ETRAP 2009

ETRAP 2009 Transactions

8 - 12 November 2009 - Lisbon Portugal

ENS itn SCK•CEN STUDIECENTRUM VOOR KERNENERGIE CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE enen european nuclear education network IAEA International Atomic Energy Agency Atoms For Peace AEN NEA

European Nuclear Society
Rue Belliard 65
1040 Brussels, Belgium
Phone + 32 2 505 30 54
Fax +32 2 502 39 02
E-mail ens@euronuclear.org
Internet www.euronuclear.org

ISBN 978-92-95064-08-9

These transactions contain all contributions submitted by 6 November 2009.

EDUCATION AND TRAINING NETWORKS

ENETRAP II 7FP: DEVELOPMENT OF E&T SCHEMES FOR RADIATION PROTECTION EXPERTS AND OFFICERS

MICHÈLE COECK
SCK•CEN, Belgian Nuclear Research Centre
Boeretang 200, BE-2400 MOL

On behalf of the ENETRAP II Consortium

ABSTRACT

This paper focuses on the current 7th framework programme ENETRAP II, which aims at developing reference standards and good practices for education and training programmes for radiation protection experts and officers, reflecting the needs of these professionals in all sectors where ionising radiation is applied. The introduction of a radiation protection training passport as a mean to facilitate efficient and transparent European mutual recognition of these professionals is another ultimate deliverable of this project. It is envisaged that the outcome of ENETRAP II will be instrumental for the cooperation between regulators, training providers and customers (nuclear industry, research, non-nuclear industry, etc.) in reaching harmonisation of the requirements for, and the education and training of, radiation protection experts and officers within Europe, and will stimulate building competence and career development in radiation protection to meet the demands of the future.

1. Introduction

Radiation protection (RP) is a major challenge in the industrial applications of ionising radiation, both nuclear and non-nuclear, as well as in other areas such as the medical and research area. As is the case with all nuclear expertise, there is a trend of a decreasing number of experts in radiation protection due to various reasons. On the other hand, current activities in the nuclear domain are expanding: the nuclear industry faces a so-called "renaissance", high-tech medical examinations based on ionising radiation are increasingly used, and research and non-nuclear industry also make use of a vast number of applications of radioactivity.

Within this perspective, maintaining a high level of competency in RP is crucial to ensure future safe use of ionising radiation and the development of new technologies in a safe way. Moreover, the perceived growth in the different application fields requires a high-level of understanding of radiation protection in order to protect workers, the public and the environment of the potential risks. A sustainable education and training (E&T) infrastructure for RP is an essential component to combat the decline in expertise and to ensure the availability of a high level of radiation protection knowledge which can meet the future demands.

Today's challenge involves measures to make the work in radiation protection more attractive for young people and to provide attractive career opportunities, and the support of young students and professionals in their need to gain and maintain high level RP knowledge. This can be reached by the development and implementation of a high-quality European standard for initial education and continuous professional development for radiation protection experts (RPEs) and radiation protection officers (RPOs), and a methodology for mutual recognition of these professionals on the basis of available EU instruments, such as the European qualification framework (EQF) and/or the directive 2005/36/EC.

2. State of the art

2.1 European Directive and first answers to training needs

For European Union Member States, requirements related to radiation protection training are described in Council Directive "96/29/EURATOM" of 13 May 1996. It lays down basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation (OJ L-159 of 29/06/96). Communication 98/C 133/03 (OJ L-133 of 30/04/98) from the Commission concerning the implementation of the above Council Directive 96/29/EURATOM describes a European syllabus for the training requirements for the recognition of "qualified experts" in radiation protection.

A revision of Council Directive 96/29/EURATOM is currently being prepared. The results of the 6FP ENETRAP project contribute, via the EUTERP Platform, to the advice submitted to the European Commission and the Group of Experts according to art 31 of the EURATOM Treaty, who are preparing the revision of this Directive. The outcome of the project may also lead to a new guidance document to replace Communication 98/C 133/03.

At national level, in answer to the European legal requirements of the 96/29/EURATOM Council Directive, almost all European countries provide in an E&T programme in RP. Unfortunately, nowadays, a wide variety in national approaches is observed and used terminologies are very different. This situation is most unfavourable since it does not facilitate the development of a common European RP and safety culture, and it worsens the mobility of RP professionals throughout Europe.

2.2 ENETRAP 6FP

First approaches to harmonisation of E&T activities in Europe were undertaken in the 6th framework project ENETRAP [1]. This project was a coordination action under support of the EC, contract number FI6O-516529. It started in April 2005 and was finalised in December 2007.
Within the framework of ENETRAP, a detailed study of the current European E&T programmes, regulations and skill recognitions was made. From the analysis of the results received from almost all European Member States, a proposal for harmonised programmes for both education and training in RP was put forward.

A universities Consortium was set up that developed a European Master in radiological protection [2], which is currently running. The EMRP started in September 2008. The four partners in this project are:

- University Joseph Fourier, Grenoble, France (EMRP project leader);
- North Highland College, Thurso, Scotland – UK;
- Czech Technical University, Prague, Czech Republic;
- Institut National des Sciences et Techniques Nucléaires, Gif-sur-Yvette, France.

Next to this, a training scheme was put forward. Based on a modular approach, it puts forward a general common basis, and a series of specialised modules on occupational radiation protection in different installations where ionising radiation is applied (nuclear power plants and fuel cycle industry, the medical sector, non-nuclear industry, research laboratories, waste and disposal sites, etc…). The "theoretical" programme is extended by a period of on-the-job training (OJT) and the possibility to follow (parts of) several modules via e-learning is implemented.

The results of the ENETRAP 6FP project were transferred to the EUTERP Platform. The ENETRAP 6FP Consortium also contacted expert networks who are willing to "foster" the chapters dealing with their specific competences, such as the ALARA network and EURADOS.

2.3 EUTERP

The results of ENETRAP 6FP was submitted to the EUTERP Platform [3]. This Platform addresses all stakeholders of RP training and has amongst its member's representatives from regulatory bodies, training providers, research centres, medical physicists, professional societies, international organisations and international projects. It started in 2006 and was supported by EC DG TREN for three years. One of the tasks of this Platform is to advise on a revision of the definition of the qualified expert. Another task is to seek international agreement on the requirements and qualifications for the RPE and RPO, in order to remove barriers for mobility of these professionals within the European Union. Currently, the coordinator NRG (The Netherlands) is taking actions to transform the EUTERP Platform into a legal entity, in order to achieve a sustainable network.

3. ENETRAP II 7FP

Determined to build further on the achievements of 6 FP ENETRAP, most ENETRAP partners participate in 7FP ENETRAP II [4]. The overall objective of this project is to develop and implement European high-quality "reference standards" and good practices for E&T in 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 is another ultimate deliverable of this project.

With respect to the RPE the overall objective is to be achieved by addressing both education and training requirements.
In the field of education this project deals with high-level initial programmes, mainly followed by students and/or young professionals. It is foreseen to analyse the European Master in Radiation Protection course, which started in September 2008. Broadening of the consortium and quality analysis of the providers and the content of the modules can be performed according to, primarily, the standards and guidelines for quality assurance in the European higher education area (ENQA) and, secondly, to the ENEN standards.
In the field of RPE training the ultimate goal is the development of a European mutual recognition system for RPEs. Hereto, the ENETRAP training scheme initiated as part of the ENETRAP 6FP will be used as a basis for the development of a European radiation protection training scheme (ERPTS), which includes all the necessary requirements for a competent RPE. In addition, mechanisms will be established for the evaluation of training courses and training providers.
With respect to the RPO role the desired end-point is an agreed standard for radiation protection training that is recognised 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.

Furthermore, attention is given to encouragement of young, early-stage researchers. In order to meet future needs, it is necessary to attract more young people by awaking their interest in radiation applications and radiation protection already during their schooldays and later on during their out-of-school education (university or vocational education and training). Radiation protection experts and officers work more and more on a European level. It is therefore important bringing together all the national initiatives at a European level: tomorrow’s leaders must have an international perspective and must know their colleagues in other countries.

It is envisaged that the outcome of ENETRAP II will be instrumental for the cooperation between regulators, training providers and customers (nuclear industry, medical sector, research and non-nuclear industry) in reaching harmonisation of the requirements for, and the education and training of RPEs and RPOs within Europe, and will stimulate building competence and career development in radiation protection to meet the demands of the future.

Specific objectives of the ENETRAP II project are to:

- develop the European radiation protection training scheme (ERPTS) for RPE training;
- develop a European reference standard for RPO training;
- develop and apply a mechanism for the evaluation of training material, courses and providers;
- establish a recognised and sustainable ERPTS "quality label" for training events;
- create a database of training events and training providers (including OJT) conforming to the agreed ERPTS;
- bring together national initiatives to attract early-stage radiation protection researchers on a European level;
- develop some course material examples, including modern tools such as e-learning;
- develop a system for monitoring the effectiveness of the ERPTS;
- organise pilot sessions of specific modules of the ERPTS and monitor the effectiveness according to the developed system;
- development of a European passport for CPD in RP.

A steering committee, consisting of representatives of all ENETRAP II partners, will be established to oversee and coordinate the progress of the project. The steering committee will set up and report to an advisory board, which at its turn will also give feed back and guidance to the steering committee. The composition of the advisory board should be such that all relevant stakeholders, with respect to the stated aim of the project, are represented, i.e. regulatory authorities, international organisations, professional organisations, training providers, research institutes, end-users from nuclear industry, medicine and non-nuclear industry, etc. The advisory board should advise about the best balance between supply and needs of training, thereby ensuring stable feedback mechanisms to the steering committee. This advisory board should also prepare the terms of reference for a top-level steering task group mandated by the high authorities of Europe with the objective of defining an overall policy and strategy.

The objectives of ENETRAP II 7FP will be reached by several activities dealing with

- the analysis of job requirements (RPE and RPO);
- the design and implementation of appropriate training standards and schemes to support these requirements;
- development and application of a quality assurance mechanism for the evaluation of the training events, used material and training providers;
- setting up a database of training events and providers conforming to the agreed standards;
- the development of training material (traditional texts, as well as the introduction of more modern tools such as e-learning modules) that can be used as example training material;
- monitoring the effectiveness of the proposed training schemes.

The final goal is the development of a European mutual recognition system for RPEs and the introduction of a training passport.

All these activities are carried out in the work packages defined here under.

WP1 Co-ordination of the project
WP2 Define requirements and methodology for recognition of RPEs

WP3	Define requirements for RPO competencies and establish guidance for appropriate RPO training
WP4	Establish the reference standard for RPE training
WP5	Development and apply mechanisms for the evaluation of training material, events and providers
WP6	Create a database of training events and training providers (including OJT) conforming to the agreed standard
WP7	Develop of some course material examples (text book, e-learning modules, …)
WP8	Organise pilot sessions, test proposed methodologies and monitor the training scheme effectiveness
WP9	Introduction of the training passport and mutual recognition system of RPEs
WP10	Collaboration for building new innovative generations of specialists in radiation protection

ENETRAP II 7FP will be realised by 12 partners, each having relevant experience in policy support regarding E&T projects on radiation protection. It concerns SCK•CEN (Belgium), CEA-INSTN (France), Forschungszentrum Karlsruhe, Centre for Advanced Technological and Environmental Training FZK-FTU (Germany), Federal Office for Radiation Protection BfS (Germany), the Italian National Agency for New Technology, Energy and Environment ENEA (Italy), NRG (The Netherlands), CIEMAT (Spain), Health Protection Agency HPA (UK), the ENEN Association (France), the Nuclear and Technological Institute ITN (Portugal), the Budapest University of Technology and Economics BME (Hungary), and University Politehnica of Bucharest (Romania). Staff members of the different partners who play a key role in this project, have also proven to be highly involved with E&T matters, on national and international levels, and are member of several E&T networks. Connections to international organisations such as the IAEA, EUTERP, IRPA, etc are guaranteed. The presence of the ENEN Association within the Consortium, taking the role of work package leader of the important WP9, ensures the close collaboration of the different European networks, ultimately facilitating a European network dealing with both education and training activities in the nuclear field such as nuclear engineering, radiation protection and other nuclear areas. With the implementation of the advisory board, where amongst others EUTERP will be represented, the major part of all future employers, regulators and training providers is connected to this project.

4. Conclusions

Based on the outcome of the ENETRAP 6FP, ENETRAP II 7 FP aims at contributing further to the European harmonisation of E&T of radiation protection professionals. With the introduction of a modular European reference training scheme and European recognition methodologies, key issues will be delivered for the development and implementation of mutual recognition system of RPEs. In this way ENETRAP II meets the EC requirements to rely on the principles of modularity of courses and common qualification criteria, a common mutual recognition system, and the facilitation of teacher, student and worker mobility across the EU. ENETRAP II will structure research on radiation protection training capacity in all sectors where ionising radiation is applied. End users and specifically regulatory authorities are represented through foreseen participation in the advisory board which will advise about the best balance between supply and needs, thereby ensuring stable feed back mechanisms. The tasks defined in this project maximise the transfer of high-level radiation protection knowledge and technology, addressing young as well as experienced radiation protection workers. In this context, the proposed project will thus contribute to meeting the objectives of the EURATOM 2008 work programme.

5. References

[1] www.sckcen.be/enetrap
[2] L. Musilek, J. Balosso, P. Livolsi and M. Mennie, The European Master's Degree in Radiation Protection (EMRP), proceedings of the SEFI2008 conference, http://www-ice.upc.es/butlleti2/juliol2009/sefi/, ISBN : 978-2-87352-001-4, July 2009
[3] www.euterp.eu
[4] www.sckcen.be/enetrap2

Acknowledgement

The author wishes to thank all senior experts of the ENETRAP 6FP and ENETRAP II 7FP partner institutes for their help and advice.

THE ROLE OF EFOMP IN THE EDUCATION AND TRAINING OF MEDICAL PHYSICISTS AND HEALTH PROFESSIONALS IN RADIATION PROTECTION THROUGH NATIONAL AND INTERNATIONAL NETWORKS

S. Christofides [1a,2],
[1a] *The European Federation of Organisations for Medical Physics, President*
[2] *Medical Physics Department, Nicosia General Hospital, Nicosia, Cyprus*

M. Wasilewska-Radwanska[1b, 3],
[1b] *The European Federation of Organisations for Medical Physics, Education and Training Committee*
[3] *AGH University of Science and Technology, Faculty of Physics and Applied Computer Science, Krakow, Poland*

W.J. M. van der Putten[1c,4]
[1c] *The European Federation of Organisations for Medical Physics, Professional Committee*
[4] *Medical Physics and Bioengineering, Galway University Hospitals, Galway, Ireland*

ABSTRACT

The European Federation of Organisations for Medical Physics (EFOMP) affiliates almost forty - National Member Organisations (NMOs) and one of its main objectives is the harmonisation and synchronisation of national education and training schemes in the field of medical physics including radiation protection. EFOMP has presented various recommendations and guidelines on this in the form of Policy Statements taking into consideration Euratom Directives 96/29 and 97/43. The EFOMP policies also include regular training as a requisite for Continuing Professional Development (CPD). One of the most recent Policy statements is No. 12 which deals directly with education and training. This paper outlines a number of the activities through which EFOMP promotes Learning and Education in Europe. This could serve as a model to stimulate education and training in general radiation protection including areas outside of medicine.

1. Introduction

The European Federation of Organisations for Medical Physics - EFOMP was set up in 1980 in London [1]. Among its aims and objectives are the harmonisation and synchronisation of national education and training schemes in the field of medical physics. EFOMP achieves its objectives through, amongst other, the production of guidelines for education, training and accreditation programs. One of its most recent Policy Statement is No. 12 [2] which describes the present status of Medical Physics education and training in Europe. This Policy Statement takes into consideration European Union Directives relevant to education and training. Before describing in detail the specific activities of EFOMP with respect to Training and Education it is useful to outline the educational pathways to become a Qualified Medical Physicist (QMP) and subsequently a Specialist Medical Physicist (SMP). With respect to Radiation Protection in the medical field, the SMP qualification is often considered to be equivalent to the Expert in Radiation Physics as described in EU Directive 96/29/Euratom. Figure 1 shows the pathway in some detail.

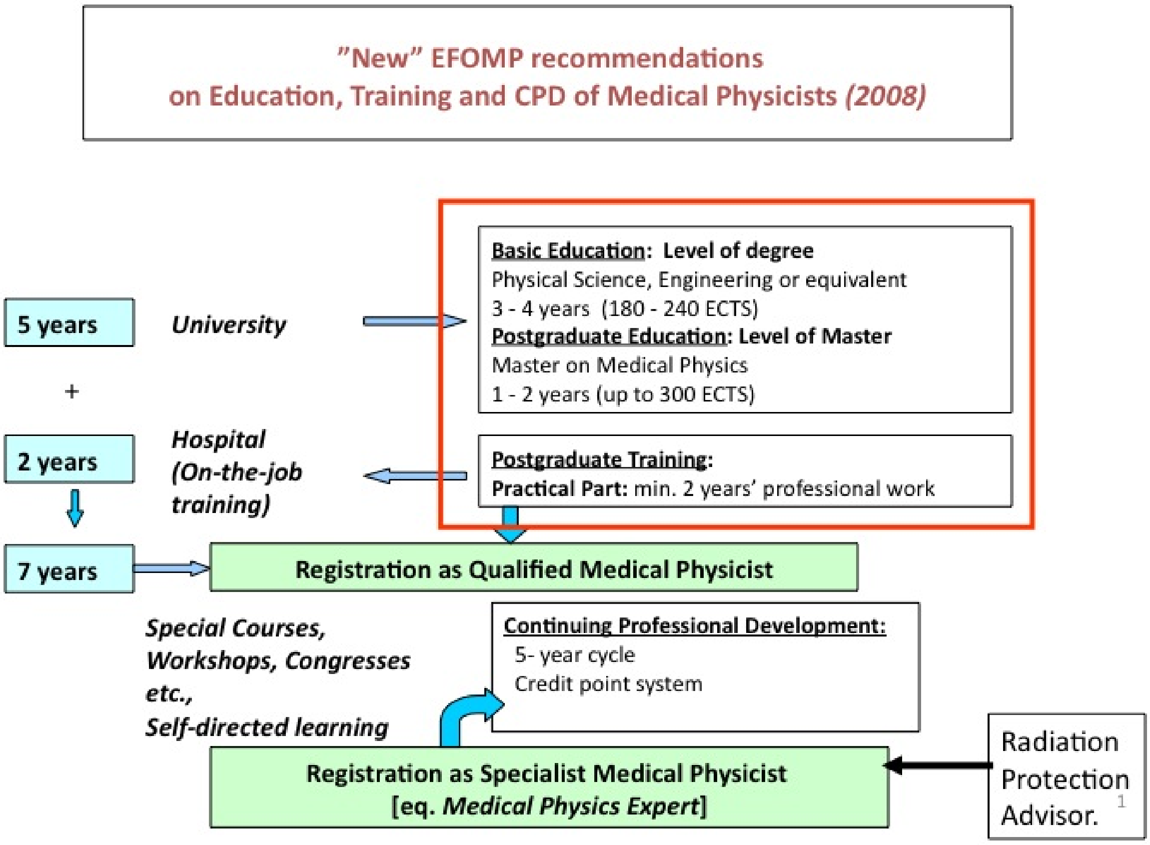

Figure 1. Educational pathway for medical physicists (EFOMP Policy Document 12)

Following a basic undergraduate degree in Physics or a degree in which physics is a major component, it is now generally accepted that a one year Medical Physics subject specialization is required. EFOMP recommends that this is done through a M.Sc. in Medical Physics and one of the activities which EFOMP is involved in is a "tuning process" of MSc programs across Europe. This will be described further below. After acquiring the MSc (which deals with the theoretical knowledge to work as a medical physicist) an individual now has to acquire practical training. The nature of this training varies widely across Europe and the development of standards on this is another activity EFOMP is planning to be involved in. An essential component of professionalism is Continuous Professional Development - CPD. This is also a critical component in the transition of QMP to MPE. EFOMP has spent considerable effort developing a standardized method to score this. Finally, EFOMP has initiated the development of an European Network of Schools of Medical Physics. Finally, the European School of Medical Physics – ESMP, is a long standing EFOMP activity, in partnership with the European Scientific Institute – ESI, in providing a forum for the Education and Training of

1. RPA : Radiation Protection Advisor : generally considered to be equivalent to Expert in Radiophysics (EU Directive 96/29/Euratom)

young Medical Physicists [3].

Medical Physicists also play a critical part in the education of other health professionals in radiation protection. A brief outline of work carried out in this under the auspices of EFOMP will be outlined. Knowledge of Radiation Protection forms an important component in all of the above activities, as will be elaborated in the following sections.

2. Tuning of Post-Graduate Degrees

The Bologna declaration was signed in June 1999 with as aim the facilitation of mobility of students, professionals and researchers in Europe [3] The implication of the EFOMP requirements for medical physics training to include a MSc program strongly suggests that a convergence of such degrees should occur across Europe in line with the stated goals of Bologna. The implementation of this convergence is through a "Tuning process". This is a methodology to "re-design, develop, implement and evaluate study programmes for each of the Bologna cycles" [4]. It is important to note that 'Tuning' *does not mean uniformity*. "The name Tuning is chosen to reflect the idea that universities do not and should not look for uniformity in their degree programs or any sort of unified, prescriptive or definitive European curricula but simply look for points of reference, convergence and common understanding" [4] This means that Tuning promotes 'points of reference' (which are essential for a system of easily comparable, compatible and transparent degrees) *whilst encouraging diversity in curricular delivery methods and learning paths according to the principle of autonomy and local culture and conditions*. For the medical physics profession a fundamental 'points of reference' is the sets of learning outcomes for the Masters in Medical Physics. A second point would be the learning outcomes for clinical skills obtained at the end of the clinical training period. These learning outcomes should be stated in terms of an inventory representing the minimum set and level of competencies that a student should be acquired.

Tuning is a university driven project. Groups of EU universities would be the drivers for determining the learning outcome student competences (including level of competence). This has to be done in consultation with future employers, recent graduates and professional organizations (e.g., EFOMP and EFOMP National Member Organizations) to ensure relevance to society and employability of graduates. Competencies refer to learner knowledge and understanding, interpersonal, intellectual and practical skills, ethical values and attitudes. Tuning recognizes two types of competences: Generic (means transferable across disciplines) and Subject Specific (applicable to a particular discipline). Generic competences can be split in three : instrumental competences (cognitive abilities, methodological abilities, technological abilities and linguistic abilities), interpersonal competences (individual abilities like social skills (social interaction and co-operation) and systemic competences (abilities and skills concerning whole systems, combination of understanding, sensibility and knowledge, prior acquisition of instrumental and interpersonal competences required). The competencies which have been identified include a considerable and significant component related to radiation protection. This includes standard areas such as ionising and non-ionising Radiation and its control, radiation protection legislation, use of equipment, Quality Assurance and safety. Specific areas such as Radiotherapy, Diagnostic Radiology and Nuclear medicine are part of it but also generic areas such as the ability to be able to communicate orally and in writing with both experts in the field and non-experts and a demonstrable respect for diversity and multicultural awareness [*ibid*]. The outcome of the process will be a set of teaching and training syllabi for use throughout Europe which will ensure compatibility of education standards thus ensuring mobility. Finally, Radiation Protection is but one aspect of Health, Safety and Risk management in the hospital environment. EFOMP is of the opinion that medical physicists by virtue of their training and experience are well positioned to advise hospital staff and management on health and safety issues. To provide a minimum standard of education as part of the tuning process, EFOMP recommends that formal Risk and Safety training is part of the curriculum of the education of medical physicists. This will of course immediately be applicable to radiation protection in the health care environment. Table 1 shows an example of such a course as provided in the School of Medical Physics and Engineering of the Department of Applied Physics in Eindhoven University of Technology in the Netherlands. (http://www.smpee.tue.nl/).

3. Clinical Training

Inherent in the educational and training pathway envisaged by EFOMP (fig. 1) is the requirement for training in clinical skills. Currently most countries in Europe have a training component in the educational pathways for their medical physicists. However, this training is far from uniform ranging from relatively unstructured "on the job" training to very structured, competency based programs. The process to develop guidelines for the development of a minimum set of clinical skills which need to be acquired will proceed along the same process as the Tuning process described above. The main difference will now be that clinical skill training by its nature occurs in a clinical setting and that representatives of hospital and health care providers need to be involved in the tuning process. Clinical skills of course include considerable aspects of radiation protection. Measurement and calculations of patient dose, shielding surveys, dealing with isotope spills etc. form all an inherent part of the "tuned training program". Another aspect which is an integral part of any training program is the assessment of the trainee. It is not clear what form this assessment process will take as different models are currently employed in Europe. Assessment could be along the lines of the UK training program : (www.ipem.ac.uk/docimages/2440.pdf) or, alternatively, similar to that operated in North America through the CAMPEP organization (www.campep.org) However, other assessment procedures may also be considered. A complicating factor is of course the fact that in an increasing number of countries in Europe, Medical Physics is now a profession protected under national legislation. The regulatory environment applies particularly to the training component of the MP education as the taught component tends to come under University Regulations and is hence amenable to the Tuning process. This development of standards related to the clinical training has just been initiated by EFOMP and it is anticipated that this process will take several years before completion.

Basic knowledge

* Basic principles of safety and human failures
* Risk analysis skills
* Risk identification and estimation
* Incident analysis, accident analysis
* Work processes and design: analysis skills
* Electrical safety
* Safety care and management tools for a learning organization

Practical training

* Risk analyses.
* Discussion of safety with (medical) colleagues.
* Practical application of risk analysis skills in the own institute, resulting in a report.

Learning Outcomes

* The trainee knows what safety is.
* The trainee knows what risk analyses are.
* The trainee knows how to relate safety and risk analyses to his daily activities.
* The trainee has attention for his own professional safety attitude and that of other medical professionals.
* The trainee knows different risk analysis methods and their (dis)advantages.
* The trainee knows which risk analysis methods apply to the clinical environment.
* The trainee knows the PRISMA method, often applied by the inspection of health care.
* The trainee is able to judge which risk analysis method applies to a distinct situation and is able to consider a detailed risk analysis or a pragmatic approach.
* The trainee knows what a safety management system (SMS) is and is able to apply SMS to medical technology.
* The trainee is capable of adequately applying insights from the course to a concrete medical physics subject.

Table 1. Example of Risk and Safety Management course as provided in the School of Medical Physics and Engineering of the Department of Applied Physics in Eindhoven University of Technology in the Netherlands. Course equivalence is 6 ECTS (http://www.smpee.tue.nl/).

4. Continuous Professional Development

Continuous Professional Development (CPD) is a critical component of the development of any professional and medical physics is not different. EFOMP has been and continues to be, very active in this area and has published a number of policy statements for CPD schemes. In addition it has established a system to recognise medical physics registration schemes which exist through individual National Member Organisations [5, 6]. This aims to set standards for education and training. A number of criteria are required for recognition of any such scheme (table 2). A total of 10 countries currently have a Registration Scheme which is recognized by EFOMP. The existence of a CPD scheme is an essential component of any such scheme for Medical Physicists.

- Statement of aims
- Properly constituted Registration Council
- Statement of required competences
- Training programme consistent with EFOMP's policy
- Mechanism for identifying specialist areas of registrants
- Regular renewal mechanism including CPD program
- Rules of Professional Conduct
- Disciplinary process

Table 2. Criteria which need to be in existence in order for a national registration scheme for medical physicists to be recognized by EFOMP

The CPD scheme as operated by EFOMP operates through "credits" which can be obtained through a number of ways e.g. conference and workshop attendance, paper publication etc. Guidelines for formal recognition by EFOMP of National Registration Schemes for Medical Physicists have been established since 1995 through its' Policy Statement 6. EFOMP approval includes the requirement for "a regular renewal mechanism with a requirement for evidence of continuing activity in relevant areas". CPD is now being recommended as the best way to meet this requirement. National Member Organisations are responsible for the administration of their National CPD schemes, in a similar manner to the EFOMP-approved National Registration Schemes. Recently EFOMP has developed a process to adjudicate on the extent of CPD credits which can be earned and in essence provide a "quality stamp of approval". Table 3 shows an overview of such activities in so far as they relate to Radiation Protection.

5. European Network of Medical Physics Schools

EFOMP has recently established the European Network of Medical Physics Schools – ENMPS [7]. The aim of the Network is to make training and education available throughout Europe as well as assist in the harmonisation of such training and education. The ENMPS intends to include training initiatives that National Members organise in their Countries in a European Network. The inclusion in an annual European calendar, that EFOMP will prepare and circulate, will provide more visibility to the national initiatives and will give the opportunity to European and non-European Medical Physicists to follow training courses in other countries establishing personal and scientific relationship useful for the progress of Medical Physics in Europe. In addition, ENMPS will be a useful vehicle to coordinate exchange programs of medical physicists throughout Europe. One international activity which has been extremely successful is the European School of Medical Physics which is run on an annual basis, this year from 15th October till 24th November 2009 in Archamps (near Grenoble in France) This is an internationally supported activity organized jointly by the European Science Institute and EFOMP. A week dedicated to Radiation Protection was introduced last year and will be provided for the second time. Detailed information can be found at:

http://lemoigne.web.cern.ch/lemoigne/esiweb/ESMPnn12.htm .

Year	Organizer	Name of the event	City (country)	Date
2007	National “Frederic Joliot-Curie” Research Institute	First Central & Eastern European Workshop on QC, Patient Dosimetry and RP in Diagnostic and Interventional Radiology and Nuclear Medicine	Budapest (Hungary)	25-28 April
2007	Quality Assurance Reference Centre. SENTINEL	Digital Mammography and the Breast Screening Programme Symposium	Newcastle upon Tyne, (UK)	1st February
2007	Technical University Delft	Workshop SENTINEL	Delft (Netherlands)	18-20 April
2007	IAEA[1)] & Azienda Ospedaliero-Universitaria S.Maria della Misericordia	IAEA group training on Dose Assessment and Dose Management in Diagnostic and Interventional Radiology	Udine (Italy)	13-17 June
2007	AIFM [2)] Scuola Superiore di Fisica in Medicina “Piero Caldirola”	The Radioprotection of the Workers and Population: Important Aspects Connected to the Sanitary Activities	Villa Olmo (COMO) (Italy)	7-9 November
2007	AIFM [2)] Scuola Superiore di Fisica in Medicina “Piero Caldirola”	External Beam Radiotherapy: Physics and Dosimetry	Villa Olmo (COMO) (Italy)	17-21 November
2008	AIFM [2)] Scuola Superiore di Fisica in Medicina “Piero Caldirola”	Physics, dosimetry and optimization in nuclear medicine (diagnostic and therapy)	Gazzada (VA) (Italy)	14-16 May
2008	EFOMP, PSMP[3)] and AGH Univ. of Sc &Techn.	Radiation Protection of the Patient (Workshop & Tutorial)	Krakow (Poland)	16-17 September
2008	Holycross Cancer Center	Modern treatment techniques and in-vivo dosimetry	Kielce (Poland)	18-20 Nov. 2008
2009	Heidelberg University, Department of Postgrad. Studies in cooperation with German Cancer Research Center Heidelberg	9th Teaching Course on IMRT/IGRT	Heidelberg (Germany)	2nd – 4th July 2009
2009	Holycross Cancer Center	Workshop “IV School of Radiotherapy”	Kielce (Poland)	22- 25 June
2009	Mater Misericordiae University Hospital	2009 Radiation Protection Autumn Workshop	Dublin (Ireland)	2nd September

Table 3. List of events accredited by EFOMP (2007-2009) directly related to radiation protection.

6. Radiation Protection for other Health Professionals

Medical Physicists do not only train themselves, but also provide a considerable amount of training to other healthcare professionals such as medical doctors and radiographers as well as others [7] EFOMP is in the process of establishing a Special Interest Group under the auspices of its Scientific Subcommittee to provide a focus to develop this further. EFOMP believes that this will lead not only to better education but also will raise the profile of the profession.

7. Conclusion

This paper demonstrates that EFOMP has initiated and is involved in a significant number of activities regarding the Education and Training of Medical Physicists and other Health Professionals. In all of these activities, radiation protection plays a significant if not central role. It can be argued that the mechanisms established by EFOMP provide a model to coordinate specific radiation protection training, outside medicine in Europe. Examples such as the "tuning process", validation of practical training, CPD requirements and recognition of national accreditation schemes can all be applied in the radiation protection arena.

8. References

[1] www.efomp.org

[2] T. Eudaldo, K. Olson (2009) The European Federation of Organisations for Medical Physics. Policy Statement No. 12: The present status of Medical Physics Education and Training in Europe. New perspectives and EFOMP recommendations (2009) Physica Medica (2009), doi: 10.1016/j.ejmp.2009.02.005

[3] The Bologna Declaration on the European Space for Higher Education http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf

[4] S. Christofides, W.Schlegel, R. Padovani, P.Sharp, A. Torresin, M. Wasilewska-Radwanska, W. van der Putten, E. Guibelalde, K.-U. Kasch, and C. J. Caruana (2009) An Initial EFOMP Position on the Tuning Process for Masters Programs in Medical Physics in Europe. WC 2009, IFMBE Proceedings 25/XIII, pp.70 – 73

[5] EFOMP. Recommended guidelines of National Registration Schemes for Medical Physicists EFOMP Policy Statement No.6. Physica Medica 1995; XI (4); 157-159

[6] EFOMP, Recommended Guidelines on National Schemes for Continuing Professional Development of Medical Physicists. EFOMP Policy Statement No.10. Physica Medica - Vol. XVII, N. 2, April-June 2001

[7] C.J. Caruana, M. Wasilewska-Radwanska, A. Aurengo, P.P. Dendy, V. Karenauskaite, M.R. Malisan, J.H. Meijer, V. Mornstein, E. Rokita, E. Vano, M. Wucherer (2009) The role of the biomedical physicist in the education of the healthcare professions: An EFOMP project. Physica Medical Vol.25 ,133-140.

ENEN'S CHALLENGES IN RESPONSE TO THE INDUSTRY AND REGULATORY NEEDS

JOSEPH SAFIEH
CEA/INSTN
Centre CEA de Saclay - INSTN - Bldg 395
F-91191 Gif-sur-Yvette Cedex, France

PETER PAUL DE REGGE, RYOKO KUSUMI
European Nuclear Education Network Association
Centre CEA de Saclay - INSTN - Bldg 395
F-91191 Gif-sur-Yvette Cedex, France

ABSTRACT

The European Nuclear Education Network (ENEN) Association is a non-profit organization with objective of the preservation and further development of expertise in the nuclear fields by higher education and training. The ENEN has provided support to its Members for the organization of and participation to selected E&T courses in nuclear fields and developed the European Master of Science in Nuclear Engineering. In 2009 three European Fission Training Scheme projects started to establish a common certificate for professionals at European level. In December 2008 the European Council welcomed the existence within the EU of coordinated teaching and training leading to qualifications in the nuclear field, provided notably by the ENEN, and expressed its hope that, with the help of the EU, ENEN and its members will continue to develop the coordination of nuclear education and training in Europe. The ENEN endeavours to respond to their expectations in the years to come.

1. Objective and Structure

The "European Nuclear Engineering Network" project was launched under the 5th Framework EC Programme in January 2002. It established the basis for conserving nuclear knowledge and expertise, created a European Higher Education Area for nuclear disciplines, and initiated the implementation of the Bologna declaration in nuclear disciplines [1]. One of the main achievements of this project was the establishment by the partners of the "European Nuclear Education Network (ENEN) Association. The ENEN project was thus given a more permanent character and a legal status of a nonprofit international organization on the 22nd of September 2003 under the French law of 1901 [2].

The main objective of ENEN is the preservation and the further development of expertise in the nuclear fields by higher education and training in response to the concerns expressed by international organisations with respect to the availability of a sufficient number of experts in the nuclear disciplines [3][4].

The ENEN Association has two kinds of members. All members should have a legal status in an EU member state or a candidate country. The Effective Members, primarily academics, provide high-level scientific education in the nuclear field in combination with research work, and use selective admission criteria. The Associated Members, such as nuclear research centres, industries and regulatory bodies, have a long-term tradition of relations with effective members in the field of research, training or education and are committed to supporting the ENEN Association. As of March 2009, the ENEN Association has members in 17 European countries, consisting of 31 Effective Members and 20 Associated Members.

Since 2007, the ENEN Association has concluded a Memorandum of Understanding (MoU) with partners beyond Europe for further cooperation (South Africa, Russian Federation, Japan, etc.)

2. Main achievements since 2003

2.1 European Master of Science in Nuclear Engineering

Supported by the 5th and 6th Framework Programme of the European Community, the ENEN Association has established and continues to monitor the equivalence of nuclear engineering education curricula at the ENEN member universities through its Teaching and Academic Affairs Working Group. As a result, the ENEN developed the European Master of Science in Nuclear Engineering. A reference curriculum, consisting of a core package of courses and optional substitute courses in nuclear disciplines, has been designed and mutually recognized by the ENEN members. To advertise and promote this realization, ENEN has established the qualification of European Master of Science in Nuclear Engineering (EMSNE). For this purpose, ENEN developed by-laws and procedures for handling and selecting the candidates and for awarding the EMSNE certificate. An information leaflet to attract applications for this EMSNE certificate has been designed [5] [6].

A European Master of Science in Nuclear Disciplines will be delivered under ENEN certification in the near future extending ENEN's certification to other disciplines such as radioprotection and waste management and disposal . By-laws have to be established.

2.2 International Exchange Courses, Advanced Courses and Training Seminars

The equivalence of nuclear engineering curricula relies on the mutual recognition of courses among the ENEN member universities. ENEN therefore also has the task of promoting student and faculty exchanges by encouraging and supporting the organization of international exchange courses at Master level, advanced courses at PhD level as well as training courses for young professionals.

A typical example is the Eugene Wigner course, a three-week course on nuclear reactor physics including theory lectures and practical exercises at three different reactors, which has been organized five times since 2003 by a group of universities and research centers in central Europe, addressing nuclear engineers and young professionals. Advanced courses have been organized by ENEN in the framework of the Integrated Project EUROTRANS (see paragraph 5.5 below).

2.3 NEPTUNO (FP6) Deliverables, Database and Communication System2

Other ENEN products related to the implementation of the EMSNE, to exchange courses as well as to training sessions for young professionals are available on the website of the Sixth Framework Programme project – Nuclear European Platform of Training and University Organizations (NEPTUNO). Deliverables of this Coordination Action include guidelines, best practices and do-it-yourself kits for the organization of international ENEN exchange courses, with examples of flyers and application forms [7]. The NEPTUNO Communication System has been also developed at: http://www.sckcen.be/neptuno

2.4 ENEN II Project (FP6) - Extension to other nuclear disciplines

The ENEN-II Coordination Action consolidates and expands the achievements of the ENEN and the NEPTUNO projects attained by the European Nuclear Education Network Association in respectively the 5th and 6th Framework Programme of the European Commission [8]. The objective of the ENEN-II project was to develop the ENEN Association in a sustainable way in the areas of nuclear engineering, radioprotection and radwaste management, including underground disposal. The current developments in the 7th Framework show that this has partially been achieved. Indeed, the interaction between the different communities, engineering, radiation protection and waste management, has been considerably strengthened. The ENEN Association experience has been exploited to the benefit of the other communities in the development of their networks and the definition of their education curricula and the training programmes. Although the training projects ENEN-III, PETRUS-II and ENETRAP-II now starting under the 7th Framework Programme are distinct activities, they have been prepared in mutual consultation by the three communities and ENEN Association is a partner in the three consortia, assuming a pivotal role in the coordination and streamlining of education and training activities in the European Union. The ENEN-II project activities have been mainly structured around the five Working Areas (WA) of the ENEN Association in close collaboration with selected consortium partners.

2.5 Nuclear Fission Training Scheme- ENEN III, PETRUS II and ENETRAP II

The ENEN Association is involved in three projects for European Fission Training Schemes under the 7th Framework Programme of the European Commission, i.e. ENEN III on nuclear engineering, PETRUS II on geological disposal and underground storage of radioactive waste [9], and ENETRAP II on radiation protection [10]. The introduction of the ENEN III project is as follows:

ENEN-III

The ENEN Association submitted a project proposal for European Fission Training Schemes under the 7th Framework Programme of the European Commission. The proposal covers the structuring, organization, coordination and implementation of training schemes in cooperation with local, national and international training organizations, to provide training courses and sessions at the required level to professionals in nuclear organizations or their contractors and subcontractors. The training schemes provide a portfolio of courses, training sessions, seminars and workshops, offered to the professionals for continuous learning, for updating their knowledge and developing their skills to maintain their performance at the current state-of-the-practice and to anticipate the implementation of new scientific and technological developments. The training schemes allow the individual professional to acquire a profile of skills and expertise, which will be documented in his training passport. The essence of such passport is that it is recognized within the EU (and possibly abroad) by the whole nuclear sector, which provides mobility to the individual looking for employment and an EU wide recruitment field for employers in the nuclear sector. The recognition is subject to qualification and validation of the training courses according to a set of commonly agreed criteria, which can be ratified by law or established on a consensus basis within a network.

The assessment of the needs identified 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. Training schemes in the following four generic types will be developed in the project:

- Type A) Basic training in selected nuclear topics for non-nuclear engineers and professionals in the nuclear industry.
- Type B) Basic training in selected nuclear topics for personnel of contractors and subcontractors of nuclear facilities
- Type C) Technical training for the design and construction challenges of Generation III

Nuclear Power Plants

- Type D) Technical training on the concepts and design of GEN IV nuclear reactors

3. International cooperation

European Union

The ENEN Association is intricately involved in several activities on nuclear education and training in the European Union. In addition, the ENEN Association intends to contribute to the European Institute of Technology.

In the framework of , the Sustainable Nuclear Energy Technology Platform (SNE-TP) launched in 2007 with the aims of coordinating Research, Development, Demonstration and Deployment (RDD&D) in the field of nuclear fission energy, the ENEN co-chairs with the EDF the Working Group on Education, Training and Knowledge Management. The objective is to make proposals to the SNE-TP Governing Board on a future framework of nuclear education, training and knowledge management at European level and implement it in a sustainable manner to ensure the further development of nuclear energy technology in Europe. Major stakeholders participate to the activities of this platform with its three working groups; Strategic Research Agenda (SRA), Deployment Strategy (DS) and Education Training and Knowledge Management (ETKM). From this involvement and by its support the ENEN expects closer contacts and interactions with major industrial partners to increase its visibility and enhance their perception of the ENEN's role in professional training and mobility in addition to its reputation as a network of academia.

International Atomic Energy Agency

The ENEN Association has been involved in several technical meetings, consultants' meetings, workshops and conferences related to education, training and knowledge management organized by the International Atomic Energy Agency (IAEA).

The ENEN Association exchanges information and participates on a regular basis to meetings of the Asian Network for Education in Nuclear Technology which has been operated by the IAEA. Asian network representatives are invited to the meetings of the ENEN Association.

4. Further challenges

The ENEN Association has developed a knowledge and human network of European high-level education and training in nuclear-related subjects, in particular within the nuclear disciplines of engineering, radiation protection, radioactive waste management and decommissioning, together with relevant academic and industrial entities and international organizations. In the framework of the ENEN Association major education and some training institutions in Europe are working together, and the ENEN is acting through education and training for the renewal of competencies across the nuclear energy life cycle (design and build, operate, decommission and dispose).

Through the Network, the adjustment of curricula and training packages has been enhanced and contributed to the young professionals, academic entities and the end-users needs, thereby improving employment and career opportunities, and the qualifications of the young professionals. Its further challenges are:

- o Expand into nuclear disciplines outside nuclear engineering such as radiation protection, radio chemistry, waste management;

- Expand activities from the academic and research environment into the industrial and regulatory organisations and attract their membership;
- Define, harmonise and promote international mutual recognition of professional training for key functions in nuclear industries, regulatory bodies and nuclear applications;
- Participate to EC framework projects, in particular in the European Higher Education and European Research Areas; and
- Continue to support and strengthen cooperation with other international and regional networks.

ENEN Association's members include today major universities in the EU27 involved in the education of nuclear disciplines at masters and PhD levels as well as leading research centres. Universities from worldwide, such as Russia, South Africa and Japan decided to join its activities through the establishment of a Memorandum of Understanding and new collaborations will be established in the near future with third countries such as China etc. Still the sustainability of ENEN will rely on a more significant increase of the involvement of "future employers", industry and regulatory bodies.

In several FP7 projects, ENEN III, ENETRAP II, PETRUS II, NUPLANTS, etc ENEN Association will be working with major industry and regulatory bodies. More synergy will be established through the activities of the third working group of SNE-TP, chaired by industry partner EDF and ENEN and its interaction with the two other working groups. For ENEN this will constitute a great opportunity to expand its activities from the academic and research environment to the industrial and regulatory organisations and to attract their membership.

The ENEN Association, its structural bodies and working groups and their members endeavour to implement this challenging programme, which will significantly contribute to the development of higher nuclear education and expertise within the European Union as well as on a global level.

REFERENCES

[1] The Bologna Agreement http://en.wikipedia.org/wiki/European_higher_education_area

[2] The ENEN Statutes: http://www.enen-assoc.org/en/about/enen-statutes.html

[3] CCE-FISSION Working Group on Nuclear Education, Training and Competence, Reflection paper, 2000.

[4] OECD/NEA, Nuclear Education and Training: Cause for Concern?, ISBN 92-64-18521-6, 2000.

[5] Moons F, BNEN: The Belgian Nuclear Higher Education Network. Your way to the European Master of Nuclear Engineering, ETRAP, 3rd International conference on Education and Training in Radiological Protection, 23-25 November 2005, Brussels, Belgium.

[6] Blomgren J, Moons F, De Regge P, Safieh J, Atomic 21, *European Nuclear Education Network Association*, February 2007, 26–27

[7] Safieh J, De Regge P, NEPTUNO, the Nuclear European Platform of Training and University Organizations, EU Research and Training in Reactor Systems, *FISA conference proceedings EUR 21231*, 13–16 March 2006, Luxembourg, 399–412.

[8] De Regge P, *Consolidation of European Nuclear Education, Training and Knowledge Management,* Nuclear Energy Review 2007 Issue II, 46-47

[9] http://www.enen-assoc.org/en/training/for-nuclear-community/efts-fp7/petrus.html

[10] http://www.enen-assoc.org/en/training/for-nuclear-community/efts-fp7/enetrap.html

ROLE OF SMALL RESEARCH REACTORS IN EDUCATION AND TRAINING IN RADIOLOGICAL PROTECTION

H. BÖCK, A. MUSILEK
Vienna University of Technology / Atominstitut
Stadionallee 2, A-1020 Wien, Austria

J.G. MARQUES
Instituto Tecnológico e Nuclear
Estrada Nacional 10, P-2686-953 Sacavém, Portugal

A. ASZÓDI
Institute of Nuclear Techniques, Budapest University of Technology and Economics,
Műegyetem rkp. 9, H-1111 Budapest, Hungary

L. SKLENKA
Department of Nuclear Reactors, Czech Technical University in Prague
V Holesovickach 2, CZ-180 00 Prague 8, Czech Republic

ABSTRACT

The number of research reactors has gradually decreased due to ageing, reduced utilization and uncertainties in fuel policies. However, there is an increased need of highly specialized facilities to support the training of personnel for the operation of a broad range of installations from nuclear reactors to medical facilities using radiations. Low power research reactors are versatile tools for education and training in radiological protection. While isotope production and state-of-the-art neutron research are better performed in high power research reactors, education and training can be better performed in low and medium power facilities, without affecting other activities. A review of the training activities supported by the small research reactors in Vienna, Lisbon, Budapest and Prague will be given in this paper, with emphasis on practical examples.

1. Introduction

Education and training of young professionals in nuclear-related science and technology is a concern in many countries, in particular since the nineties [1]. The needs in the area of radiological protection are actually broader, due to its importance for the operation of a wide range of installations, from nuclear reactors to medical installations using radiations.

Specialized experimental facilities capable of supporting a diverse curriculum, such as research reactors, hot cells, radiochemistry facilities and radiation measurement facilities are ageing and many were decommissioned. Research reactors in particular suffer from uncertainties in spent fuel policies, which have a higher impact in countries with no (or a reduced) nuclear power program.

Low power research reactors are versatile tools for education and training in radiological protection. While isotope production and state-of-the-art neutron research are better performed in high power research reactors, education and training can be better performed in low and medium power facilities, without affecting other activities.

A review of the training activities supported by the small research reactors in Vienna, Lisbon, Budapest and Prague will be done in this paper, with emphasis on practical examples.

2. Overview of the research reactors

The Atominstitut Vienna (ATI) is attached to the Vienna University of Technology and operates a 250 kW TRIGA Mark-II reactor since March 1962. This research reactor is the only nuclear facility in Austria and is presently the only contributor to nuclear knowledge management in the country because two other Austrian research reactors (in Seibersdorf and Graz) were decommissioned during the past decade. The fact that it is the nearest nuclear facility to the IAEA further increases its international importance. The ATI reactor uses both Low Enriched Uranium (LEU) fuel and Highly Enriched Uranium (HEU) fuel [2].

The Nuclear and Technological Institute operates the Portuguese Research Reactor (RPI) since April 1961. The RPI is a 1 MW pool-type reactor, converted from HEU to LEU fuel in 2007 [3]. As in the previous case, this reactor is the only nuclear installation in the country. Although not integrated in a university, the RPI supports education and training programs inter alia in the three main universities in Lisbon.

The Institute of Nuclear Techniques (NTI) is part of the Faculty of Natural Sciences of the Budapest University of Technology and Economics, Hungary. NTI operates a 100 kW pool-type reactor of Hungarian design since 1971. The NTI reactor uses LEU fuel since its start-up. The reactor is the focal point of exercises for undergraduate and graduate students and serves as a neutron- and gamma-radiation source [4].

The Faculty of Nuclear Sciences and Physical Engineering of the Czech Technical University in Prague operates the VR-1 “Sparrow” training reactor since December 1990. The VR-1 operates normally at 1 kW and at 5 kW for short periods. It was converted from HEU to LEU fuel in 2005 [5].

The nominal age of these facilities ranges from 19 to 48 years. One must note however that significant refurbishment and modernization of the above facilities has been undertaken, so critical components and systems are considerably more recent [6-8].

3. Overview of education and training activities

Table 1 presents an overview of the education courses, ordered by subject, which are supported by the four research reactors in this work. The subject classes are the ones used in the NEPTUNO [9] project funded by the European Commission under its 6^{th} Framework Program and reflect the situation in 2006 with minor updates.

The ATI offers about 100 highly specialized theoretical lectures and more than 10 practical courses where students have to perform experiments in small groups. The program includes also several courses on radiation protection. Many of them use the research reactor as a neutron and gamma source. On an international scale the ATI co-operates closely with the nearby located IAEA and CTBTO in international research projects, coordinated research programs and as a supplier of expert services. Regular training courses are carried out for Safeguards trainees of the IAEA and fellowship places are offered for scientists from developing countries. Since 1984 more than 130 trainees spent about 4 weeks of intensive practical training at the ATI and many of them joined the IAEA as safeguards inspectors. Other fellows spent between one to twelve months at the ATI and are integrated in the work program of the institute. Experience showed that these fellowships result in a long-term professional relationship with ATI and its teams. Specialized practical courses are also carried out for foreign nuclear institutions in countries such as Germany, Czech Republic, Slovak Republic, and the United Kingdom. Although Austria has a strong anti-nuclear policy, nuclear and corresponding radiation protection knowledge in this country is preserved by the ATI’s competences.

Tab 1: Overview of training and education courses supported by the research reactors in this work, following the categories used in the NEPTUNO project.

Subject	ATI	RPI	NTI	VR-1
Nuclear Energy: Introduction	X	X	X	X
Introduction to Nuclear Physics	X			
Nuclear Reactor Theory	X	X	X	X
Nuclear Thermal-Hydraulics			X	
Nuclear Materials			X	
Experimental Reactor Physics	X		X	X
Nuclear Fuel Cycle			X	X
Radiochemistry	X	X	X	
Operation and Control	X		X	X
Radiation Protection and Nuclear Measurements	X	X	X	X
Reliability and Safety				X
Waste Management and Decommissioning				
Nuclear Fusion				X
Advanced Courses	X			X

In addition a new training program started directed to nuclear emerging countries which plan their first step into the nuclear area. In May 2009 a six weeks course were carried out at the ATI to supply participants on a large spectrum of nuclear issues to help them in their decision about steps towards nuclear reactors.

The NTI and VR-1 reactors are also in a university environment, but in countries (Hungary, Czech Republic) with nuclear energy, in contrast with Austria and Portugal. They are used in the education and training of university students, in scientific research and in the training of specialists for the nuclear power industry. Both support courses in a wide range of subjects as summarized in Table 1. The ATI, NTI and VR-1 reactors share several initiatives, such as the Eugene Wigner Course (together with the Slovak Technical University, Bratislava) held yearly since 2003.

The RPI does not benefit from a central location in Europe; thus its activities are focused mostly in Portugal. Even if not integrated in a university, the RPI supports theoretical lectures and practical sessions in chemistry, physics and engineering in the three main universities in Lisbon, as well as specialized training sessions for these and other universities. In 2009 it also supported an ERASMUS Intensive Course on Accelerator and Reactor Operation organized by the Cooperation for Higher Education on Radiological and Nuclear Engineering (CHERNE) group [10], with 27 students from 9 European universities.

4. Specific advantages of research reactors

Research reactors have unique characteristics that can be used as an advantage for education and training in radiological protection:

- Intensity of the radiation fields depends on the reactor's power;
- Simultaneous gamma and neutron fields;
- Production of specific isotopes;
- Pre-operational and operational surveys.

Research reactors are "programmable" radiation sources. As the power can be varied several orders of magnitude within some minutes, one can have neutron and gamma radiation with variable intensity, at request, while keeping the same geometry in a given setup. Figure 1 shows a simple example of spectra obtained with a He-3 neutron detector (proportional counter) in the thermal column of the RPI at various powers from 1 to 10 kW. These spectra show the linear behaviour of the detector, with a clear separation of events due to neutrons from the low amplitude events due to gammas. Further spectra at higher power would show that the conditions would be above the practical operating limit of the detector, which is an important lesson for the trainees.

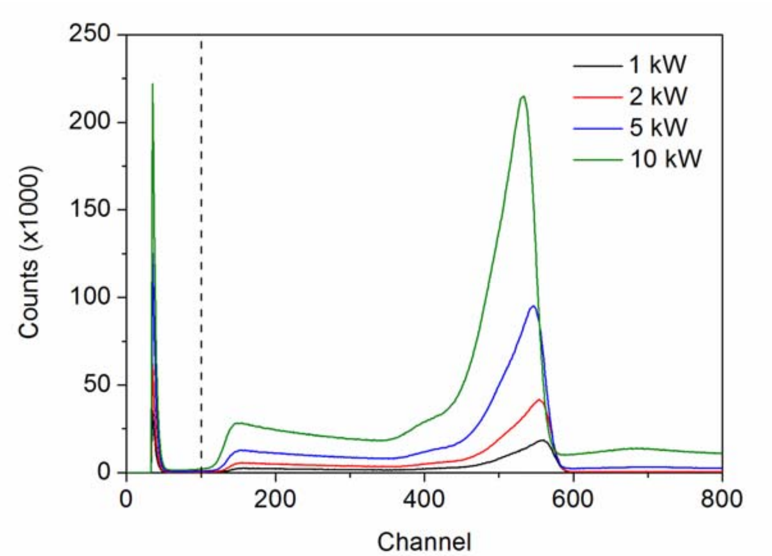

Fig 1: Spectra obtained with a He-3 neutron detector at different operating powers, from 1 to 10 kW. The spectra show the linear behaviour of the neutron detector, with a clear separation of events due to neutrons (to the right of the dashed line) from the ones due to gammas (to the left of the line). Further increasing the operating power would render the detector no longer responsive.

When using a beam port in a reactor, gamma radiation is normally present together with the neutrons, as shown in Fig. 1. This is not necessarily a nuisance, as it allows inter alia to study:

- Interference phenomena in active and passive detectors.
- Properties of different materials as shield for gammas and neutrons – e.g. students will find that the Pb they know to be a good gamma shielding material will also attenuate neutrons.
- Optimization of combined shielding, discussing the advantages and disadvantages of using first a material with higher efficiency for gammas or for neutrons.

In practical courses on radiation protection, it is important to be able to produce radioactive isotopes precisely tailored for particular experiments. Through the use of the reactor as a neutron source this is easy to realize by neutron activation. By choice of appropriate samples (chemical composition, mass) and appropriate irradiation parameters (irradiation time, neutron flux, and irradiation position in the reactor), activity and dose rate of samples can easily be adapted to different radiation protection experiments. By the use of this method specific isotopes are produced, which can be used amongst others for the following training aspects of radiation protection:

- Average activity, average half-live: Theoretical prediction and verification of dose rates at certain distances of the irradiated sample including the explanation of terms like absorbed dose, KERMA, dose equivalent and effective dose.
- Low activity, short half-live: Determination of half-lives.
- Average activity, long half-live: Handling of unsealed radioactive materials.
- High activity, long half-live: Handling of sealed radioactive materials.
- Average activity, short half-live: Contamination and decontamination.

Through the subsequent use of radiochemical procedures in the radio-chemical laboratories of the Institute, the resulting knowledge will be deepened. For example, the "Plutonium - URanium Extraction" (PUREX) separation process or the absorption of radioactive isotopes in organic substances can be introduced experimentally in this way. Through the use of such procedures a safe handling of unsealed radioactive material can be excellently taught.

Research reactors have a wide range of monitoring systems for liquid and airborne effluents. Although many of these monitoring systems are not student-friendly, it is relatively easy to perform exercises in which the students collect air, water and swipe samples, measure the samples with appropriate detectors and correlate the results with other monitoring systems at different operating powers.

While isotope production and state-of-the-art neutron research are better performed in high power research reactors, education and training can be better performed in low and medium power facilities, without a large impact in normal operation. The activities above described are just highlights of the experimental training in the ATI, ITN, NTI and VR-1 reactors in the area of radiation protection.

5. Conclusions

Research reactors are versatile tools for education and training in radiological protection, presenting excellent opportunities to teach practical radiation protection. Any research reactor can in principle be used, even if education and training can be better performed in low and medium power facilities, as it will not impact significantly normal operation for other users.

6. References

[1] Nuclear Energy Agency, "Nuclear Education and Training: Cause for Concern?", NEA (Paris, 2000).

[2] M. Villa, H. Böck, "44 Years of Operation: The Successful History of the TRIGA Mark II Reactor Vienna", Trans. 10th International Topical Meeting on Research Reactor Fuel Management (RRFM 2006), Sofia, Bulgaria, April 2006, European Nuclear Society (Brussels, 2006), pp. 275-279.

[3] J.G. Marques, N.P. Barradas, A. Kling, A.R. Ramos, J.P. Santos, J.G. Stevens, J.E. Matos, "Commissioning of the New LEU Core of the Portuguese Research Reactor", Trans. 12th International Topical Meeting on Research Reactor Fuel Management (RRFM 2008), Hamburg, Germany, March 2008, European Nuclear Society (Brussels, 2008, ISBN 978-92-95064-04-1).

[4] A. Aszódi, "The Next 20 Years Operation of the 36 Years Old Hungarian Training Reactor", Int. Conf. on Research Reactors: Safe Management and Effective Utilization, Sidney, Australia, 2007, paper S-71.

[5] L. Sklenka, R. Skoda, J. Rataj, K. Matějka, "LEU Experience on the Sparrow Training Nuclear Reactor", Proc. 28th International Meeting on Reduced Enrichment for Research and Test Reactors (RERTR 2006), Cape Town, South Africa, 2006.

[6] H. Böck, M. Villa, "Experience with Modernization and Refurbishment of the Vienna Triga Mark II Reactor I&C System", TECDOC-1625, IAEA (Vienna, 2009), pp. 17-24.

[7] J.G. Marques, A.R. Ramos, A. Kling, "Planning and Initiation of an I&C System Upgrade for the Portuguese Research Reactor", TECDOC-1625, IAEA (Vienna, 2009), pp. 141-151.

[8] J. Rataj, M. Kropík, L. Sklenka, K. Matějka, "Modernization of the VR-1 Training Reactor", TECDOC-1625, IAEA (Vienna, 2009), pp. 41-47.

[9] J. Safieh, P. De Regge, "The European Platform of Training and University Organizations (NEPTUNO) Project", Proc. FISA 2006 Conference, European Communities (Brussels, 2006) pp. 399-412.

[10] J. Ródenas, "A Network to Enhance Cooperation for Higher Education on Radiological Protection", this conference.

European Nuclear Society

Rue Belliard 65, 1040 Brussels, Belgium
Telephone +32 2 505 30 54, Fax + 32 2 502 39 02
etrap2009@euronuclear.org - www.euronuclear.org