientific and technical conferences on the main directions of Corporation's activities;
- Development and implementation of various training courses supporting the programmes of strategic development of Corporation’s industrial enterprises and R&D institutes;
 Corporate policy transfer to the international markets through the training of personnel from foreign companies;
 Preliminary training of managers and specialists for the nuclear power plants construction programme;
 Participation in research and consulting projects in the area of the human resources management;
 Participation in the accreditation system for external technical support organizations in the field of education and training;
 Participation in the development of nuclear sector and international system of personnel certification.

In 2011, according to the current demands, the institute’s organization has undergone reformation. A distributed regional network of branches has been created with maximum functional and territorial relationship of branches to the nuclear power plants and nuclear fuel cycle enterprises.

The headquarters of the institute are located in Obninsk in Kaluga region.

The organizational chart of CICE&T is listed at Figure 1.

Each branch has training centres which are responsible for the development of managerial, professional and technical competencies.

St. Petersburg branch of CICE&T has Centre for Professional Competencies in Construction and four centres for competencies in the following areas: technical competencies, industrial design and construction; industrial and occupational safety; economics and management in construction. Centre for International and the Regional Communications and Scientific and Methodological Centre of the Regular Labour Force Training are also the part of the St. Petersburg branch.

The full scale simulator of the floating power plant was commissioned in the St. Petersburg branch in 2012. The first nuclear power plant will be commissioned in 2014; training of the personnel for this plant will start this year. In the future as new floating power plants will be
commissioned, a Training Centre for the Personnel of the Floating Power Plants will be created.
The training complex of St. Petersburg branch is supplied with all materials and resources as required for organization and support of continuous training activities. These include classrooms fitted with modern training hardware, a training laboratory of radiation control; training ranges for special activities, a library of scientific, technical and methodological literature, electronic database of nuclear facilities and technologies, photo and video materials and other information resources. Hardware and software in conference rooms and classes allows holding videoconferences with participation of leading experts from R&D institutions, Rosatom enterprises and organizations. Trainees are accommodated at our own hotel.
Available faculty staff and other personnel ensures high quality of education and training, provision of consulting and information services in the area of nuclear and radiation safety, preparation for licensing, certification and qualification, participation in expert reviews. Today, universities tend to release graduates of broad specialization, without training them specifically to operate particular technologies and productions. At the same time, training of specialists for nuclear industry requires, in addition to conscious choice of speciality and good level of general technical knowledge, a vast number of practical skills, which simply cannot be acquired in university. In addition, areas such as nuclear and radiation safety, radiation monitoring, emergency response, economy of safety, are not included in the educational programmes in a proper scale. Institutes for continuing education and training are designed to fill these gaps.
Centre for Technical Competencies realizes a set of training programmes on the following directions:
- Nuclear and radiation safety;
- Radioecological and chemical safety;
- Radiological emergency preparedness and response, rescue operators training;
- Nuclear technologies (radiochemical technologies, radioactive waste and spent nuclear fuel management, decommissioning of nuclear facilities)
- Instruments and methods of radiation control: radioactivity measurements, spectrometry, dosimetry;
- State systems for ensuring nuclear and radiation safety: state system for control of and accounting for radioactive materials and radioactive wastes, automated system of transport safety, automated system for radiation monitoring, unified system of individual dose control, etc.;
- Safety culture;
- Physical protection of ionizing sources and radioactive material storage facilities;
- Ensuring radiation safety at the nuclear facilities and other industries using ionizing sources and radioisotope instruments.
Fig 2. Simulators of radiation control instruments and training on radiation monitoring at the computer simulator

All our training programmes are developed according to recommendations and requirements of the IAEA, ICRP, UNSCEAR and national norms and regulations, programmes are licensed and certified, when necessary. For example, training programme on radiation protection for the personnel, working with ionized sources, contains the following topics:

- Basic Russian Federation legislation in the field of atomic energy use and radiation safety;
- State regulation and supervision for safety of atomic energy, nuclear and radioactive materials and products use;
- Current approaches to radiation protection and exposure risks for individual persons, population and environment;
- Principles and requirements to radiation safety;
- Requirements of federal norms and rules in the field of radiation safety;
- Radiation safety organization at facility level. Tasks of health physics division;
- Instruments and methods for radiation control;
- Methods and means for radiation protection;
- Ways and methods of professional exposure optimization
- Safety culture;
- Emergency preparedness and response.

The length of basic programme is 32 hours. For categories of persons receiving operation license in regulatory body (persons, which are responsible for radiation safety at facility level and senior management), duration of this programme is 72 hours. Training programme for them includes some additional topics as follows:

- Radiation and hygiene certification of facilities and territories;
- Social safety of population, nuclear liability insurance and compensation of losses;
- Safety of radioactive waste management. Methods for assessment of environmental contamination by radionuclides. Radionuclide emissions and discharges to the environment. Allowable levels of emissions and discharges.
- Current requirements to accounting for, control and storage of radioactive materials, radioactive sources and fissile materials. Nuclear non-proliferation regime;
- System of radioactive waste management: classification, activity, isotopic composition, waste collection, treatment, storage and disposal;
- Fire and explosion-proof safety;

Over 100 trainees were trained on these programmes in 2012.

Fig 3. Practical training on the use of radiation control instruments during dwelling inspection and individual monitoring of personnel
After adoption of a large-scale federal programme of the Russian nuclear sector development and signature of a number of international agreements to construct several nuclear power plants by the Russian design abroad, a range of problems became evident in the construction complex that deals with building and modernising nuclear plants. Key problems of that kind are the weakness of the production basis and acute shortage of qualified personnel.

St. Petersburg branch of CICE&T was the first training centre to be accredited by the three top self-regulated construction organizations and organize training for construction activities. A training plan has been written and approved, which envisaged provisions for training and qualification in all activities performed by the partner organisations, participating in nuclear construction. On the basis of the institute, a training and qualification centre is being created for welders and robotics operators of the highest qualification that have permission to carry out work on the primary and secondary NPP circuits. Thus, on an entirely new ground the institute is restoring the once mighty construction direction of activity.

Special faculty for maintenance of nuclear power equipment was established in CICE&T. A great attention in maintenance personnel training is paid to the issues of radiation safety and protection during maintenance works.

Aside from that, CICE&T implements distance learning courses in its training activities. Distance learning system has been functioning in the institute since 2008. For such a vast country as Russia, distance learning offers the following advantages;

- Provision of educational services regardless of the student’s location;
- Students can independently plan the duration and timing of their training sessions, as well as the list of subjects that they study;
- Students can learn according to their own schedules, personal features and training needs in the most comfortable and efficient conditions;
- Usage of state-of-the-art training technologies, which allows developing useful work skills in parallel with the training process.

CICE&T patterns its activities on the best standards of professional education and training, co-operates with leading European organisations in the education and consulting market. Utilization of international experience, own developments and best practicing specialists helps the institute to offer the industry a comprehensive range of innovative educational and training services.

The best evidence of the high quality of educational and training services supplied by CICE&T is development of training programmes jointly with our partners from Sweden, Finland, USA and other countries, as well as carrying training programmes for the countries embarking nuclear power (Egypt, Bangladesh, Vietnam). The positive feedback and subsequent joint projects make us confident that education and training received at CICE&T will provide the essential step towards professional growth.

Every year CICE&T together with its partners, regulatory bodies of Finland and Sweden, implements training courses and seminars for Russian trainees.
One of the most remarkable samples of such co-operation is the International Nuclear Manager Training Course. The course was organized by the Rosatom State Corporation, St. Petersburg branch of CICE&T, Finnish Radiation and Nuclear Safety Authority (STUK), TVO and ES-Konsult companies with the support of the IAEA, Swedish Radiation Safety Authority (SSM) and Rostechnadzor (Russian nuclear regulator). The Course is intended to provide an overview of the most important topics of nuclear and radiation safety. The course should meet the needs of manager and supervisory level employees for understanding the broad range of topics that make up the body of fundamental knowledge in nuclear and radiation safety, to promote career development.

The course programme is divided into 3 modules:

- First module: Nuclear and radiation safety principles and nuclear fuel cycle
- Second module: Nuclear safety in design and construction
- Third module: Operational safety

Training was done in the form of lectures, workshops, seminars, discussions, visits to the nuclear power plants and training centres, simulators, radioactive waste storage facilities in Russia, Finland and Sweden.

Among lecturers and instructors were managers and leading specialists from Rosatom State Corporation, Rostechnadzor, regulatory bodies from Finland and Sweden, R&D, design institutions, nuclear training centres, nuclear operators such as Rosenergoatom Concern, AREVA, TVO, Fortum, E.ON and technical support organizations.

63 representatives of 14 countries took part in the course in 2009. Participants of the course distinguish high relevancy of this course and importance for the nuclear and radiation safety.

Methodology for radiation protection training that was developed jointly with our colleagues from the Swedish Radiation Safety Authority (SSM) for training of the personnel working for the SevRAO enterprise, which is operating with legacy military radioactive waste and spent nuclear fuel, was then successfully used for the development and carrying of the training course on radioactive waste and spent nuclear fuel management for engineers. 9 specialists from Egypt were trained according to this programme in 2011; the duration of the programme was 100 hours. Trainees recorded that the course reached its aim and was useful for them.
St. Petersburg branch of CICE&T holds meetings for nuclear sector specialists, national and international scientific workshops and conferences, expert group meetings, including expert groups from the IAEA, WANO and other international organizations on a regular basis. International Nuclear Forum “Safety of Nuclear Technologies”, which is annually held in St. Petersburg branch, is a high recognition of level of professionalism and competencies of CICE&T personnel. Main topics of the Forum are as follows:

- Legal regulation, nuclear and radiation safety and physical protection requirements, state regulation, licensing, certification;
- Instruments and methods of radiation control;
- Emergencies and emergency preparedness, risk assessment and nuclear liability insurance;
- International organisations and international projects in nuclear and radiation safety;
- National and international experience, prospects of nuclear and radioactive material transportation, technologies, logistics, transport vehicles and packages;
- Radioactive waste and spent nuclear fuel management;
- Public communication.

VIII International Nuclear Forum will be held in September 2013, this year the main topic of the Forum will be safety culture.

For further enhancement of the continuous professional education and training it is proposed to create specialized training complexes which could provide training and retraining on various directions and specializations.

The tasks of such a complex are:

- Training of specialists of various backgrounds: from secondary technical education to training and retraining of managers and specialists with the use of advanced educational technologies and methods according to the certified programmes and requirements of educational standards.
- Close collaboration with nuclear industry, training and retraining based on the programmes, which are required by industry.

Application of these tasks to the nuclear and radiation safety training includes:

- Development of sufficient training facilities (classrooms, laboratories, training ranges with necessary equipment), which must ensure training on scenarios, approximated to the real field conditions with actual use of modern instruments and protection equipment;
- Selection and training of faculty staff, researches, instructors and service staff. Personnel competencies must ensure high level of education and training, R&D activities, consulting and information services in the field of nuclear and radiation safety, preparation for licensing, certification and attestation, participation in expert reviews;
- Creation of information and methodological basis, including a library of scientific, technical and methodological literature, electronic database of nuclear facilities and technologies, photo and video materials and other information resources;
- Development of modular programmes with the possibility of their adaptation for various groups and categories of personnel;
- Organizing of conferences, workshops, meetings, panel discussions, instructor training and other events on nuclear and radiation safety topics complimentary to education and training;
- Priority of the safety culture as the base for integrated nuclear and radiation safety system at facility level;
- Co-operation with foreign countries and international organizations for the development of international system approaches to the issues of nuclear and radiation safety.

2. Capabilities for education and training of the personnel from countries embarking nuclear power development
The recent experience of effective practical training has helped to identify key areas where opportunities could be offered to countries seeking to create the necessary infrastructure for the preparation of their own nuclear human resource, as well as potential buyers of Russian nuclear technologies.

The first area is introduction to nuclear technology for NPP construction personnel, contractor and subcontractor personnel, according to IAEA recommendations. The second area is development of specialised courses for university faculty staff in the states which are potential recipients of Russian nuclear power technology. This standard programme of advanced training spans 72 hours of sessions (two weeks) and in terms of scope corresponds to a university semester’s worth of classrooms sessions, helping teachers, who already possess the basic competencies, to quickly master for programme for nuclear students. Courses are offered on reactor physics, reactor operation and control, nuclear power plant engineering, nuclear safety, safety of research reactors, radiation protection and environmental protection. The courses take into account the experience that CICE&T gained from practical interface with nuclear industry.

In 2009, two training courses - "Nuclear reactors control and protection systems" and "Radiation and environmental safety" - were taught to professors and teachers of Belarusian universities. In December 2009, CICE&T, in cooperation with the IAEA, taught the course "Safety during operation of research reactors" to employees of the Institute of Nuclear Physics of the national Academy of Science of the Republic of Kazakhstan. Summaries of the training courses have been presented at various IAEA-sponsored forums and attracted a lot of attention from the developing countries.

The traditional way of introduction to nuclear university education is usually based on sending the students abroad or inviting foreign professors to start teaching the courses at national universities. The format of training offered by CICE&T, however, reduces the risk of “drain” of young specialists to other, higher developed countries with better employment opportunities and living standards.

The third area is the creation of an international venue for discussion of non-proliferation issues. Since 2008, the institute has been holding an annual International Workshop on Non-Proliferation, with the objective of discussing recent trends in the proliferation resistant nuclear fuel cycles and identification of effective practices of development of curriculum for university course on non-proliferation. The Workshop highlighted the following subjects:

- Essentials of advance proliferation resistant fuel cycles;
- Implementation of legal and organisational support to increase proliferation resistance,
- Best practices in R&D for developing proliferation resistant fuel cycles,
- Uranium fuels. Challenge of proliferation,
- Simulation of proliferation resistant features,
- Advanced methods of monitoring and control,
- Development of university courses on non-proliferation.

After the Fukushima accident in the CICE&T special emphasis is made on the development of safety related courses for the countries embarking on the nuclear power programme. These courses are focused on the Russian computer codes used for safety analysis and capable of severe accidents modelling starting from the core melting, through hydrogen accumulation in the containment building to radioactivity release and its transport in the environment. These courses were successfully piloted in 2012 for regulatory body of Vietnam.

3. Conclusions

The specific feature of the system of continuing education and training is a strong link with nuclear industry. This gives it an advantage of flexibility in reacting to the changing educational demands and thus could be used as essential complementary factor in reforming the university educational programmes based on professional standards. In addition to that the leading institutes of continuing education and training might play the role of regional
International Centres for capacity building for the states embarking on nuclear programmes. Central Institute for Continuing Education and Training (Obninsk, Russian Federation) invites for cooperation scientific, engineering and university communities from the states potential recipients of Russian nuclear power technologies in the area of specialized professional training.
TURKISH EXPERIENCE IN EDUCATION AND TRAINING IN RADIATION PROTECTION FOR DIAGNOSTIC RADIOLOGY

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ABSTRACT

Education and training in radiation protection (RP) is widely recognized as one of the basic components of the optimisation of medical exposures to ionising radiation. The aim of the presented study is to describe the Turkish experience in RP education and training of radiation protection officers, such as medical doctors, radiologists, technicians, physicians and workers and also to identify main contents of syllabus on RP courses in Turkey. Meanwhile, general learning objectives and main content and course duration for RP courses are tried to summarize in the study. The courses are designed to provide both theoretical and practical sessions in scientific and technical bases of recommendations of The International Commission on Radiological Protection (ICRP) and The Council Directive 97/43/EURATOM and standards on radiation protection and their implementation as well. Ankara Nuclear Research and Training Centre (ANAEM) affiliated with Turkish Atomic Energy Authority (TAEK) carries out national and international education, training and research about the topics of mainly radiation protection on radiation safety, and also nuclear safety and security. The course syllabus on RP for radiologist in Turkey has been implemented according to the final course programme of the ANAEM. Ten RP courses for radiologist have been organized by the ANAEM and total 243 participants were trained in between 2011–2012. The RP training programs are quite beneficial and useful to fulfil intended purpose of providing protection of the patients and the staff involving in the field area from the harmful effects of radiation. Similar training courses for interventional cardiologists and other medical practitioners, conducting interventional procedures can also be organized by institutions and organizations as stated in the Turkish related Regulation system providing that these institutions and organisations fulfil the specified requirements by the regulation in Turkey.

1. Introduction

Education and training in radiation protection (RP) is considered one of the basic aspects for optimization programmes in medical radiation exposures. The continuous education programmes on RP are of paramount importance to ensure that patient and staff doses are kept to a minimum level. The International Commission on Radiological Protection (ICRP), in its publication 73 [1], states that “one important need is to provide adequate resources for the education and training in radiological protection for future professional and technical staff in medical practice. The training programmes should include initial training for all incoming staff and regular updating and retraining.” The ICRP has recently issued a new document that is giving recommendations on this related topic. Council Directive 97/43/EURATOM [2], establishes in Article 7 that “Member States shall ensure that practitioners and individuals mentioned in related
articles should have adequate theoretical and practical training for the purpose of radiological practices, as well as relevant competence in RP. For this purpose, Member States shall ensure that appropriate curricula are established and shall recognize the corresponding diplomas, certificates or formal qualifications.” According to Article 9.2, “Member States shall ensure that practitioners and the individuals referred to above those who are performing high doses to patients, such as interventional radiology (IR), obtain appropriate training in these radiological practices.”

The purpose of the study is to present the Turkish experience in RP education and training in diagnostic radiology, different professional levels, the regulatory requirements and the feedback obtained from various RP actions. Radiation protection training is one of Ankara Nuclear Research and Training Center’s (ANAEM) tasks among other training activities through which educational courses at national levels are offered and the trainees certified. ANAEM also hosts international courses organized by International Atomic Energy Agency and many other similar organizations at the international level.

2. Materials and Methods

The Ankara Nuclear Research and Training Center (ANAEM) is affiliated with Turkish Atomic Energy Authority (TAEK). TAEK was first established with the name of the Atomic Energy Commission in 1956 as a governmental organization. The name of the Atomic Energy Commission and its structure has been reformed by the new Act (No: 2690- year 1982) establishing TAEK with the main objectives of policy making on nuclear energy and technology, regulation, licensing and inspection, research and development and training. All topics in radiation protection in Turkey are regulated and supervised by the TAEK as well. The duties and responsibilities of the ANAEM are national and international education, training and research about topics of RP, such as radiation safety, nuclear power, nuclear safety, application of nuclear/radiation. Providing public information about nuclear topics is also among the duties and responsibilities of ANAEM.

Other centers relevant to training affiliated with TAEK are Çekmece Nuclear Research and Training Center (ÇNAEM) and Sarayköy Nuclear Research and Training Center (SANAEM). The ÇANAEM is located in Istanbul and is specialized in nuclear applications and technology such as research reactors, nuclear engineering, reactor safety, nuclear materials, non-destructive testing, nuclear electronics, radiobiology, radioactivity and analytical measurements and analyses, environmental radioactivity monitoring, radioactive waste management, calibration of nuclear instruments, health physics.

The SANAEM located in Ankara and is specialized in various types of radioactivity and analytical measurements and analyses, accelerator physics, nuclear medicine, health physics, detection of irradiated food, nuclear biotechnology, polymer chemistry, radioactivity detection systems, detector and dosimeter materials and neutron physics with respect to nuclear applications. The Gamma Sterilization Facility and Proton Accelerator Facility are in service at the SANAEM. Specific trainings, such as in the detection of irradiated food, non-destructive testing methods, comet assay analysis method, fundamentals of radiopharmacy and radiography, are carried out by ÇNAEM and SANAEM under the coordination of ANAEM.
The job title of a Radiation Protection Officer (RPO) is defined by National Regulation of Radiation Safety, in Article 4-i, (No:23999)(3). According to this regulation, an RPO is a person who has qualified with basic safety standards for RP and implements these standards according to characteristic requirements of his job. Also, RPO must have a proven track record of accomplishment in this field, approved by TAEKK. These are the key elements to be done before applying to the Authority for a licence. The duties and responsibilities of the RPOs are also defined in the Regulation’s Article 73. According to the National Regulations of Radiation Security any facility tackling with radiation, including radiation sources shall have a RPO that certified by TAEK after the RPO having successfully completed training courses. Several pilot apprenticeship training and training courses were carried out, and evaluated after these trials at the ANAEM involving RP education and training aimed at specialized education for radiologists, medical doctors, technicians, physicians, radiation workers. The results were seen positive.

2.1. Review of syllabus

In the recommendations from the European Association of Radiology (4), there is a defined “Core of knowledge for general radiology” syllabus. Elements of the basic sciences of this syllabus include:

- Radiation physics;
- Radiobiology;
- The physical basis of image formation including conventional x-ray, computed tomography, nuclear medicine, magnetic resonance imaging and ultrasound;
- Quality control;
- Radiation protection;
- Anatomy, physiology, biochemistry and techniques related to radiological procedures;
- Cell biology, DNA, RNA, and cell activity;
- Pharmacology and the application of contrast media;
- Basic understanding of computer science, image post processing, image archiving and image communication and teleradiology.

To fulfil these demands, a syllabus for a course, “Diagnostic imaging-physical and biological aspects” has been presented by the European Association of Radiology (EAR), through its working group for radiation protection. The course is meant to fulfil the demands, and designated to be given for 40 hours of theoretical education, supplemented by demonstrations. The syllabus has the following content in the final course programme of the ANAEM according to the EAR recommendations:

- Fundamental concept of ionizing radiation (Atomic structure, natural and artificial radiation, radiation dose, external and internal exposure, X-ray production, interaction of X-rays with matter)- 4 hours.
- Units and conversions (application)- 2 hours.
- Radiation measurement and detection, -1 hour and (application)-2 hours.
- Biological effects of radiation- 2 hours.
- Systems security of radiation (Justification and optimization)- 2 hours.
- Personal monitoring, dose limits, typical patient and staff dose levels.- 2 hours.
- Radiation shielding for radiology-2 hours.
- National legislation for radiation security-1 hour.
- Imaging modalities for diagnostic radiology (e.g. X-ray generators, film and digital sensors, CT, fluoroscopy, new imaging modalities)- 5 hours.
- Dose reduction techniques (for physician, patient and technician - 4 hours.
- On the job-training for dose reduction (practical radiation protection)- 8 hours.
- Quality assurance programmes/acceptance testing - 2 hours.

Figure 1 presents the percentage of total course time devoted to each subject area for the years 2011-2012.

3. Results and Conclusion

The courses are presented as five-day seminars by physicist, radiation biologists, radiation protection experts, and medical physicists. Course notes are disseminated to all attendees for future reference. At the end of each training course, an examination is performed. Evaluation questionnaires are also completed by attendants and their results later used to improve teaching strategies. Ten radiation protection courses for diagnostic radiology were organized by the ANAEM and 243 participants were trained between 2011-2012 years. Table 1 presents the best- and the worst-rated aspects of the training courses for the between 2011-2012 by assessing questionnaires and overall assessments obtained by the ANAEM. Table 2 presents the rated aspects of the training courses by participants for evaluation of instructors in their own designated syllabus performance (over 5 points).
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<thead>
<tr>
<th>Educational Planning and Materials</th>
<th>Agree absolutely</th>
<th>Agree in part</th>
<th>Don’t agree</th>
</tr>
</thead>
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<tr>
<td>Suitability and content</td>
<td>80,1</td>
<td>19,9</td>
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<td>25,4</td>
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<tr>
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<td></td>
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<tr>
<td>Scope</td>
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<td>22,8</td>
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<td>Applications</td>
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<td>Lecture hall</td>
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<tr>
<td>Transportation</td>
<td>92,1</td>
<td>6,2</td>
<td>1,7</td>
</tr>
</tbody>
</table>

Table 1. The best- and worst-rated aspects of the training courses (%).

| Fundamental concept of ionising radiation | 4,5   |
| Units and conversions                     | 4,3   |
| Radiation measurement and detection       | 4,2   |
| Radiation measurement and detection (application) | 4,2   |
| Biological effects of radiation           | 4,3   |
| Systems for security of radiation         | 4,1   |
| Personal monitoring                       | 4,0   |
| Radiation shielding for radiology         | 4,3   |
| National legislation                      | 4,2   |
| Imaging modalities for diagnostic radiology | 4,2 |
| Dose reduction techniques                 | 4,3   |
| On the job-training for dose reduction    | 4,4   |
| Quality assurance                         | 4,1   |

Table 2. The rated aspects of the training courses by participants for evaluation of instructors in performing designated syllabus (over 5 points).

At end of the each training course, participants were given a test. According to examination score, two different certificates were issued for the participants by TAEK. If the examination score was ≥ 70, a “Certificate of achievement” was issued, for lower scores, a “Certificate of attendance” was given. 241 participants took the examinations. The results have shown that examination scores under 70 were only received by two participants. From the above figures, it can be assumed that currentRP training
programs are quite beneficial and useful to fulfill their intended purpose of providing protection of patients and staff from the harmful effects of radiation.

Education in radiation physics, radiobiology, and RP are, currently well defined, and the guidelines for contents of educational courses are defined through collaboration between the European Association of Radiology (EAR), and the European Federation of Organisations of Medical Physics (EFOMP). Radiological training in Turkey is provided centrally by the competent authority, (TAEK), for RP and, locally, by institutions experienced in this field. Coupled and combined training programmes and on-the-job training programmes were found to be effective and efficient. It was found that RP education and training for diagnostic radiology should be implemented at all levels of education, including continuous training for practitioners with professional experience. It has been found that educational objectives should be given appropriately according to the role, played by the physician (referrer, practitioner non-radiologist, radiologist and interventionalist). This training is usually welcomed, when it allows for a better long-term implementation of RP rules.

The authors would like to express their gratitude to the training instructors of TAEK and personnel of the ANAEM for their contributions to the presentation of the courses.

**Acknowledgements**

The authors would like to express their gratitude to the training instructors of TAEK and personnel of the ANAEM for their contributions in the realization of the courses.

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**REFERENCES**

THE EFFECTIVENESS OF RADIATION PROTECTION TRAINING IN LITHUANIA
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Skills and knowledge gained in radiation protection training courses guarantee proper and effective use of radiation protection principles to protect public, patients and workers, dealing with sources of ionizing radiation from harmful ionizing radiation effects for health and environment. Several years experience of radiation protection training in Lithuania has proved that the quality of the training courses depends on the collaboration between Technical Support Organizations (TSO), regulatory authority and different ministries. Therefore, following the International Atomic Energy Agency (IAEA) Safety Reports Series No. 20 (Training in Radiation Protection and the Safe Use of Radiation Sources) and European Union requirements and recommendations, Radiation Protection Centre (RPC) prepared the legal acts on compulsory radiation protection training.

RPC is a regulatory authority, which plays very important role not only in Radiation Protection Supervision and Control, but also in creation of Radiation Protection Training system in Lithuania. The Law on Radiation Protection is one of the main legal documents in Lithuania, regulating the requirements for persons, who have to be trained in radiation protection. Regarding to the mentioned Law, on 2011 there was adopted an Order of the Minister of Health (Order No. 1001 On the Approval of Compulsory Radiation Protection Training and Instruction Procedure). On this Order there are determined the requirements for: persons, who have to be trained in radiation protection; for persons, who want to become lecturers; for training programmes and for the institutions (TSO), which want to provide the radiation protection training. According to this Order, the persons, working with ionizing radiation sources, also the persons, who might deal with the ionizing radiation sources on their work and the persons, responsible for radiation protection at their working facilities, have to be trained by initial training programmes before they start a work and have to be retrained every five years by the refresher training programmes to renew their knowledge.

After every radiation protection training course the knowledge of course participants is evaluated by the competent commission. There are some requirements for the effective knowledge assessment:

• The Chairman of Evaluation Commission should be a representative of RPC;
• At least one member of the Evaluation Commission has to be a qualified lecturer;
• Evaluation is divided into two parts - theory and practice: a test (30 questions for theoretical knowledge assessment) or 3 open questions, which requires oral answers and demonstration for practical knowledge assessment;
• Evaluation results must be recorded in an examination protocol;
• If participants pass the examination, they get certificates.

Also for the effective training it is necessary to have high qualified lecturers, who would be able to share their knowledge with the participants of the courses. Persons wishing to be radiation protection lecturers have to pass an examination of the Attestation Commission and get a certificate. The certificate is issued for specified topics. The Attestation Commission is consisted under an order of the Director of RPC and the members of this Commission are the professors and lecturers from different Universities. Examination is divided into two parts - theory and practice. A certified person must have a University degree in technology or physics, or biomedical sciences. The person wishing to be certificated and be a lecturer can select a number of topics to be certificated for. The list of the Attestation topics is approved by the Minister of Health on the earlier mentioned Order.

RPC is interested in effective implementation of radiation protection training, so once per year (or if it is necessary – more than once) it is organizing the verification of institutions (TSO), providing radiation protection training. Also, RPC organises qualification improvement courses – seminars, radiation protection trainings for radiation protection officers and workers dealing with ionizing radiation sources, where qualified radiation protection specialists presents the changes in radiation
protection system. In cooperation with IAEA and other international organisations as European Commission organises trainings for trainees, trainings and practices for specialists. RPC cooperates with various Governmental institutions and organises compulsory radiation protection training courses for Government officials (Customs officials, State Border Guard Service, Police officers, Fire fighters, Municipal Civil Protection specialists).

The created radiation protection training system helps to ensure the effectiveness of the radiation protection training in Lithuania.
1. Introduction
CORONA is a project co-funded by the European Commission, under the 7th Framework Programme (FP7) – Euratom. The essence of the project is to provide a special purpose structure for training and qualification of personnel for serving VVER technology as one of nuclear power options used in EU. Such approach should allow unifying existing VVER related training schemes according to IAEA standards and commonly accepted criteria recognized in EU.

2. Background
The project proposal was submitted to the European Commission in April 2011 under the Euratom Programme for Nuclear Research and Training Activities. The type of the funding scheme is Coordination and Support Actions that covers not the research itself, but the coordination and networking of projects, programmes and policies. The project will be implemented under main activity Human resources, mobility and training and the topic addressed is 2011-5.1.1 Euratom Fission Training Schemes (EFTS) in nuclear energy and radiation protection.

3. Participants
For the implementation of the project a consortium of eleven partners has been established and Kozloduy NPP Plc. is the project coordinator. The other partners are the Institute for Nuclear Research and Nuclear Energy (Bulgaria), Risk Engineering Ltd (Bulgaria), PM Dimensions (Austria), Nuclear Research Centre Rez (Czech Republic), EC Joint Research Centre – Institute of Energy (EC), Fortum Power and Heat Oy (Finland), Atomic Energy Research Institute (Hungary), Moscow Energetic Physics Institute "MEPHi" (Russia); Tecnatom (Spain), Intellectual Technologies Slavutich (Ukraine).

The partners have a long experience in the area of nuclear research, support, operation and training. The accumulated up to now knowledge in VVER technology, the shared experience and good practices constitute a solid basis for training and qualification of personnel. The members of the consortium possess a good practice in coordination of activities gained through close collaboration within several EU funded networks such as COVERS on nuclear operation safety, SARNET on analyses of severe accident, NURESIM and NURISP on reactor simulations, REDOS, TACIS, PERFECT, RADE on reactor dosimetry for irradiation damage of reactor pressure vessel metal and reactor lifetime prediction. They have a long experience in reactor safety and many important surveys and results obtained in common researches.

The beneficiaries (Bulgaria, Czech Republic, Finland, Hungary, Ukraine, and Russia) have in operation units of VVER technology of first and second generation. The Training Centre of Kozloduy NPP is well equipped for carrying out the training. Many years of the plant survey carried out by IAEA, WANO and other international organizations created a high expertise in training of operational personnel and good recognition of the safety requirements. The INRNE is research organization witch supports KNPP from its creation till nowadays. Furthermore, INRNE has a long experience in training specialists for the nuclear power plant at Ms.Sc. and Ph.D scientific levels. REL is a technical support organisation that carried out many safety related tasks. The experience of EC JRC-IE in knowledge portal creation will guarantee the preservation of the information. The base as well as the last knowledge that will be shared with Russia, as a designer of VVER technology, will maintain the high level of the regional centre of
competence. The experience gained from the other partners - Czech Republic, Hungary, Finland and Ukraine in VVER training will be additional contribution to develop a well balanced centre. The rich experience of Tecnatom (Spain) in soft skills management will be transferred and will provide new approaches in possibility to teach and to motivate the trainees.

4. Concept and objectives
The project structure is based on three general pillars [1]:
1) Training schemes for different target groups;
2) VVER related knowledge management system, which will accumulate available information;
3) Specialized regional training centre for supporting VVER customers with theoretical and practical training sessions, training materials and general and special assignment training tools and facilities.

The overall objective of the project is to develop competences and new skills within the context of the Nuclear Renaissance for implementing the EC decisions following SNETP [3] and SRA [4] and to contribute to improvement of safety and reliability of nuclear installations. Based on the project’s outcomes the long term vision of the proposal envisages evaluation of the options to establish the Regional centre of competence as a legal entity and to join ENEN [5].

The specific objectives of the project are:
- Enhancing safety and performance of nuclear installations with VVER technology through specialized initial and continuous training of personnel involved;
- Emphasis on safety culture enhancing the importance of maintaining an adequate level of safety culture in VVER installations;
- Contributing to the development of Knowledge Management System for VVER technology;
- Preserving and further developing nuclear competencies, skills and knowledge related to VVER technology, as a technology used in the EU;
- Contributing to research initiatives and education actions as well as to future business opportunities for the nuclear industry;
- Catalyzing the building of national network related to nuclear industry, research and academia, and other types of community of practice;
- Stimulating the cooperation with ENEN and SNETP/ETKM - opening research and training facilities of common interests to a wider community of students, scientists and operators.

5. Scope
The scope of the project includes the following aspects [2]:

5.1. Training needs analysis.
Identification of training needs, elaboration of a list of generic types of training where specific training schemes have to be developed including training sessions, seminars, workshops, etc. to constitute the portfolio offered to postgraduates and professionals for training and further personal development.

The training schemes will be developed according to the Systematic Approach to Training (SAT) and will include the following five phases: Analysis, Design, Development, Implementation and Evaluation.

This approach is in compliance with European strategy for vocational training.
EQF will be used for definition of minimum required entrance level and definition of expected level of professional qualification.

5.2. Training schemes development.
Training schemes in the following four generic groups will be developed within the project:

- Group A. Specialized training on specific VVER technology aspects for nuclear professionals and researchers
Continuous training is one of the goals to maintain the high performance level of plant personnel. To achieve this goal, areas of knowledge necessary for safe plant operation should be systematically reviewed. The continuing training programme should cover recent industry and plant specific operating experience, identified problems in performance, plant modifications and procedural changes. The continuous training should achieve the following:

- improve the knowledge and skills of personnel when changes in the scope of work are identified;
- maintain and in certain areas enhance the skills and knowledge necessary to accomplish routine, abnormal and emergency duties;
- increase the level of understanding of certain fundamental matters presented in the initial training, with emphasis on areas of demonstrated weakness;
- maintain an awareness of the responsibility for safe operation of the plant and of the consequences of negligence and faults;
- correct deficiencies in personnel performance that have been detected through the analysis of plant operating experience;
- maintain the personnel’s knowledge of plant modifications and procedural changes in areas to which they are assigned;
- emphasize lessons learned from industry and plant specific operating experience to prevent the repetition of errors;
- emphasize topics identified by managers and supervisors;
- enhance the performance of operations personnel through timely training for infrequent, difficult and important operational tasks;
- keep the adequate level of safety culture.

Within the scope of this group specialists of the following categories are included:

**Category A.** NPP personnel employed in the management, maintenance, operations, technical support and safety control:
- Managers responsible for nuclear safety and radiation protection,
- Operators, shift supervisors, chief supervisors,
- System/component/maintenance engineers,
- Performance/safety engineers,
- Technical support engineers,
- Leading specialists and experts in the above areas;

**Category B.** Nuclear professionals from research and engineering organizations, surveillance and regulatory bodies performing activities in the areas of design, technical support and decommissioning of nuclear facilities, RAW and SNF management, nuclear safety and radiation protection surveillance/control:
- Managers responsible for nuclear safety and radiation protection
- System/component engineers,
- Performance/safety engineers
- Regulatory Body inspectors and specialists
- Leading specialists and experts in the above areas;

**Category C.** Specialists involved in nuclear training related activities in the areas indicated in item 2.
- Lecturers from educational organizations – universities, specialized schools.
- Instructors from nuclear specialized training centres and NPP personnel training specialists

The development of training schemes for two Target Groups has been planned:

**WP-2 Target Group A1: Basic training scheme on VVER technology for nuclear professionals**

The scheme is intended for initial specialized training of specialists graduated in certain specific areas like nuclear science, nuclear engineering or nuclear technology without job experience. The minimum required entry level according to EQF for entrance in this scheme is the Level 6. The qualification level to be achieved after completion of the envisaged education shall include, but not limited to the following groups of competences:
- Safety Principles of Nuclear Facility
- Nuclear Facility theory/technology
- Nuclear Facility Components/ Equipment
- Nuclear Facility Systems
- Nuclear Facility procedures to perform work
- Safety culture and soft skills

While developing this scheme the level of the expected competences and the required training for particular specialists within the areas, as well as within the type of the main functions performed by them shall be defined. Maintaining and enhancing specialists’ qualification shall be achieved through training in certain courses, included in the training scheme “Advanced training scheme on VVER technology for nuclear professionals”.

**WP-2 Target Group A2: Advanced training scheme on VVER technology for nuclear professionals**

The scheme is intended for experienced nuclear professionals graduated in nuclear area. It assures maintaining and enhancement of the specialists’ qualification in the abovementioned areas through long term continuous training.

Three principal grades of experience can be distinguished as follows:

a) General plant experience, which comprises a general knowledge of nuclear power plants and the related activities. This sort of experience may be gained by occupying various positions at different plants.

b) Plant familiarity, which is the detailed knowledge of a particular plant or activity, and which can only be obtained by day to day work in a particular position.

c) Breadth of experience, which relates to knowledge not directly connected with the duties of a particular position. It includes knowledge of interfacing activities, and a wider knowledge of the plant and the operating organization which may extend to other activities outside the plant.

The minimum required entry level for this scheme is:

- EQF Level 6,
- Passed specialized initial training for the particular position,
- Experience and the requirements of the particular position.

The qualification level to be achieved after completion of the envisaged education shall include, but not limited the following groups of competences:

- Safety Principles of Nuclear Facility
- Nuclear Facility theory and technology
- Nuclear Facility Components and Equipment
- Nuclear Facility Systems
- Nuclear fuel
- Nuclear Facility procedures to perform work
- Safety culture and soft skills

**Group B. Basic training on VVER technology specifics for non-nuclear professionals and subcontractors.**

The requirements for qualification of contractor personnel are generally defined in terms of education, experience and training in the IAEA-TECDOC-1232 [6]. The determination of qualification requirements depends on the nature of services requested by the contractor. Training scheme could be applicable for different VVER plants taking into account the specific requirements of the country regulator. Such program will be useful for the stage of design and build of new power stations.

In general the contractor personnel shall obtain site access, radiological control and other type of training when applicable. The contractor shall demonstrate that their personnel are suitably qualified according to all the defined standards and criteria of the specified work.

Training schemes for two target groups will be developed:

**WP-3 Target Group B1: Basic training scheme on VVER technology for contractors**
Within the scope of this group all suppliers and contractors involved in design, engineering, manufacturing, construction, operation, maintenance or other safety related activities will be included.
The staff of contracting organizations selected for specific safety related work should be competent, qualified and medically fit to perform their assigned tasks. The contractors should possess documentary evidence that they and their staff have the appropriate training and qualification to perform the assigned work and, if necessary, the required certification.
Suppliers and contractors should be aware of the applicable standards while working at a nuclear power plant or for an operating organization. They should understand the safety culture demonstrated by the plant personnel.
In addition, confirmation of relevant experience in carrying out similar work may be requested from the contractor.
This scheme is intended for initial specialized training of personnel, which will carry out activities in nuclear installations and which possesses the required technical competences concerning the equipment, systems and activities, related to the contracted work:
- activities on the equipment and systems of the nuclear installation;
- activities not directly related to equipment and systems of the nuclear installation
- activities related to engineering support;
- equipment manufacturers and suppliers who install or provide their services onsite;
- civil construction contractors, supervisory members involved in nuclear facilities (plant, spent fuel and RAW storages, etc.) construction
More specifically this scheme is dedicated to experts from the following areas:
- qualified craftsmen;
- design, system, component, maintenance engineers;
- contractor’s managers
Minimum required entry level according to EQF for personnel to be included in this scheme is Level 4 (Abitur, vocational school).
The training under this scheme is intended to provide general knowledge, related to the nuclear facility specifics – general description of the technology (equipment, systems and processes), safety requirements, quality management, and requirements for the fulfilment of the activities. Radiation exposed contractor personnel has to meet at least the same requirements as those for the professionals. In addition, they should have passed radiological protection training before working in a radiation controlled areas. The objective of this training is to inform the personnel about radiological risks and their consequences, and to provide them with the necessary skills to conduct work in radiation controlled areas in a safe manner. The training should support the achievement and maintenance of adequate level of safety culture.
The qualification level to be achieved after completion of the envisaged training and includes general competencies, associated with:
- Safety Principles of Nuclear Facility
- Nuclear Facility theory/technology
- Nuclear Facility procedures to perform work
- Safety culture and soft skills
The implementation of the scheme will provide basic factual knowledge related to the safe performance of the activities of the contracted work.
The length, frequency and content of the programme are subject to national regulations and have to be in accordance with the relevant international standards. Contractor’s personnel must not only initially achieve the necessary qualifications; they must also maintain those qualifications over a period of time. Retraining requirements should be met.
In the training scheme description should be defined the requirements related to the scope and periodicity of the training.
Maintaining and enhancing the qualification of certain specialists can be achieved through training on selected courses included in the scheme for non-nuclear professionals.
WP-3 Target Group B2: Basic training scheme on VVER technology for Non-nuclear professionals
The most frequently required non-nuclear technical disciplines in a nuclear power plant are mechanical, electrical and I&C engineering. These disciplines should be available for many direct operating, support and monitoring functions. Chemistry or chemical engineering should be available for chemical and waste treatment functions, and physics or health physics for radiation protection functions.

The scheme is intended for initial specialized training of non-nuclear professionals among:

- personnel of nuclear facility serving systems and facilities outside the nuclear island
- research, engineering, design and civil construction organizations performing NPP life-time related activities – construction, start-up, operation, decommissioning,
- employees involved in nuclear technology matters (government, municipality, branch, ecological, public, trade union, etc.)

Minimum EQF entry level for the scheme is Level 6 in the areas of non-technical and non-nuclear technical specialties.

Qualification level to be achieved after passing the envisaged training shall include, but not limited to the following groups of competences:

- Safety Principles of Nuclear Facility (basic knowledge)
- Nuclear Facility theory/technology (basic knowledge)
- Nuclear Facility Components and Equipment within the bounds of specific job area and duties;
- Nuclear Facility Systems within the bounds of specific job area and duties;
- Nuclear Facility procedures to perform work (basic principles);
- Safety culture and soft skills

While developing this scheme the level of the expected competences and the required training for the particular specialists within the areas, as well as within the type of the main functions performed by them shall be defined.

Maintaining and enhancing the specialists' qualification can be achieved through training on certain courses included in “Basic training scheme on VVER technology for nuclear professionals”.

- **Group C. Specialized technical training on VVER technology for students studying nuclear disciplines.**

The purpose of the training scheme is using different forms of training (theoretical training, practical training, OJT and simulator training) to enhance and overbuild the knowledge obtained in educational institutions. The training should create adequate attitude and understanding of the safety culture. This shall be achieved through transfer of specialized knowledge on operation regimes, radiation protection; RAW management; fuel management; nuclear safety; safety analyses to the students, and at the same time to create skills related to the specific equipment, systems and processes, etc. Training shall follow the education and universities can therefore play a key role in training, along with industry.

Not all the engineers working in the nuclear field need to be nuclear engineers. It might be of interest to define a minimum basic nuclear training programme for "standard" engineers to facilitate their entry in the nuclear field and work on nuclear programmes and installations.

The development of close cooperation with the training organizations/universities, creating employees for the nuclear field and the “transfer” of some academic study to working environment will provide:

- extension of the possibilities for the universities to conduct the study in real working conditions and using real equipment;
- wider usage of the available resource base of the specialized training centers;
- time reduction to provide specialized training after possible employment of the young specialist in a nuclear facility

Training schemes for two target groups will be developed:

**WP-4 Target Group C1: Basic training scheme on VVER technology for power and non-power nuclear students**
The scheme is intended for specialized training of last-year students of bachelor's or master's degree, studying nuclear specialties: nuclear physics, nuclear engineering, and others related directly to the nuclear technology.

The students from both sub-groups have acquired higher education at the level, at least, of BS degree in engineering and techniques. The first sub-group ("power nuclear students") consists of students (at the level of BS degree, at least) in designing, manufacturing, operation and maintenance of NPF. The second sub-group ("non-power nuclear students") consists of students (at the level of BS degree, at least) who are only indirectly connected with NPF operation but NPF cannot exist as a nuclear object without their activities.

As a rule, the students from the power nuclear sub-group are taught under several basic educational programs like:

- Physics of nuclear power facilities
- Thermal physics of nuclear power facilities

The graduates may be claimed by NPP sections involved into operation, maintenance and safety validation of nuclear power facilities.

a) NPP operation and maintenance

The students graduated from the BS Graduate Program “NPP operation and maintenance” are able to work in the following areas of their professional activity: nuclear-physical, thermal-hydraulic and electrical processes in the equipment units intended for generation, conversion and utilization of nuclear and thermal energy; nuclear-power, thermal-mechanical and electrical equipment in usage at NPP and some other NPF; technical procedures for control of the reactor parameters, for safe operation ensuring and diagnosis of current NPF states; operation safety and radiation control at nuclear objects and facilities.

The students from the second subgroup (non-power nuclear) are taught under the following nuclear educational programs:

b) Radiation protection

The graduates acquire necessary volume of information about main regulatory acts in peaceful use of nuclear energy, radiation safety, sanitarian and epidemiological human well-being, about main regulatory guidelines and norms on radiation and general sanitarian safety.

The graduates are able to have a job positions in nuclear research centres, at nuclear power plants and some other objects of nuclear power industry.

c) NM physical protection, control and accountability.

The students training under this nuclear educational program makes them able for working in the following areas of nuclear power industry:

- Development, operation and maintenance of NM physical protection systems at nuclear sites and NM accountability systems.
- Development and surveillance of safe and secure technologies for NM management at nuclear facilities.

The qualification level to be achieved after completion of the requested training covers part of the competences defined for Group A1 Basic training scheme on VVER technology for nuclear professionals referring to:

- Safety Principles of Nuclear Facility
- Nuclear Facility theory and technology
- Nuclear Facility Components and Equipment
- Nuclear Facility Systems
- Nuclear fuel and RAW management
- Non-proliferation
- Safety culture and soft skills

The training will be mainly aimed at acquisition of knowledge about the equipment and systems specifics. The skills to be acquired are related to their location and interrelations and the main requirements concerning the operation, maintenance and technical support rules.

**WP-4 Target Group C2: Basic training scheme on VVER technology for non-nuclear students**
The scheme is intended for specialized training of last-year students of bachelor’s or master’s degree, studying engineering disciplines related to NPPs operation, e.g. chemistry, ecology, technical disciplines.

This group consists of the students with higher engineering and technical education at the level of the BS degree, at least. However, in contrast to the first group, these students acquired no any special training in nuclear disciplines. So, their educational background in nuclear area is limited by learning the training course in nuclear physics from the University course of general physics. This group consists of the specialists who are only indirectly connected with nuclear industry, but NPP can not exist as a complex nuclear engineering object without their activities. The students from the non-nuclear group are taught but not limited under the following educational programs:

a) Information and control systems and their components.

The graduates may be claimed by R&D institutions involved into designing of automatic control systems for regulation of technological processes, reliability validation of automatic control systems, analysis of failures in operation of automatic control systems, safety validation for operation of critical systems and so on.

b) Methods and tools for non-destructive testing of materials.

Basing upon fundamental education in physics and mathematics, the graduates acquire necessary volume of information about designing, research and development, manufacturing, operation and maintenance of devices for non-destructive quality control. The specialists graduated from the educational program are demanded very much for working in this area of scientific, technical and economic activity.

The qualification level to be achieved after completion of the required training covers part of the competences defined for Target Group B2 (Basic training scheme on VVER technology for non-nuclear professionals) referring to:

- Safety Principles of Nuclear Facility
- Nuclear Facility theory/technology
- Safety culture and soft skills

The training will be mainly focused to obtaining basic knowledge about the nuclear technology and the safety requirements

- **Group D. Safety culture and Soft skills training for nuclear professionals and personnel of nuclear facilities suppliers and contractors.**

Safety culture is significant topic of importance and requires continuous consideration. It is vital for the acceptance of nuclear energy by the public and for the safe performance of the nuclear installations. EU-wide consensus on the quality criteria might help to distribute the safety culture principles. All training programmes for specific plant activities should make reference to safety culture. Soft skills, like leadership, human performance, self-assessment, training skills, knowledge management etc. are required for the plant personnel, because this knowledge shall improve the effectiveness of the training, create awareness of the personal responsibility and implement it in the everyday practice. The knowledge and skills referring to this topic are common for all participants. Thus the programme and the materials could be unified and trough combination of all efforts to achieve cost reduction and standards unification.

The training programmes shall emphasize the necessity of understanding the safety issues, shall include consideration of the possible safety consequences caused by errors and shall deal in particular with the ways to avoid or correct these errors.

The assessment of the strengths and weaknesses, the evaluation of the safety culture practices are integral part of the delivery of quality training. Assessing the strengths and weaknesses and analysis of the safety culture practices are approaches that have to be developed and used in the high-quality training. For example, the ALARA principle should be a state of mind therefore training in the application of ALARA principle is a very important part of the training programme, both for radiation protection experts and for workers.

Considerable part of the activities related to the safe plant operation could be performed by Contractors. The operating organization shall ensure that contractor’s personnel involved in safety related activities is competent, qualified and medically fit to perform their assigned tasks.
All suppliers and contractors involved in design, engineering, manufacturing, construction, operation, maintenance or other safety related activities should be aware of the applicable standards while working at a nuclear power plant or for an operating organization. This understanding of the safety culture is mutually beneficial for the suppliers and the contractors as well as for the operating organization.

The objectives of the Safety culture training for the personnel (operation and engineering) are:
- to understand better the involvement of each one in nuclear safety;
- to identify areas for improvement in nuclear safety when carrying out the activities;
- to exchange experience based on real-life situations (operation and engineering).

Practical aspects like development of questioning attitude, elaboration and use of procedures, providing and use of feedback, development of efficient communication shall be achieved through investigation of real situations (incidents in operation, design errors) occurred in their company.

The safety culture and soft skill training are incorporated as an integral part of training schemes of all the above groups (A to C).

The partner responsible for WP5 will develop and implement specific training for each group in the programs related to WP 2 – 4.

5.3 Creation of knowledge management (KM) portal for VVER technology

The role of a KM portal is to act as a gateway to users through which they could access all information they need for their activity, safe, secure and in the best quality. Its purpose is to be an integration tool for easy, computer based access to any VVER related information, which can be used by staff to maintain and improve their productivity and performance. In addition, the portal has to be a communication tool for sharing and growth of corporate knowledge. An effective knowledge portal should therefore facilitate formal and informal communication between individuals, work and project teams and various Communities of Practice in real time.

5.4. Assessment and recommendations for RCC sustainable development.

The experience gained in international practice highlighted the importance of a consistent training of the staff of different countries which operates the same type of nuclear installations. The separate training organizations make efforts to establish state of the art methods for training of personnel, but not always they have capability to cover all scope prescribed by standards and regulations. Discrepancies between training programs, out of date training materials, inconsistent training are very likely. Establishment of methodically assured and well equipped regional training centre will therefore contribute to training quality enhancement, human performance improvement and nuclear safety securing.

Development of technical specification for general and special assignment training tools and equipment for the RCC for VVER Technology and Nuclear Applications will be a part of project outcomes.

6. Impact

The CORONA project covers the organization, coordination and implementation of activities in cooperation of organizations with long experience in the area of nuclear research, support, operation and training related to VVER technology from different countries. They are intended to join their efforts to continuously maintain and improve the qualification of nuclear professionals and young people oriented to work in nuclear field applications through establishment of a Regional Centre of Competence (RCC) for VVER Technology and Nuclear Applications. The centre will be recognized by the EU nuclear sector and will develop and implement training schemes for VVER specifics in cooperation with local, national and international training and educational organizations. The training schemes will cover different profiles of students and professionals and will ensure specialized training and competency required by that specific branch of nuclear industry. Tasks and responsibilities of RCC will include also support and services for preservation and transfer of VVER related nuclear knowledge and know-how and
capacity building through collaboration with ENEN organisation, NULIFE project aims and SNETP/ETKM objectives.
The ECVET principles will be used to overcome the differences in qualification requirements regarding the proposed training schemes of the partner countries. The cooperation of partners from different European countries and cultures according to quality assurance principles by an "accreditation/certification" structure to be established will facilitate the mutual recognition of the qualifications and the skills throughout the European Union.
The practical implementation of the project outcomes will result in the participation in the consolidation of a sustainable European Area of Higher Education and Training covering training in the nuclear fields. It will contribute to the preservation of the nuclear knowledge in Europe by attracting young professionals needed by the industry for the safe operation of existing nuclear power plants, the construction and safe operation of Generation III reactors.
The Knowledge Management portal shall collect information related to the operational experience of VVER reactors, outcomes of scientific researches and their application in the nuclear industry, various aspects of the methods implemented, technologies and safety requirements and rules, which will contribute to its wide dissemination and application in various countries, operating that type of reactors.
The results of the project will support the regulators, utilities and technical support organisations (TSOs) for long term sustainable utilization of the power fission reactors, when programs for modernization and lifetime extension of existing NPP, construction of 3rd and 4th generation reactors, as well as plans for decommissioning and clean-up of ageing facilities have to be created.
The courses, seminars, workshops and internships of each training scheme (TS) will be selected to provide the trainees with high-level knowledge covering the latest state-of-the-practice applications in the field and the current state of technological development and operational practices. Different entry levels to the training schemes will ensure access of trainees with different background to reach the final stage. The final stage of each training scheme will be adjusted to the qualifications and skills of the job profiles. It is expected that this approach with different entry levels will attract a larger number of candidates while still achieving relatively homogeneous profiles after completion of the training scheme.

References

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