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Presentations

Proceedings

Learning Outcomes for Education & Training Programs for Radiation Protection Officers responsible for open radioactive sources – a German – Dutch comparison

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ABSTRACT

Commissioned by the Dutch Authority for Nuclear Security and Radiation Protection (ANVS) the University of Groningen has coordinated a project for determining qualification descriptors and therefore learning outcomes for RPO Education & Training for open radioactive sources. The project was conducted as part of the implementation of the EU Directive 2013/59 and its immediate predecessor.

The Universities of Groningen and Hannover are collaborating in comparing the new Dutch learning outcomes with the current and possible future German requirements for RPOs for open radioactive sources. This bilateral project aims at providing advice to the ANVS and the German Bundesamt für Strahlenschutz (BfS) to formulate the final learning outcomes for E&T programs for these RPOs. Furthermore – as the lowest level of these programs will also be suitable for radiation workers (RWs) – the project aims at facilitating employers in both countries in mutually recognizing the instruction programs for RWs.

Essential elements of the new Dutch learning outcomes will be presented along with the preliminary results of the bilateral comparison.

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1. Introduction

The Dutch Authority for Nuclear Safety and Radiation Protection (ANVS) requested the field to revise the training system for Radiation Protection Officers. The core of these revisions which derive from the European Basic Safety Standards (EU-BSS) [1] is that the training for Radiation Protection Officers should be application specific. During the past years, a start has been made on these revisions [2]. As an outcome, the University of Groningen has decided to form a workgroup whose task is to formulate the qualification descriptors for the training of Radiation Protection Officers responsible for Dispersible Radioactive Materials, abbreviated as RPO-DRM. The workgroup consisted of 20 members from 15 organizations and met twice in 2016. In the first part of this contribution we present the result of this workgroup.

In the second part of this contribution the objectives and preliminary results of the bilateral comparison between the learning outcomes of the RPO-DRM training with the German equivalent are presented.

2. Scope of the Qualification Descriptors

The qualification descriptors are meant for the tasks of the Radiation Protection Officers responsible for Radioactive Materials in dispersible form in unlimited quantities. Unlimited here refers to “all permits that relate to radioactive materials in dispersible form, regardless of the licensed activity”. The definition and tasks of the Radiation Protection Officer are given in the Radiation Protection Decree [3]. The qualification descriptors are primarily meant for

- Research, analysis and material research
- Production of radioactive materials in dispersible form
- Human radio diagnostics, radiotherapy and nuclear medicine
- Performance of leakage tests

on the understanding that a RPO-DRM can supervise in the medical sector as long as radioactive materials are not applied to the patient (no direct patient contact). Should this be the case, then the supervisor should have successfully completed a training for Radiation Protection Officer for Medical Applications. The qualification descriptors for RPO-DRM should also be sufficient to function as a Radiation Protection Officer for small calibration sources.

The RPO-DRM can be the responsible party for releasing material, waste, equipment and the performance of control measurements on any residual contamination in the laboratory. The *RPE* is actually responsible for the release of the entire laboratory, including technical facilities outside of the lab such as sewer pipes and ventilation systems. The release or dismantling of rooms and technical facilities (during decommissioning) where there is a risk of activated material also falls under the responsibility of a RPE.

The ANVS is currently working on an adjusted system of permits, registrations and notifications as part of the new national Decree on Basic Safety Standards for Radiation Protection (Bbs) and the implementation of the new EU-BSS. The implementation of this project strives for a gradual approach, which is to say that the requirements increase as the risk of the application becomes greater.

In light of this, the workgroup is of the opinion that a two- to three-fold division in the level of RPO-DRM is desirable, and for pragmatic reasons it is proposed to hold to the limits of the Directive Radionuclide Laboratories, which in any case adheres to the gradual approach for regular applications:

- RPO-DRM B for radionuclide laboratories at B-level (A_{max} = 2000 Re_{inh}*)
- RPO-DRM C for radionuclide laboratories at C-level under the direct repsonsibility of a RPE (A_{max} = 20 Re_{inh}*)
- RPO-DRM D for radionuclide laboratories at D-level under the direct repsonsibility of a RPE (A_{max} = 0,2 Re_{inh}*)

(*: In the Netherlands the quantity Re_{inh} is used for the amount of activity A that leads to an effective committed dose of 1 Sv upon inhalation)

A RPO-DRM will, in many situations regarding radiation protection, work under the direct “responsibility” of a RPE. A RPE generally possesses a broad expertise in the area of radiation protection and functions as the first contact point for the RPO-DRM for incidents, etc. Some RPO-DRMs work alone and occasionally must quickly make a decision based on the relevant radiation risks. In such a situation, the RPE is mostly hired in and has limited tasks as minimally defined by law in the Radiation Protection Decree. More is expected from the RPO-DRM, such as quickly making decisions during incidents. The workgroup believes that the difference between these two situations is mainly a distinction in the basic knowledge of a RPO-DRM B with respect to a RPO-DRM C and D. A solitarily-operating RPO-DRM should thus be trained to the RPO-DRM B level.

The EU-BSS states that a Radiation Protection Expert can perform the tasks of a Radiation Protection Officer. Beginning with the assumption that this implies that in the Bbs the tasks from a RPO may be performed by a RPE, there is no reason to formulate separate qualification descriptors for an RPO-DRM Level B – this person should successfully complete the training for a RPE. The workgroup recommends to state explicitly in regulations that the application-specific portion of the training for a RPO-DRM C counts as appropriate (refresher) training in radiation protection for a RPO-DRM B. Summarizing, we assume for the qualification descriptors given here that the RPO-DRM works under the substantive responsibility of the RPE within the organization.

3. Qualification Descriptors / Core Competencies

Two separate documents were produced presenting the qualification descriptors for RPO-DRM C and RPO-DRM D respectively. Both documents summarize the main assignments of RPOs along with the required skills.

The training for a RPO-DRM C is on EQF-level 6. The prerequisites for a course participant will in many cases be a BSc (or just below) with a profile in the exact sciences (physics and health, or physics and technical) from secondary school. The training for a RPO-DRM D is on EQF-level 4 to 5.

The draft qualification descriptors for the basic competencies of an RPO-DRM are grouped in four clusters:

- Core competency 1: The RPO-DRM supervises and enforces (for the applications for which he is responsible) the relevant laws and regulations in the area of ionizing radiation and gives content appropriate advice to the workers and the organization in consultation with the RPE.
- Core competency 2: De RPO-DRM contributes to the appropriate management of an unintentional event or (imminent) incident for the applications for which he is responsible.
- Core competency 3: The RPO-DRM actively works on furthering his own expertise and those of others for whom he is responsible.
- Core competency 4: The RPO-DRM possesses knowledge, skills, attitudes and competencies that specifically apply to radioactive materials in dispersible form.

The core competencies have each been worked out in detailed learning outcomes including a table of keywords for the E&T programs. Learning outcomes for the practical have also been formulated along with recommendations for the assignment procedure.

The nominal training period can vary per educational institute according to the didactic interpretation (schedule, contact hours versus self-study, contact hours versus e-learning/blended-learning, the use of web lectures, etc.), the combination with other courses for RPOs, the entry level of the participants (prerequisites), and the extra packets offered in addition to the minimally required packet. Indicative figures for the training period are given below:

	Indicative length (incl practicals)	Practicals	Professional attitude
RPO-DRM C	10-12 days	2-3 days	1-1,5 days
RPO-DRM D	3-5 days	1-2 days	Not specified

In September 2016, the documents containing the draft learning outcomes for RPO-DRM C and D have been approved by the Advisory Committee on Radiation Protection for inclusion in the new Dutch regulations. The English and Dutch version of the draft learning outcomes are or will be available through our website http://tinyurl.com/RPO-DRM [5].

4. Relation with the old Dutch system of Education & Training

When drafting the qualification descriptors, the workgroup realized that the former Level 4B [6] training is from origin the training for workers who in large part may work independently in radionuclide laboratories. The former Level 5B training had been used by many employers the past decade to train workers who may in large part work independently in radionuclide laboratories. Both Level 4B and 5B experts may even be deployed occasionally as an RPO (currently for sealed sources of limited risk). Consequently there is a large overlap with the old qualification descriptors of the training Radiation Expert Level 4B and 5B [7].

In order to provide employers the possibility to use an acknowledged E&T program for radiation workers (RWs) in the future, the workgroup explicitly recommends the application of the qualification descriptors for the RPO-DRM D to those exposed workers working with radioactive material in dispersible form.

5. Towards a German-Dutch comparison

Building on earlier work the Universities of Groningen and Hannover are collaborating in comparing the new Dutch learning outcomes with the current of possible future German requirements for RPOs for open radioactive sources [8]. This bilateral project aims at providing advice to the ANVS and the German Bundesamt für Strahlenschutz (BfS) to formulate the final learning outcomes for E&T programs for these RPOs. Furthermore – as the lowest level of these programs will also be suitable for radiation workers as indicated above – the projects aims at facilitating employers in both countries in mutually recognizing the instruction programs for RWs.

With the implementation of the EU-BSS ahead and the changes in the Dutch Education and Training system in mind, there is a clear necessity to update the bilateral report, while at the same time an extension to other countries in NW Europe would be of great value. As a first step in this process we intend to compare learning outcomes for E&T programs meant for the RPO-DRM (D) in The Netherlands and the S4.1 Module in Germany [9,10].

The project aimed to reach the following objectives

1. A translation into English of the draft learning outcomes for RPO-DRM C and D in the Netherlands.
2. A description of the expected changes in the current learning outcomes for these RPOs in Germany.
3. Identify gaps between both learning outcomes and formulate advice how to bridge these gaps. This advice will be offered to the competent authorities in relation to mutual recognition of these courses.
4. To make the results available to the whole EUTERP-community as well as to employers interested in mutual recognition of E&T for RWs working with open radioactive sources.

6. Preliminary results of the bilateral comparison

To identify the gaps between both learning outcomes of the RPO-DRM D in the Netherlands and the S4.1 Module in Germany as well as the conformities, a table was generated. As a first step, the learning objectives were compared by focusing on the keywords. As a result, the table illustrates which subjects harmonize most. If the content differs partially, the differences are marked and integrated as supplements. In general, the German learning outcomes are more detailed, which causes an assignment of several German subjects to one Dutch learning objective. Learning outcomes, which are content-wise identical, are contrasted in the following way:

Firstly, the table opposes the importance of the various subjects, as indicated in the Dutch and German learning outcomes respectively, to give advice concerning the arrangement of radiation protection courses. The importance is rated with the help of numbers or rather an amount of crosses. Secondly, the table presents to which extent the learning outcomes are communicated to the course participants. The extent of the training program is a direct consequence of the importance. The Dutch learning objectives are classified by three different categories:

knowledge, skills and competences. The German learning outcomes are categorized with the help of their dyadic operators. The table opposes directly the Dutch category graduation to the German operators. Apart from that, the German learning objectives, which base on the radiation protection ordinance or on other national guidelines are specially marked. Most of those subjects implicitly exhibit a Dutch equivalent. This is because the content is similar and only the legal basis is different.

The table enables to identify legislation related learning outcomes, which indicates conversely the identification of the most significant gap: the knowledge and application of national legislation and national organization structures.

Furthermore, the table illustrates which subjects are supported by experiments. The course providers are responsible for the application and the arrangement of experiments. As a result, this comparison is limited and bases on the information of the Dep. of Health, Safety and Environment / Radiation Protection Unit of the University in Groningen and the Institute for Radioecology and Radiation Protection of the Leibniz University in Hannover. At a first glance, the University of Groningen includes more experiments than the Institute for Radioecology and Radiation Protection in Hannover. In Germany seven hours must be spent on experiments, which is defined in the “Guideline for the requisite qualification concerning Radiation Protection for technical applications”. In the Netherlands there is no specific definition on the extent of the experiments, although roughly 12 hours are spent on experiments at the University of Groningen. As a consequence of the implementation of the EU-BSS the Dutch course arrangement is likely to be extended with a few hours of lecturing or experiments focusing on supervising skills.

Generally, Germany has not proceeded that much in formulating new learning outcomes. Thereby, the requirements concerning the radiation protection education will probably not change, which means that the German subjects will only slightly be modified. Therefore, the comparison bases on the current learning objectives catalogue and on the draft learning outcomes for RPO-DRM D.

The detailed report with all relevant information will presumably be published in August 2017 and will, among others, be available on our website [5].

7. Conclusions

The formulation of qualification descriptors for RPOs responsible for radioactive material in dispersible form contributes to the implementation of the European BSS. Simultaneously, the fact that the qualification descriptors for the RPO-DRM D can also be used as adequate instruction for RWs, facilitates bi- or multilateral comparison of training programs not only for RPOs, but also for RWs.

The bilateral comparison of learning outcomes for E&T programs for the RPO-DRM (D) in The Netherlands and the S4.1 Module in Germany is well under way. Preliminary results indicate a large overlap between the learning outcomes except for the knowledge and application of national legislation and national organization structures.

References

[1] Council Directives 96/29/Euratom (13 May 1996) and 2013/59/Euratom (5 December 2013)

[2] B.C. Godthelp and A.M.T.I. Vermeulen, Ned. Tijdschrift voor Stralingshygiëne, jg.6, nr.3 (2015), p.9 and references therein

[3] Radiation Protection Decree 16 July 2001, Staatsblad 397 (2001), http://wetten.overheid.nl/BWBR0012702/2015-01-01/0
[4] Guideline Radionucliden-laboratoria, Min. van VROM, Hoofdinspectie Milieuhygiëne, Publication 94-02, 1994 – withdrawn in 2002; relevant portions are incorporated into many permits
[5] Full url: http://www.rug.nl/education/other-study-opportunities/radiation-protection/strcursusinformatie/strcureindtermen/eindtermen
[6] For the current Dutch E&T system, see e.g. H.F. Boersma et al. in Transactions of ETRAP 2013, p.38
[7] Appendix 3.2, Uitvoeringsregeling Stralingsbescherming EZ 2013 (Staatscourant 2013, 32478)
[8] Jack Haagen et al. 'Comparison of the lowest level Radiation Protection Courses in Germany and the Netherlands' – a bilateral pilot' – 2012 (available from the presenting author)
[9] Richtlinie über die im Strahlenschutz erforderliche Fachkunde (Fachkunde-Richtlinie Technik nach Strahlenschutzverordnung) vom 18.06.2004, GMBl. Nr. 38 vom 27.7.2006 S. 735
[10] Lernzielkatalog zu den Fachkunde-Richtlinien Technik nach RöV und StrlSchV, FS-2011-166-AKA-NETZ , ISSN 1013-4506, http://www.fs-ev.org/fileadmin/dummy/lernzielkatalog_fs_aka_april_2007_1.pdf (05.04.2017)

IMPLEMENTING THE EU BSS: IMPLICATIONS FOR THE SYSTEM OF EDUCATION AND TRAINING IN GERMANY

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ABSTRACT

Implementing the EU BSS will change the German legislation considerably. Concerning E&T two major facts will be important: First the implementation of the RPO and RPE has to be discussed presupposing that the proven German system should be preserved. Additionally, as a consequence of the implementation of the EU BSS, two important ordinances (Radiation Protection Ordinance and X-Ray Protection Ordinance) will be combined to one. This might have a major impact on E&T in Germany because the existing complex system of many different knowledge-groups might be harmonized and made clearer as well. This development has been presented the first time at the EUTERP workshop in Athens in 2015. In the meantime the national discussion of how to implement E&T in the revised system of legislation in Germany has been going on. In this presentation an update of the current state of this discussion concerning E&T in Germany will be presented and possible further developments will be discussed.

1. Introduction

The establishment of comprehensive radiation protection standards for different European countries was one of the main objectives of the revision of the European Basic Safety Standards. These revised European Basic Safety Standards [1] replace the former definition of a qualified expert by two more detailed definitions of persons responsible for RP, named Radiation Protection Officer (RPO) and Radiation Protection Expert (RPE).

The Radiation Protection Officer is defined in article 4 (81) of the revised EU BSS as *"an individual who is technically competent in radiation protection matters relevant for a given type of practice to supervise or perform the implementation of the radiation protection arrangements".*

The definition of the Radiation Protection Expert is given in article 4 (79) of the revised EU BSS as

"an individual or, if provided for in the national legislation, a group of individuals having the knowledge, training and experience needed to give radiation protection advice in order to ensure the effective protection of individuals, and whose competence in this respect is recognized by the competent authority".

By implementing the EU-BSS two major issues have to be considered. First, the definition of the RPO and RPE has to be implemented in the national legislation in line with the European Guidelines. Second, the identification of commonalties concerning RP with emphasis on E&T should be supported in order to foster the mutual recognition of different qualifications. However, different systems of RP that have been established and worked properly in different European Countries can not be expected to be changed easily. In this contribution, the national discussion in Germany concerning the implementation of the EU-BSS into national legislation and possible implementations concerning E&T in RP are presented.

2. The German system of RP organisation – strengths and weaknesses

Until today the organization of RP in Germany is regulated by the Ordinance on the Protection against Damage and Injuries Caused by Ionizing Radiation (Radiation Protection Ordinance) [2] and by the Ordinance on the Protection against Damage and Injuries Caused by X-Rays (X-Ray Protection Ordinance) [3] on the basis of the atomic energy law [4]. Requirements related to the organization of RP and related to the E&T in RP are regulated very similar in these both ordinances. Insofar as this is necessary to ensure radiation protection for the practice, the appropriate number of radiation protection commissioners (in German "Strahlenschutzbeauftragte") for the control and surveillance of the practice in question shall be appointed in written form by the radiation employer. When a radiation protection commissioner is appointed, his functions, his in-plant authority and his authorization required for him to comply with his functions shall be defined in writing. In addition, the tasks and duties according to the responsibility of a radiation protection commissioner are described in detail in the ordinances. The competent authority shall be notified immediately about the appointment of the radiation protection commissioner, his functions and authorization, any alterations of his functions and authorization and his resignation from this position.

To ensure that a radiation protection commissioner can fulfill the tasks and duties his training and education has to be appropriate. For this reason the notification of appointment shall be accompanied by the certificate about the requisite qualification in radiation protection. The requisite qualification in radiation protection shall, as a rule, be acquired through a vocational training scheme suited for the respective area of application, practical experience and successful participation in courses recognized by the competent agency. The vocational training scheme shall be documented by reports, practical experience by supporting documents and successful participation in a course by a certificate. Further details concerning the requisite qualification in radiation protection are specified in different Directives. Because two different Ordinances concerning ionizing radiation have to be taken into account, these Directives distinguish between technical applications with radionuclides [5] or X-rays [6] and between medical applications again concerning the handling of radionuclides [7] or X-Rays in the medical sector [8].

Concerning the technical application of radiation protection except for some specialized workers in major institutions (like research institution, accelerator facilities or nuclear power plants) most of the radiation protection commissioners are only marginally concerned with radiation protection during their working hours. Therefore they cannot be considered as professional radiation protection experts. In that case the purpose of radiation protection courses is to train these employees in a way that ensures their competence in radiation protection especially for their specific application supported by their knowledge about the existing local conditions in their company. Hence a diversified system of many different radiation protection courses (more than 60 different courses) for a large amount of radiation protection commissioners has been established in Germany. This fact has been criticized many times in the past [9-11] On the other hand this diversified system is a direct consequence of the organization of RP in Germany and leads to a very tailor-made and application-based education and training system. Additionally each Radiation Protection Commissioner has to be appointed to the competent authorities. In that way a Radiation Protection Commissioner maybe seen as an RPE, trained sufficiently exactly for his application of ionizing radiation, even if an academic degree is missing.

3. A new law - opportunities and traps

As a consequence of the implementation of the EU BSS the German legislation concerning RP will be restructured completely. Although this process has not been finished yet, a new law is going to be established, the so called Radiation-Protection-law (German “Strahlenschutzgesetz”). Ordinances have to be revised, too, and most probably this process will lead to a fusion of the Radiation Protection Ordinance and the X-Ray Ordinance. Consequently, now existing Directives like [5] and [6] or [7] and [8] could be merged to at least two Directives: one for technical and one for medical applications. That in turn could lead to a fusion of different qualifications groups in order to make the German system of RP-courses more clearly and in order to decrease the number of different RP-courses. At the moment, combined courses are only destined for technical applications in the field of non-destructive testing and for teachers in public schools; for medical applications a basic course exists that covers both, X-ray applications and the use of radioactive materials in hospitals. Further combined courses could be possible e. g. for applications with external radiation only, like the handling of sealed sources and X-Ray-application in the technical field, if learning outcomes do not differ significantly. On the other hand, participants of these courses benefit only if the additional knowledge taught in a course is useful for them. Right now, it is under discussion whether a more clearly arranged course system justifies to blur the tailor-made and application-based approach now established in RP-courses.

Additionally some new applications have to be integrated in the German system of E&T in RP. New qualification groups have to be established for RPEs in the field of

1. handling of Naturally Occurring Radioactive Material (NORM),
2. exposure due to cosmic radiation in aircrafts and
3. transport of radioactive material.

Requirements for the necessary vocational training, the practical experience and content and duration of RP-courses are under discussion right now.

4. Outlook

In the new German Radiation Protection law applications concerning radioactive sources, accelerators and X-rays will be distinguished between existing, planned and emergency exposure situations only. For that reason today (April 2017) the two major German Ordinances concerning Radiation Protection for Ionizing Radiation, [2] and [3], will be merged to one Ordinance with the consequence that the number of qualification groups may decrease, too. On the other hand, the very good experiences made with the implementation of RP in Germany, based on a very use-oriented system, leads to the firm conviction that this tailor-made system of E&T has to be preserved. The final results of this discussion are not clear yet and the development of the German system of E&T in RP, described in Ordinances and Guidelines, will take some more months or years. Apart from that other European Countries might see the advantages of an application-based approach and might adapt their system in order to foster the mutual recognition of different qualification in RP.

5. References

[1] COUNCIL DIRECTIVE 2013/59/EURATOM of 5 December 2013, laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom, Official Journal L 13/1 of 17.01.2014

[2] Strahlenschutzverordnung vom 20. Juli 2001 (BGBl. I S. 1714; 2002 I S. 1459), die durch Artikel 6 des Gesetzes vom 27. Januar 2017 (BGBl. I S. 114) geändert worden ist

[3] Röntgenverordnung in der Fassung der Bekanntmachung vom 30. April 2003 (BGBl. I S. 604), die zuletzt durch Artikel 6 der Verordnung vom 11. Dezember 2014 (BGBl. I S. 2010) geändert worden ist

[4] Atomgesetz in der Fassung der Bekanntmachung vom 15. Juli 1985 (BGBl. I S. 1565), das zuletzt durch Artikel 1 des Gesetzes vom 26. Juli 2016 (BGBl. I S. 1843) geändert worden ist.

[5] Richtlinie über die im Strahlenschutz erforderliche Fachkunde (Fachkunde-Richtlinie Technik nach Strahlenschutzverordnung) vom 18.06.2004, GMBl. Nr. 38 vom 27.7.2006 S. 735

[6] Richtlinie über die im Strahlenschutz erforderliche Fachkunde und Kenntnisse beim Betrieb von Röntgeneinrichtungen zur technischen Anwendung und genehmigungsbedürftigen Störstrahlern sowie über Anforderungen an die Qualifikation von behördlich bestimmten Sachverständigen (Fachkunde-Richtlinie Technik nach Röntgenverordnung, Bek. d. BMU v. 21.11.2011)

[7] Strahlenschutz in der Medizin - Richtlinie nach der Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung - StrlSchV), RS II 4–11432/1, 26.05.2011

[8] Richtlinie Fachkunde und Kenntnisse im Strahlenschutz bei dem Betrieb von Röntgeneinrichtungen in der Medizin oder Zahnmedizin, GMBl. Nr. 22 vom 07.04.2006 S. 414, 22.12.2005, geändert durch Rundschreiben vom 27.06.2012

[9] Lothar Spieß: Strahlenschutzanwendung in der Technik. In: Strahlenschutzpraxis 1/2013, S. 34-37

[10] Lothar Spieß: Vorschläge zur Neugliederung der Fachkunde-Richtlinie für Technik. In: Strahlenschutzpraxis 1/2013, S. 85-87

[11] Karl-Ludwig Stange: Neue Kurse braucht das Land. In: Strahlenschutzpraxis 2/99, S. 28-31, 1999

LECTURING ETHICS IN NUCLEAR SCIENCE AND TECHNOLOGY AND RADIATION PROTECTION COURSES: MOTIVATIONS, APPROACHES AND ATTENTION POINTS.

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ABSTRACT

For more than a decade now, the SCK•CEN Academy for Nuclear Science and Technology, in cooperation with the Science & Technology Studies unit of SCK•CEN, organises 'Seminars on Ethics, Science & Technology', either in the form of self-standing events or as part of nuclear science and technology and radiation protection courses. Target audiences include science and engineering students and professionals working in the nuclear field, and seminar formats vary from one-hour-introductions to interactive workshops running over two days.

This short discussion paper presents a specific understanding of ethics in relation to science & technology in general and in relation to nuclear technology in particular[1], and this in the form of five attention points:

- Science & technology studies as the reference framework, from an ethics perspective
- The case of nuclear technology: neutral application contexts for meaningful evaluations
- Risk inherent technology assessment as a responsible policy-supportive research practice
- Ethics, fairness and trust: the idea of fair risk governance
- Education as critical capacity building

The reason to elaborate on these attention points in this text is that they figure as key topics of discussion in the seminars on ethics, science and technology themselves. At the same time, they inspire specific skills required to deal responsibly with risk inherent technologies such as nuclear technology. In the following text, the proposed attention points are each topic of a chapter. While they can be perceived separately, it may be clear that they are closely interrelated. A concluding chapter presents how these attention points are discussed in practice in the seminars on ethics, science and technology organised by the SCK•CEN Academy for Nuclear Science and Technology.

Content

[1] The ideas presented here are elaborated in more detail in (Meskens 2013, 2015, 2016a, 2016b, 2017).

1 Introduction

The last years, one can observe growing interest in ethics of radiological protection and related to nuclear technology as topics of education, research and research policy. The International Commission on Radiological Protection (ICRP) completed a broad reflection process on the ethical foundations of the system of radiological protection[2], International organisations such as the ICRP, the International Atomic Energy Agency (IAEA), the International Radiation Protection Association (IRPA) and the International Youth Nuclear Congress regularly include sessions on ethics in their conferences, workshops or education programmes, and research on ethics is slowly finding ground in various EURATOM-funded networks, platforms and research projects. In addition, more and more academies and universities include sessions on ethics in their education and training programmes related to applications of nuclear science and technology.

Already more than fifteen years ago, the PISA research programme[3] of the Belgian Nuclear Research Centre SCK•CEN started to pay attention to ethical aspects of the application of nuclear technology (Turcanu et al. 2016), and the public dissemination of the research triggered an interest in lectures and courses devoted to ethics from out of the wider nuclear research and policy community. For more than a decade now, the SCK•CEN Academy for Nuclear Science and Technology, in cooperation with the Science & Technology Studies unit of SCK•CEN, organises 'Seminars on Ethics, Science & Technology', either in the form of self-standing events or as part of nuclear science and technology and radiation protection courses. Target audiences include science and engineering students and professionals working in the nuclear field, and seminar formats vary from one-hour-introductions to interactive workshops running over two days.

This short discussion paper presents a specific understanding of ethics in relation to science & technology in general and in relation to nuclear technology in particular[4], and this in the form of five attention points:

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- Education as critical capacity building

The reason to elaborate on these attention points in this text is that they figure as key topics of discussion in the seminars on ethics, science and technology themselves. At the same time, they inspire specific skills required to deal responsibly with risk inherent technologies such as nuclear technology. Important to stress here is that these skills requirements apply in the same way to anyone concerned with risk-inherent technology applications, being it nuclear workers, scientists, radiation protection officers, managers, policy makers and citizens. As a consequence, the seminars become self-reflexive, in the way they invite reflection and dialogue on the specific role, expertise and responsibility of all participants.

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[2] ICRP Task Group 94 developed an ICRP Publication presenting the ethical foundations of the system of radiological protection recommended by the Commission. The purpose of this publication is to consolidate the basis of the recommendations, to improve the understanding of the system and to provide a basis for communication on radiation risk and its perception. See http://www.icrp.org/icrp_group.asp?id=86

[3] The 'Programme of Integration of Social Aspects into nuclear research' (PISA) is a research programme undertaken by the Science & Technology Studies Unit of SCK•CEN.

[4] The ideas presented here are elaborated in more detail in (Meskens 2013, 2015, 2016a, 2016b, 2017).

In the following text, the proposed attention points are each topic of a chapter. While they can be perceived separately, it may be clear that they are closely interrelated. A concluding chapter presents how these attention points are discussed in practice in the seminars on ethics, science and technology organised by the SCK•CEN Academy for Nuclear Science and Technology.

2 The reference framework: science & technology studies, from an ethics perspective

Science and technology have dramatically changed our world in the last centuries, albeit in conflicting ways. On the one hand, they have significantly contributed to the improvement of our individual life, our collective well-being and the organisation of our society. On the other hand, they have resulted in various threats to life and well-being and provided multiple tools to distort and even destroy our society and habitat as a whole. The development and application of modern science and technology in the various 'sectors' of organisation of our society (health, food, water, housing, energy, transport, industry, …) can be called one of the five evolutions that, in a historical perspective, made up modernity. The other four happened in the 'fields' of politics (the emergence of democracy, the nation state and international politics), economics (the emergence of globalised markets and the financial economy), culture (the emergence of popular culture and modern and postmodern art) and the social (the emergence of new lifestyles and new forms of communication).

Evaluations of how science and technology (might) affect us cannot be done in isolation from the contexts wherein they operate, which means these evaluations have to take into account aspects of the fields of politics, economy, culture and the social as mentioned above. The reason is that the potentialities and (possible) threats of science and technology affect the way we live but also our considerations on the way we want to live. Conversely, current political, economic, cultural and social interests and dynamics affect the way science and technology develop and are applied now and in the future. The recognition of this interrelation is what characterises 'science & technology studies' (STS), and the 'nature' of this interrelation, in terms of its various scientific, technical, political, economic, cultural, social and ethical aspects, is topic of analysis in STS.

The question whether STS should be 'free' from normative thinking or should rather 'allow' or even be driven by normative thinking is a topic of STS research in itself. Based on the underlying research on ethics, science and technology, the seminars on ethics discussed here deliberately take the second position. In other words: ethical aspects of the interrelation of science, technology and society are thus not only seen as 'just another set of aspects' for analysis. On the contrary: the idea is that ethics primarily provide the lens for STS. Evaluations of how science and technology (might) affect us are motivated by a general concern for social justice, environmental protection and sustainable development on the one hand and from a critical perspective on the practice of science as policy advice on the other hand. Danger for bias in this perspective is prevented precisely by the open and deliberative character of the seminars and of the underlying research, taking into account that the meaning of the concepts of social justice, environmental protection and sustainable development are topic of reflection in these seminars themselves.

What do we talk about when we talk about ethics? In simple terms, ethics is about being concerned with questions and concepts of 'what ought to be' with respect to a specific issue in the absence of 'evidence' that would facilitate straightforward judgement, consensus and consequent action. The 'what ought to be' can refer to 'good or wrong conduct' or, on a higher conceptual level, to 'rights and responsibilities'. The missing evidence can refer to knowledge-related uncertainty due to incomplete or speculative knowledge (including scientific knowledge), an undisputable law or an 'absolute' (set of) value(s) to guide behaviour or choice. All of these apply to the case of the evaluation of a risk-inherent technology such as nuclear in our society today, and the idea elaborated in the seminars on ethics is that anyone with a specific interest with respect to a risk-inherent technology such as nuclear becomes a moral agent and has a specific responsibility in dealing with that technology in a 'fair' way.

3 The case of nuclear technology – neutral application contexts for meaningful evaluations

Looking at societal impacts of science and technology, nuclear technology probably represents an extreme case of how science and technology can serve both cure and destruction. While medical applications of nuclear technology save individual lives every day, nuclear weapons have the potential to destroy humanity as a whole. Nuclear energy is a low-carbon source of electricity, but a nuclear accident can have dramatic impacts on the environment and on the physical and psychological health of a whole population for a long time.

What are we speaking about when we speak of ethics in relation to the nuclear risk? Dealing with radioactivity in society is a complex challenge in any respect, but one can distinct four fundamental contexts that require different visions on that complexity, and on what it would mean to responsibly deal with it. The first context is the context of natural radiation. The second context concerns (industrial) practices that result in technically enhanced natural radiation. The third context is the context of peaceful applications of nuclear science and technology. These include applications of nuclear physics processes, such as the fission or fusion of nuclei for energy production or the use of decay radiation in medical treatment and diagnose or in industrial purposes. The fourth context is the use of nuclear technology or material as a weapon, either as a mean for political deterrence, in organised military operation or in terrorist actions.

The reason to distinct these different contexts is motivated by the scope of this chapter: to highlight the importance of 'neutral application contexts' for a meaningful evaluation of the nuclear risk. To put it simple: if we consider average natural background radiation as an element of our natural habitat, then any significantly enhanced level of radioactivity in the vicinity of living species represents a 'health risk' – in the sense of a potential harm – to the health of those living species. In these cases, pragmatic reasoning thus requires us to consider the possibility of protection, mitigation or avoidance, but essentially it requires us to first evaluate why the radioactivity occurs in the first place, and whether we can possibly justify it. Whether that justification exercise can be done meaningfully or not depends on how we perceive the context of the occurrence of radiation.

For what the first context is concerned, whether we want it or not, natural radiation is there and any naturally enhanced occurrence (e.g. in the case of high concentrations of Radon) has a potential impact on health. Thinking in terms of justification of the presence of that radiation is meaningless, which leaves us with evaluating the justification of exposure, and thus of the possibility of protection, mitigation or avoidance of its impact. In the second context of technically enhanced natural radiation (as in the oil refinery industry or in aviation), radiation exposure manifests as a 'side effect'. Practices as such may be contested (as is the case with the oil or phosphate industry), but very rarely the issue of radiation exposure will become a decisive factor in the evaluation of the justification of these practices. Similar to the case of natural radiation, the radiation justification exercise thus restricts itself to the evaluation of exposure, and thus to the evaluation of the possibility of protection, mitigation or avoidance of its impact. In the third context, evaluation of the justification of the use of nuclear technology obviously takes the reason of that proposed use (the projected 'benefits') as a first criterion, with the aim to 'balance' it with the projected risks. Despite the fact that opinions on these projected benefits and risks differ among people, in this context, an evaluation of the justification of the use of a risk-inherent technology, or thus of the presence or 'creation' of radiation, remains meaningful, and this because the application context is 'neutral': while opinions may differ on how to produce energy or to do a medical treatment, nobody is ‘against energy’ or ‘against medical care’ as such. The neutral context thus makes a meaningful joint evaluation of the justification of the nuclear technology application possible, and it will not affect possible outcomes (a rejection or acceptance of the technology) as such. Finally, in the fourth context, a meaningful joint evaluation of the justification of (the risk of) the nuclear technology application is not possible, and this for the reason that the context of application itself is not neutral. A pacifist perspective does not support a principle justification of nuclear deterrence and armed conflict strategies, while, in a perspective that sees politics always as a politics of power and conflict, these strategies may be perceived as justified.

4 Technology assessment as a responsible policy-supportive research practice

The case of nuclear energy technology is also an extreme example of how technology assessment can be troubled by the fact that ‘benefits and burdens’ of a technology are essentially incomparable. From a philosophical perspective, we could say that, due to the specific character of the nuclear energy risk, the societal justification of nuclear energy is troubled by moral pluralism. That is: even if we would all agree on the scientific knowledge base for the assessment of the risk, then value-based opinions on its acceptability could still differ. Science may thus inform us about the technical and societal aspects of options, it cannot instruct or clarify the choice to make. The matter becomes even more complex if we take into account the fact that science can only deliver evidence to a certain extent. Nuclear science and engineering are mature, but we have to acknowledge that the existence of knowledge-related uncertainties puts fundamental limits to understanding and forecasting technological, biological and social phenomena in the interest of risk assessment and governance. Last but not least, we have to accept that important factors remain to a large degree beyond control. These are human behaviour, nature, time and potential misuse of the technology…

The resulting room for interpretation complicates the evaluation of nuclear energy as an energy technology option, and puts a specific responsibility on nuclear science and technology assessment as a policy-supportive research practice. In simple terms, that responsibility comes down to acknowledging and taking into account uncertainty and pluralism as described above, and the consequences thereof for research and policy. This responsibility does not only apply to scientists, but to everyone concerned with applications of science and technology in general and with the issue of nuclear energy in particular.

5 Ethics, fairness and trust: the idea of fair risk governance.

Whatever aspect of nuclear technology we consider, we have to acknowledge that the health risk coming with the use of nuclear technology remains of central concern, given that its evaluation will affect the assessment of all other aspects of the technology (technical, social, economic, political)[5]. Any thinking of ‘fair governance’ of nuclear technology should therefore start from a reflection on how to ‘fairly deal’ with the nuclear risk. As this idea is central to the ethics seminars that focus on the case of nuclear technology, it is elaborated a little further in this text.

Gaining insight in the character and meaning of fairness (and of the consequences for risk governance) can start with a simple comparison of specific risks we (might want to) take in our highly ‘technological’ society today. Knowing that any evaluation of the acceptability of a risk-inherent practice in general may be based on knowledge-based opinions and values-based opinions, we can construct a simple picture of four distinct cases as presented in the table below. The table may be oversimplified in the sense that one cannot ‘distinct’

[5] As an example: the issue of insurance and liability anticipating a potential nuclear accident directly affects any assessment of the economics of nuclear energy.

knowledge from values (in risk evaluation, specific knowledge may influence the importance of specific values and specific values may influence as well the importance of specific knowledge as the way it is used in evaluation) but it can be used as a meaningful tool to determine key concepts of fairness of risk assessment and governance and to understand differences between risky practices in that respect.

risk-inherent practice acceptable?		value-based assessment	
		dissent 'moral pluralism'	**consent** 'shared values'
knowledge-based assessment	**uncertainty** (incomplete and speculative knowledge)	governance by **deliberation** examples *nuclear energy* *(fossil fuels)* fairness: caring for 'intellectual solidarity' in dealing with incomplete & speculative knowledge and moral pluralism ↓ key concepts precaution informed consent transparency confrontation of rationales accountability to next generations	governance by **pacification** examples *medical applications of radioactivity* *mobile phones* *smoking* fairness: caring for 'intellectual solidarity' in dealing with incomplete & speculative knowledge ↓ key concepts precaution informed consent transparency confrontation of rationales
	consent (consensus on 'evidence')	governance by **negotiation** examples *(fossil fuels)* fairness: caring for 'intellectual solidarity' in dealing with moral pluralism ↓ key concepts precaution informed consent confrontation of rationales accountability to next generations	governance by **'simple' regulation** examples *traffic* *bungee jumping* fairness: caring for 'intellectual solidarity' in our behaviour towards each other ↓ key concepts precaution informed consent fair play

Justifying risk – Mapping the field (adapted from (Hisschemöller and Hoppe 1995))

The context of this text does not allow broad elaboration on the table, but it shows primarily that the risks of bungee jumping, mobile phones or nuclear energy are incomparable as joint evaluation of their acceptability depends in different ways on knowledge and values. The bungee jumper will not ask to see the test procedures of the rope before making a jump. In general, the jumper trusts that these ropes will be ok, but, more importantly, he or she makes the decision to jump on a voluntary basis. Despite the fact that more than one million people die in car accidents globally[6], no reasonable person is advocating a global car ban. Similar to bungee jumping, the key concepts of fairness related to taking the risk are precaution, informed consent and fair play. In the case of car driving, precaution not only refers to protection measures such as air bags but also to the value of driving responsibly. And fair play refers in that case to the idea that one can only *hope* that the other drivers also want to drive responsibly.

[6] The World Health Organisation (WHO) Global status report on road safety 2013 indicates that worldwide the total number of road traffic deaths remains unacceptably high at 1.24 million per year (World Health Organisation 2015).

The evaluation of the risk that comes with smoking or the use of mobile phones is what one could call a 'semi-structured' or 'moderately structured' problem (Hisschemöller and Hoppe 1995) that can be handled on the basis of 'pacification'. The reason is that, despite of the uncertainties that complicate the assessment of those specific risks[7], people agree to take or allow them on the basis of 'shared values'. Shared values are thus about those situations wherein we have the feeling that we all accept or allow a specific 'risky' practice in light of a shared value. This shared value can be a joint benefit (such as in the case of mobile phones) but also a specific freedom of choice 'to hurt yourself' in view of a personal benefit, taking into account that this behaviour should not harm others (such as in the case of smoking). With reference to the table, one could say that fairness is thus in the way we care for 'intellectual solidarity' in dealing with incomplete and speculative knowledge, and the key concepts of fairness in this sense are precaution, informed consent, transparency (with respect to what we know and don't know and with respect to how we construct our knowledge) and our joint preparedness to give account of the rationales we use to defend our interests ('stakes'). Because of the uncertainties that complicate the assessment, protection measures are essentially inspired on and supported by the precautionary principle. In the case of mobile phones, this principle translates as the recommendation to use them in a 'moderate way' and the recommendation to limit the use by children. For smoking, it translates as anti-smoking campaigns towards (potential) smokers (with special attention to young people) and as measures to protect those 'passively involved' (the passive smoker). Knowing of the addictive character of smoking, additional measures are gradually adopted to 'assist' smokers who want to quit. In similar sense, evaluating the risk coming with the use of radiation in medical context can also be called governance by pacification. The value of informed consent remains central and also applies to the close relations of the patient (family members), but essentially all agree that the patient takes the risk of a delayed cancer (due to diagnose or therapy) in light of a 'higher' benefit (respectively information about a health condition or the hope that the current cancer will be cured).

In contrast to complex problems that can be handled on the basis of 'pacification', justifying or rejecting nuclear energy seems to be an unstructured problem that will always need deliberation. Not only do we need to deliberate the available knowledge and its interpretation, deliberation will also need to take into account the various 'external' values people find relevant in their judgements, and the arguments they construct on the basis of these values. Therefore, the fairness of evaluation relates to 'intellectual solidarity' in dealing with incomplete and speculative knowledge but also in dealing with moral pluralism. The key criteria are then again precaution, informed consent, transparency and (the preparedness for a) confrontation of rationales, now completed with a sense for accountability towards those who cannot be involved in the evaluation (the next generations). In comparison with nuclear energy, the evaluation of the risk that comes with the use of fossil fuels is a complex problem that, in principle, can be treated on the basis of 'consent on causality'. The 5th Assessment Report of the Intergovernmental Panel on Climate change states that […] *Human influence on the climate system is clear* […] and that […] *Warming of the climate system is*

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[7] With regard to mobile phone use, the WHO states that 'The electromagnetic fields produced by mobile phones are classified by the International Agency for Research on Cancer as possibly carcinogenic to humans' (World Health Organisation 2014). With respect to smoking, of course there is the known relation with lung cancer, but the lack of evidence is in the delayed effect and especially in the fact that there is contingency into play (there is no evidence (yet) for why apparently some individuals are more susceptible than others). In addition, while the WHO now clearly states that tobacco kills up to half of its users (World Health Organisation 2015), we don't see these statistics 'happening' in our near social environment. To put it more provocative, our shared values support the idea that we should protect the non-smokers from the smokers, but also the idea that we still live in a free and democratic society where informed people have 'the right' to smoke themselves to death. It is true that the addictive character of smoking is influencing 'the freedom of choice', but nowadays addicted smokers can always decide for themselves to seek medical and social assistance in their attempt to quit smoking.

unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen […] (Intergovernmental Panel on Climate Change 2014). Despite this evidence of a 'slowly emerging adverse effect', the assessment of whether *concrete* droughts or storms can be contributed to human induced climate change or what the *concrete* effect of specific mitigation or adaptation policies would be remains troubled by knowledge related uncertainty. Therefore, also fossil fuel use is a complex problem that requires 'deliberation', and the key concepts of fairness remain the same as for the evaluation of nuclear energy: precaution, informed consent, transparency, confrontation of rationales and accountability to next generations.

The discussion of the table above allows us now to make three reflections related to ethics, fairness and trust in relation to risk governance. Obviously these reflections are based on my specific understanding of risk assessment in relation to fairness and are therefore presented as list of ideas that are as such open to discussion:

1. The assessment of what is an acceptable health risk for society is not a matter of science; it is a matter of justice.

1.a. A health risk is not a mathematical formula: it is a potential harm that you cannot completely know and cannot fully control but that you eventually want to face in light of a specific benefit. People will accept a risk they cannot completely know and that they cannot fully control simply when they trust that its justification is marked by fairness. And fairness relates primarily to the value of precaution, but even so to the possibility of self-determination ('informed consent').

1.b. Despite the differences between the cases discussed, they can all be characterised in relation to one idea with respect to self-determination: the idea that 'connecting' risk and fairness is about finding ground between ensuring people *the right to be protected* on the one hand and *the right to be responsible* themselves on the other hand. The right to be responsible leans thereby on the prime criterion of the right to have information about the risk and the possibility of self-determination based on that information, but one has to take into account that, in a society of capable citizens, self-determination with respect to risk-taking can have two opposing meanings: it can translate as the right to co-decide in the case of a collective health risk (as in the case of nuclear energy), but also as the freedom to hurt yourself in the case of an individual health risk (as in the case of smoking or bungee jumping).

1.c. For any health risk that comes with technological, industrial or medical practices and that has a wider impact on society, 'the right to be responsible' equals 'the right to co-decide'. And enabling this right is a principle of justice.

2. Societal trust in the assessment of what is an (un)acceptable collective health risk for society should be generated 'by method instead of proof'.

2.a. With respect to nuclear energy, no scientific or political authority can determine alone whether the risk would be an acceptable collective health risk for society. Good science and engineering, open and transparent communication and the 'promises' of a responsible safety and security culture would be necessary conditions but they can never generate societal trust in themselves. The reason is that there will always be essential factors beyond full control: nature, time, human error, misuse of technology.

2.b. The fact that people take specific risks in a voluntary way and often based on limited information may not be used as an argument to impose risks on them that might be characterised as 'comparable' or even less dangerous. That principle counts to the extreme. As examples:

The fact that the risk of developing cancer from smoking might be ‘higher’ than that from low-level radiation may not be used as an excuse to impose a radiation risk on people.

The fact that a nuclear worker may voluntarily accept an accumulated occupational dose of 20 mSv per year may not be used to justify a citizen’s dose of 1 mSv per year originating from a nuclear technology application without asking for his or her informed consent.

2.c. Fair risk governance is risk governance of which the method of knowledge generation and decision making is trusted as fair by society. When the method is trusted as fair, that risk governance has also the potential to be effective, as the decision making will also be trusted as fair with those who would have preferred another outcome.

3. A fair dealing with the complexity of risk assessment and justification requires new governance methods.

3.a. Is fair risk governance with respect to collective health risks as characterised above possible today? In other words: do the methods we use to produce policy supportive knowledge and to make political decisions have the potential to enable ‘the right to co-decide’ (as a principle of justice) and to generate trust by their method instead of by their potential or promised outcome? My short answer is no. In (Meskens 2016a) and (Meskens 2017), I argue in depth why and how the ‘governance methods’ we use today to make sense of the complexity of assessment and justification of typical collective health risks remain to be driven by the doctrine of scientific truth and the strategies of political ‘positionism’ and economic profit. As the context of this text does not allow deeper reflection on this general argument, the following reflections are restricted to the case of nuclear energy in the context of energy governance.

3.b. For the nuclear energy case in particular, I argued in (Meskens 2013) that, because of the doctrinal working of science and of the strategies of political ‘positionism’ and economic profit, the nuclear energy issue is now locked in a comfort of polarisation that does not only play in public discourse but that is deeply rooted in the working of science, politics and the market. As a result, in sharp contrast with the way fossil fuel energy technologies are now subject of global negotiations driven by the doom of climate change, nuclear energy technology remains to ‘escape’ a deliberate justification approach as an energy technology on a transnational level.

3.c. Critiques and appraisals with respect to the nuclear energy option are meaningless if not formulated ‘within’ the general theme of energy governance as the context of concern. This also implies that highlighting the benefits of other nuclear technology applications, such as those in the medical, industrial or space context, cannot be used as a strategy to indirectly put nuclear energy in a more positive light.

Energy governance is a complex social problem in itself, and probably today one of the most complex humanity is facing[8]. The complexity goes beyond that of dealing with climate change or nuclear energy as such. In energy governance, there is complete interdependence of the local and the global, and the scientific and technical issues cannot be isolated from the social, political and cultural dimensions of the governance practices in which these issues figure. Moreover, every energy-related act, whether undertaken by individual citizens, private companies or political regimes, involves

[8] I develop a characterisation of complexity of complex social problems and a reasoning on how to deal with that complexity ‘fairly’ in (Meskens 2016a) and (Meskens 2017).

ethical considerations with respect to freedom, authority, vulnerability (of men and nature) and individual and collective responsibilities now and in the future.

However, with the minimisation of adverse impact on health and the environment as a central concern, and despite the fact that opinions with respect to the nuclear option differ fundamentally, it is possible to formulate three policy principles of energy governance with which, in principle, most people could agree. In order of priority, these policy principles can be phrased as follows:

1 The policy principle to minimise energy consumption (or thus to maximise energy savings) through democratic deliberation on how and where;

2 The policy principle to maximise renewables through democratic deliberation on how and where; and

3 The policy principle to organise a fair debate on how to produce what cannot be done with 1 and 2 yet, and to 'confront' in that debate fossil fuels and nuclear, being the two 'nasty' risk-inherent energy technologies, with each other. Democracy in this sense implies that a society would need to be able to decide on how to produce 'the rest' of its needed energy for the time to come: with nuclear, with fossil fuels or with a combination of both. In line with the reasoning above, a fair method of decision making would in this context be a method that would be sensed as fair because of its method by all concerned, regardless of whether the decision making would result in the acceptance or in the rejection of nuclear energy or fossil fuel use. The fact that we are in a historically evolved situation where nuclear and fossil fuels are present while there have never been real democratic debates on their introduction cannot be used as an excuse to not organise this kind of debate now. While it is true that, in terms of their adverse effects, nuclear and fossil fuels are 'incomparable', that additional complexity would not prevent a democratic society to make deliberate decisions on them.

Although we don't live in a world where politics, science and the market would be prepared to engage in deliberation that would put policy principles 1 and 2 upfront and that would take principle 3 serious, we have the capacity to put that deliberation in practice. Justice with regard to how a specific collective health risk such as the risk of nuclear or fossil fuels is evaluated in society remains the central ethical principle, and that ethical principle translates in practice as the need for transdisciplinarity and civil society participation in scientific research and the need for participation of the potentially affected in democratic decision making.

6 Education as critical capacity building

The previous considerations may make clear that a fair and effective dealing with complex problems such as technological risk governance would require advanced governance methods that would have the potential to generate trust by their method instead of by anticipated or promised outcome. The context of this text does not allow further elaboration on the specific motivations, forms and practical workings of these methods, but they can be identified as follows:

1 Inclusive democratic deliberation as a collective holistic learning process, bottom-up, connecting the local and the global;

2 Transdisciplinary and inclusive research, seeking synergy among 'disciplines' and between expert knowledge and lay knowledge;

3 Education inspired by plurality and with a focus on developing an ethical sense and the capability of critical-reflexive thinking.

While these ‘advanced methods’ may seem rather utopian, it may also be clear that we don’t need to wait for a total reform of society to apply them in practice already now. Even in the ‘old’ forms of politics, politicians have the choice to organize public participation and deliberation on concrete issues and to take the outcome of that deliberation seriously. In the case of research, there are in principle no ‘diplomatic’ or practical hindrances to care for transdisciplinarity and inclusion and to put them in practice. For what education is concerned, one knows that disputes remain on how to organise basic (primary and secondary) and higher education, taking into account professional requirements directed by the ‘job market’ but also cultural differences and the still enduring influence of religion. In (Meskens 2017), I argue that basic and higher education should move beyond the 19th Century disciplinary approaches and cultural and religious comfort zones, and become pluralist, critical, and reflexive in itself. Instead of educating young people to optimally function in the strategic political and economic orders of today, they should be given the possibility to develop as a cosmopolitan citizen with a (self-)critical mind and a sense for ethics in general and for intellectual solidarity in particular.

The context of this text does not allow further elaboration on these thoughts. Rather, given the focus on science & technology, I restrict myself to formulating the idea of critical capacity building in higher education in the interest of a responsible dealing with science and technology. In short, the idea is that, for anyone concerned, developing an ethical sense with respect to how science and technology (might) affect us (for better or worse) and with respect to how this relates to general concerns for social justice, environmental protection and sustainable development essentially starts from critical-reflexive thinking, or thus from critical thinking with respect to ‘the bigger picture and yourself in it’. The preparedness of someone to be reflexive about her/his own position and related interests, hopes, hypotheses, beliefs, and concerns in this respect can be called a moral responsibility, but that preparedness essentially leans on the capability to do so, as nuclear worker, scientist, radiation protection officer, manager, policy makers or citizen. In other words, reflexivity as an ‘ethical attitude’ requires reflexivity as an intellectual skill. How this is put in practice in seminars on ethics, science and technology is elaborated further in the following chapter.

7 The SCK•CEN seminars on ethics, science and technology

It is in the spirit outlined above that the seminars on ethics, science and technology (with a focus on nuclear technology) of the SCK•CEN Academy for Nuclear Science and Technology are organised. Seminars typically start with an analysis of the complexity of nuclear risk governance to then link these insights to the question of how approaches to science as policy advise and political decision making could ‘generate societal trust’. The idea is that this trust would need to be generated ‘by method instead of proof’, regardless of whether the outcome of decision making would be acceptance or rejection of the technology. The overall aim of the seminars is to stimulate thinking and dialogue with respect to the complexity of the relation between ethics, science and technology in general (and of risk-inherent technology assessment in particular) and to reflect on the moral foundations for risk governance as well as the practical implications for research and policy. One can understand that this approach unavoidably inspires thinking with respect to specific skills required to deal responsibly with risk inherent technologies such as nuclear technology. As stressed in the introduction, these skills requirements apply in the same way to anyone concerned with risk-inherent technology applications, being it nuclear workers, scientists, radiation protection officers, managers, policy makers and citizens. As a consequence, the seminars become self-reflexive, in the way they invite reflection and dialogue on the specific role, expertise and responsibility of all participants.

The topics treated in a ‘basic’ format of the seminar on ethics, science and technology are:

- Analysis of current issues, challenges and controversies;
- Ethics, fairness and trust: the idea of fair risk governance;
- Seeking societal trust facing scientific uncertainty and value pluralism – the challenge for science as policy advice (this includes case studies such as post-accident situations);
- ‘Ethical skills’ or ‘virtues’ for nuclear workers, scientists, radiation protection officers and managers;

If time allows, the basic format of the seminars can be extended with the following topics:

- Further reflections on the concepts of social justice, environmental protection and sustainable development;
- The bigger picture – a critique on modernity (critical views on how traditional approaches to political decision making, scientific research and education, inherited from modernity, fail to ‘grasp’ the complexity of challenges such as fair risk governance);
- Reflections on advanced methods for political decision making, research and education, able to ‘grasp’ the complexity of challenges such as fair risk governance and able to generate societal trust by their method instead of by anticipated or promised outcome;
- An understanding of the interrelation of science & technology and society, from an ethics perspective (including deeper discussion of concepts such as ‘post-normal science’ (Funtowicz and Ravetz 2003), ‘science as social knowledge’ and ‘contextual empiricism’ ((Longino 1990), (Longino 2001)), ‘well-ordered science’ ((Kitcher 2011a), (Kitcher 2014)), ‘Mode-2 science’ (Gibbons 1994), ‘transdisciplinarity’ (Bernstein 2015), ‘the co-production of science and social order’ (Jasanoff 2004), ...);
- Ethical foundations of the system of radiological protection;
- Ethics in relation to science and technology – the consequences for radiological protection and safety culture;
- Ethical case studies in the nuclear energy, medical applications and NORM fields;
- Ethics of energy governance, including reflections on existing energy technologies (nuclear, fossil fuels, renewables) and on the issue of climate change;
- Historicism of ethics, science and technology;
- Analysis and discussion of existing law, soft law, standards and recommendations relevant to applications of nuclear technology and radiological protection (IAEA standards and recommendations, ICRP recommendations, EC Directives, the Aarhus Convention, UNSCEAR assessments, …).

List of invited seminars on ethics in 2015 and 2016:

- Ethics and Lightening the Dark Side of Science, Trinity College, Dublin, 25 February 2015
- The ethics of justifying nuclear technology applications, European Master in Radiobiology, Mol, 13 March 2015
- Ethical aspects of the radiological risk, BelV RP course, Brussels, 2 April 2015
- Ethical considerations on the application of nuclear technology, BNEN Course Nuclear and Radiological Risk Governance, SCK•CEN, Mol, 20 – 24 April 2015
- Ethics at the science-policy interface, Gent University Permanent Education – Contemporary Philosophy 2014 – 2015, 6 May 2015
- The trouble with justification: exploring the ethical dimensions of risk-inherent energy technology assessment, World Nuclear University Summer Institute 2015, Uppsala, 4 August 2015
- Workshop ethics and radiological protection, Technical University Delft - Reactor Institute, Delft, 9 November 2015
- Seminar on Ethics - the case of nuclear technology applications, Universidad Politécnica de Madrid, 24 & 25 November 2015
- Seminar on Ethics - the case of nuclear technology applications, Aachen University of Applied Sciences, Campus Jülich, Jülich, 17 & 18 December 2015

- Ethical aspects of the radiological risk, Radiation Expert Course, University of Hasselt | SCK•CEN, 29 January 2016
- Ethical aspects of the radiological risk, Refresher Course RP FANC, Brussels, 2 March 2016
- Ethical considerations on Nuclear and Radiological Risk Governance, Course on Nuclear and Radiological Risk Governance, SCK•CEN Lakehouse, Mol, 18-22 April 2016
- Beyond Paternalism and Strategy: Understanding Radiological Risks as a Mutual Learning Experience, Seminar "The Chernobyl Accident: 30 years later", Ghent University, 26 April 2016
- The ethics of justifying nuclear technology applications, European Master in Radiobiology, Mol, 3 May 2016
- Ethical aspects of the radiological risk, RP training for Doel NPP, SCK•CEN, 17 May 2016
- The trouble with justification: exploring the ethical dimensions of risk-inherent energy technology assessment, World Nuclear University Summer Institute 2016, Ottawa, Canada, 20 July 2016
- Ethics and the future generations in the case of radioactive waste governance, IYNC2016, Hangzhou, China, 28 July 2016
- The politics of hypothesis - An inquiry into the ethics of scientific assessment, Opening of the 15th BNEN academic year 2016-2017, KU Leuven, 28 September 2016
- The trouble with Justification: an Inquiry into the Ethics of Nuclear Technology Assessment, IAEA, Vienna, 12 October 2016
- Ethical aspects of the radiological risk, RP Course | 2016, SCK•CEN, 21 October 2016
- Seminar on Ethics, Science and Technology, The case of nuclear energy, Universidad Politécnica de Madrid, Madrid, 27 – 28 October 2016
- Workshop ethics and radiological protection, Technical University Delft - Reactor Institute, Delft, 28 November 2016

References

Bernstein, Jay Hillel. 2015. 'Transdisciplinarity: A Review of Its Origins, Development, and Current Issues'. Journal of Research Practice 11 (1): 1.

Funtowicz, Silvio, and Jerome Ravetz. 2003. 'Post-Normal Science'. International Society for Ecological Economics (Ed.), Online Encyclopedia of Ecological Economics. http://korny10.bke.hu/angol/ravetz2003.pdf.

Gibbons, Michael. 1994. 'The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies'. Los Angeles [u.a.: Sage Publ.

Hisschemöller, Matthijs, and Rob Hoppe. 1995. 'Coping with Intractable Controversies: The Case for Problem Structuring in Policy Design and Analysis'. Knowledge and Policy 8 (4): 40–60.

Intergovernmental Panel on Climate Change. 2014. 'IPCC Fifth Assessment Synthesis Report'. http://ar5-syr.ipcc.ch/.

Jasanoff, Sheila, ed. 2004. 'States of Knowledge: The Co-Production of Science and the Social Order'. 1 New edition. London: Routledge.

Kitcher, Philip. 2011a. 'Science in a Democratic Society'. Amherst, NY: Prometheus Books.

Kitcher, Philip. 2014. 'The Ethical Project'. Cambridge, Mass.: Harvard University Press.

Longino, Helen E. 1990. 'Science as Social Knowledge: Values and Objectivity in Scientific Inquiry'. Princeton, N.J.: Princeton University Press.

Longino, Helen E. 2001. ‘The Fate of Knowledge’. Princeton, N.J: Princeton University Press.

Meskens, Gaston. 2013. ‘The Trouble with Justification – Getting Straight on the Science and Politics of Nuclear Energy’. Energy Strategy Reviews 1 (4): 233–42.

Meskens, Gaston, 2015, ‘Beyond Paternalism and Strategy: Understanding Radiological Risks as a Mutual Learning Experience’, Fukushima Global Communication Programme Working Paper Series, United Nations University Institute for the Advanced Study of Sustainability.

Meskens, Gaston, 2016a, ‘Ethics of radiological risk governance: justice of justification as a central concern’, Annals of the ICRP, SAGE Publishing.

Meskens, Gaston, 2016b, ‘Overcoming the framing problem—a critical-ethical perspective on the need to integrate social sciences and humanities and stakeholder contributions in EURATOM radiation protection research’, Journal of Radiological Protection, IOP Publishing.

Meskens, Gaston, 2017, ‘Better living (in a complex world) – An ethics of care for our modern coexistence’, in ‘Ethics of Environmental Health’, Routledge.

Turcanu, Catrinel, Jantine Schröder, Gaston Meskens, Tanja Perko, Nicolas Rossignol, Benny Carlé, and Frank Hardeman. 2016. “Like a Bridge over Troubled Water – Opening Pathways for Integrating Social Sciences and Humanities into Nuclear Research.” Journal of Environmental Radioactivity 153 (March): 88–96.

World Health Organisation. 2014. ‘WHO | Electromagnetic Fields and Public Health: Mobile Phones’. http://www.who.int/mediacentre/factsheets/fs193/en/.

World Health Organisation. 2015. ‘WHO | Tobacco’. http://www.who.int/mediacentre/factsheets/fs339/en/.

World Health Organisation. 2015. ‘WHO | Global Status Report on Road Safety 2013’. http://www.who.int/violence_injury_prevention/road_safety_status/2013/en/.

RADIATION EDUCATION IN THE DELFT SCIENCE CENTRE

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ABSTRACT

The Reactor Institute Delft, the Netherlands, has developed a special exhibit in close collaboration with the Science Centre Delft. This exhibit explains the basics of radiation and radiation detection to children and their parents or teachers. Science Centre Delft turns Delft University of Technology inside out and allows you to see the roll technology and science play in society. As a visitor, you are invited to participate in and contribute to its development. Inspiration, creativity, timeliness and true interactivity are the principles behind the Science Centre, putting humanity, designs and buildings first. Within this context it was essential that the exhibit should be constructed with real live sources and radiation measuring equipment and at the same time the exhibit had to be safe to use for children. Furthermore, the Science Centre organises a yearly open day for all members of the public, on which scientist and teachers explain what their research is about. These days mostly attract young children with their families. During these days the teachers of the Reactor Institute Delft have used cloud chambers to visualize the ever present and mysterious background radiation.

1. Introduction

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, which is the largest provider in radiation protection training in The Netherlands. The RID considers outreach activities and informing the public as one of its important tasks. Information is given to the public via various channels. Guided tours are given and we host a website on ionising radiation for the public. A collaboration with the Science Centre Delft resulted in an exhibit about radiation. During the Delft science days we inform children and their parents in a playful way about radiation. Teenagers in secondary schools and sixth form college with questions about reactors and radiation are provided with information and help.

2. Exhibit

For the public at large it is often a mystery what happens at a technical university. The Science Centre Delft gives the public a look behind the scenes of the university at large. It houses several exhibits that represent recent research and student projects. The exhibits are mostly replicas of real research set-ups because the Science Centre wants to show the reality. As a visitor, you are invited to participate in and contribute to its development. The Science Centre first approached the RID in 2011 with the request to come up with a topic that would fit their aims. At first, all thoughts were focussed on current research that is done at the scientific department of the RID, Radiation Science and Technology (RST). Although most research is done with neutron and positron radiation, this was not feasible for an exhibit. Other bits of research have to do with new and improved detector materials, again something which is difficult to visualise.

Eventually the basics of radiation detection became the focus for the exhibit. The idea was to make use of real live sources and real detectors. At this point a commercial bureau, Tinker, was contacted by the Science Centre. Tinker specialises in making constructions or spaces that stimulate people to interact with.

2.1 Set-ups and sources used in the exhibit

The first part of the exhibit deals with measuring and shielding radiation. In this part of the exhibit the differences between alpha, beta and gamma radiation are shown. Am-241 was selected as an alpha source, Sr-90/Y-90 as a beta and Cs-137 as a gamma source. All these sources have a relatively long half-life, 28 years and up and if they also emit another type of radiation this does not interfere with the measurements, due to a relatively low yield and/or energy. The chosen shielding materials were paper, Perspex and lead. The second part of the exhibit shows that sources may be identified by their radiation spectrum (gamma spectrometry), Na-22, Cs-137 and Eu-152 were chosen as sources of photon radiation. These radionuclides have very different spectra and the use of Na-22 allowed the introduction of beta plus radiation for the more advanced groups of pupils. The third and last part shows that also some everyday objects such as tiles, watches and pieces of rock might be radioactive. A tile and watch were purchased online and the pieces of rock (one radioactive and one phosphorescent) came from the collection of the mineral museum in Delft. Because this makes people wonder about their own watches and other objects also a position was reserved for personal objects.

2.2 Permit

The aim was to use real radioactive sources in the exhibit. However, the application of ionising radiation sources for education purposes in the Netherlands requires a license unless the activity of the source(s) is below exemption values. The activities of the sources that were selected due to their type of radiation and half-life were above the exemption values. The Science Centre is part of the TU Delft, which has a licence that allows a system of internal permits. So for the use of the sources an internal permit had to be obtained at the radiation protection unit of the TU Delft, this is still a formal application procedure, but in general the handling time is much faster. In the permit, information on the type of sources as well as information about expected dose and dose rates needed to be included. Because none of the set-ups, not individually and not combined, resulted in a significant dose to the public (the equivalent dose was estimated to be less than 0,1 μSv) a permit was given.

2.3 Construction

The colours for the exhibit were based on the warning signs for ionising radiation. The sources had to be difficult to remove, so sources mounted on a brass screw were purchased. Furthermore the sources were encased in a Perspex housing, the shielding material was placed in a rotating disk, both can be moved by pressing a button. The objects that were used for radiation measurements were separated by lead screens, to prevent radiation from one source interfering with the measurements of the other objects.

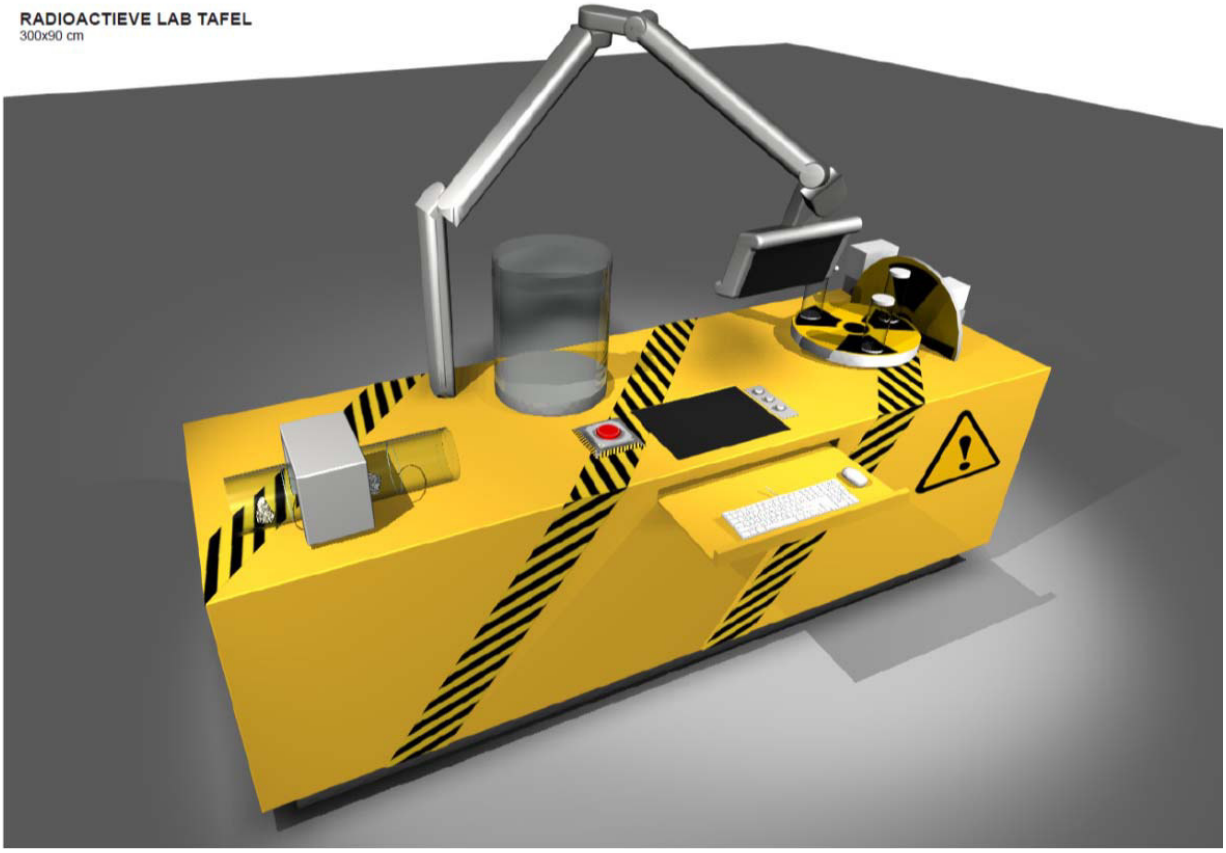

Figure 1. *Original drawing by Tinker for the exhibit.*

Figure 2. *Details of the actual exhibit*

3. Delft Science Day

The exhibit was launched during the Delft Science days. These Delft science days on the one hand are an opportunity for Delft companies to show their expertise and knowledge to the public. On the other hand it allows members of the public to get some insight in the organisations.

During the Delft Science Day the Science Centre acts as a host to several Delft companies and institutes, together they show the public all sorts of recent and ongoing research. Combined with the free admission on this special day, it ensures a big crowd, which was perfect for the launch. The Reactor Institute hosted several sessions during this day. Guided tours were given in the reactor hall. For those who could not participate in the tours, we hosted special skype sessions during which one of the employees of the reactor institute used a tablet to show the inside of the reactor to people in the science centre. Another employee was present in the science centre to facilitate the conversation between the two parties. During another activity the children and their (grand)parents could build a cloud chamber. This does not always give satisfactory results and that is why also a larger cloud chamber was brought along to show the visitors that radiation is always present. In later years also a radiation quiz was added in which children could measure everyday objects and in which they could guess if an object was radioactive or not. For the quiz all sources were placed on separate plastic plates to facilitate handling and also to identify them as special objects. Objects used were: KCl (salt substitute or nu salt), brazil nuts, a banana, an old watch with radium dials, a thorium gas mantle and a phosphorescent (non-radioactive) toy.

Figure 3: Skype guided tour (left panel) and radiation quiz (right panel). For the quiz all sources were placed on separate plastic plates to facilitate handling and also to identify them as special objects.

4. Guided Tours

The domed reactor hall of the Reactor Institute inspires a lot of curiosity. Many people living in Delft know that the building houses a reactor, but in general they don't know what happens on the inside. The RID regularly hosts tours for interested groups such as student associations, companies and government officials on a regular basis. In 2013, the 50 year anniversary of the reactor was celebrated. These celebrations were seen as a good opportunity for outreach activities. Since the RID, as part of TU Delft, has limited resources it was necessary to identify the target audience. Two main groups were identified; future students and citizens of Delft.

The future students were addressed by writing to the sixth form colleges that supply most students to TU Delft and informing them about the possibility to sign up for a guided tour in the reactor hall. We reserved space for 50 classes, with a maximum of 30 pupils per class. It was the goal to let these sixth formers share their experience during the tour. The problem was that cameras and mobile phones are not allowed in the reactor hall due to security restrictions. This drawback was solved by giving the sixth formers a camera during their tour and allowing them to film everything that they found interesting. Additionally the students could provide their three favourite pieces of music that could function as background music throughout the film. The camera was handed back and a professional editor made a clip, without any security sensitive details, that was made available to the pupils within five days. Not all pupils filmed their visit, many teachers thought that filming would distract their pupils, but 24 classes did film their tour and the resulting film clips have been watched for just over 10,000 times in total on YouTube.

For the people from Delft another approach was taken. They were invited for a visit on a Saturday during the Delft Science Day that was dedicated to visitors of the Delft municipality. On this day, tours in the reactor hall were planned for a maximum of 150 people and several interactive stands explaining the current research were displayed throughout the building. This day was announced in a local newspaper on a Wednesday morning. The same evening all tours were fully booked.

5. Acknowledgements

Many useful discussions between the people from the Science Centre Delft, Tinker and the RID have led to the realisation of the exhibit.

6. References

Primary website addresses:
www.watisradioactievestraling.tudelft.nl
www.whatisnuclearradiation.tudelft.nl
http://sciencecentre.tudelft.nl/

IMPACT EVALUATION OF IAEA'S POSTGRADUATE EDUCATIONAL COURSE IN RADIATION PROTECTION AND THE SAFETY OF RADIATION SOURCES

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ABSTRACT

The Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC) is a flagship course of the International Atomic Energy Agency (IAEA). It was established in order to provide the basic professional training in radiation protection and the safety of radiation sources for young professional graduates, especially those from Member States receiving technical assistance from the IAEA. The course also provides support for those participants who will become trainers in radiation protection in their home countries. The PGEC syllabus is based on the IAEA Safety Standards and includes both theoretical knowledge and practical, hands-on training. The course follows a blended learning approach, combining on-line learning with traditional face-to-face techniques.

The PGEC was first conducted in Argentina in 1981 and it is now regularly delivered at nine Regional Training Centres (RTCs) around the world in English, French, Arabic, Spanish, Russian and Portuguese. In 2016, IAEA's Division of Radiation, Transport and Waste Safety initiated an impact evaluation of 77 PGECs that have been conducted in Africa, Asia and the Pacific, Europe and Latin America and the Caribbean from 1981 to the end of 2015. The methodology of the four-level Kirkpatrick evaluation model provided the basis for measuring effectiveness in an objective way. The aim was to evaluate the extent to which the PGEC has had an impact on: a) participants' professional career and personal development; and b) the application of knowledge and skills in support of the development and strengthening of radiation safety infrastructure at the organizational and/or national level.

This paper therefore describes the methodological basis of the impact evaluation of the PGEC; presents the results in a qualitative and quantitative manner; draws key conclusions; and reflects on the sustainability of the course.

1. Introduction

The Statute of the International Atomic Energy Agency includes the establishment of, and provision for, the application of Safety Standards for the protection of health, life and property against ionizing radiation. IAEA offers several approaches and mechanisms to support Member States to apply its Safety Standards, including rendering radiation safety services, providing technical cooperation, fostering information exchange, encouraging knowledge management and networking, and promoting education and training. The education and training activities that are supported and promoted by the IAEA are therefore aimed at fulfilling its statutory safety functions to assist Member States in their application of the Safety Standards.

IAEA's education and training activities are in-line with the resolutions of the General Conference and reflect IAEA Safety Standards [1, 2, 3]. A comprehensive portfolio of training packages and material in the field of radiation, transport and waste safety has been developed by IAEA, including:

- The Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC) is a comprehensive and multidisciplinary 5.5-month long programme aimed at young professionals who may in later years become senior managers or high-level decision makers with responsibilities related to radiation protection. The PGEC was first run in Argentina in 1981 and is now offered at IAEA Regional Training Centres (RTCs) in Africa (English and French), Europe (English and Russian), Latin America and the Caribbean (Spanish and Portuguese), and Asia (Arabic and English);
- Specialized training courses of shorter duration (between 3 days to 6 weeks) that cover a range of subjects (e.g. regulatory framework; occupational protection; patient protection; radioactive waste management; transport of radioactive materials; and the safety of radioactive sources) and are offered for various target audiences (such as regulators; workers in industry, medicine and research; and medical staff);
- A training course for Radiation Protection Officers (RPO)[1] is based on a syllabus with a core module and practice-specific modules. The core module is aimed at providing a basic understanding of radiation protection principles and source safety, the general requirements of the IAEA Basic Safety Standards [1] and the duties of the radiation protection officer. Practice-specific modules cover the additional topics to be covered by RPOs at a range of medical and industrial facilities;
- Train-the-Trainers (TTT) courses are aimed at developing participant's communication and presentation skills and familiarizing them with various training methodologies. The course is aimed at building a core of national trainers in radiation protection and it is highly interactive with an emphasis on practicing the required skills. TTT courses for RPOs in medical and industrial applications have been conducted around the world at both national and regional levels.

In 2016, IAEA's Division of Radiation, Transport and Waste Safety (who are responsible for the technical oversight of the PGEC) decided to initiate an evaluation of the PGEC with regard to its long- and short-term impact on: a) the career and professional development of the participants; and b) the utilization of their new knowledge and skills towards strengthening the radiation safety infrastructure in their home country. This paper presents the findings of that impact evaluation at the individual and organizational/national level.

2. Overview of the PGEC

IAEA's PGEC is based on a standard syllabus [4] that is derived from the IAEA Safety Standards. The syllabus is currently being updated to take account of the most recent IAEA Safety Standards and to ensure its consistency with the International Commission on Radiological Protection´s (ICRP) recommendations. The updated course syllabus covers: Review of Fundamentals; Quantities and Measurements; Biological Effects of Ionizing Radiation; International System of Radiation Protection and the Regulatory Framework; General Requirements for Protection and Safety; Assessment of External and Internal Exposures (other than medical); Planned Exposure Situations - Generic Requirements; Planned Exposure Situations – non-medical applications and medical applications; Emergency Exposure Situations; Existing Exposure Situations. The PGEC also includes a module on 'Train the Trainers' as well as a work (research) project in which participants are encouraged to focus on a topic that will be of direct benefit to their institution or home country.

[1] Radiation Protection Officer, according to the IAEA Basic Safety Standards, is a person technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant, licensee or employer to oversee the application of relevant requirements.

Figure I.1 in Annex I provides a detailed overview of the course structure. The course is implemented through a blended learning approach (Table I.1), where specific activities (e.g. pre-training, collection of course feedback and implementation of the training impact evaluation) are conducted online through the IAEA Cyber Learning Platform for Network Education and Training (CLP4NET), whereas the rest of the course includes face-to-face components, (e.g. lectures, assessments of competence, laboratory exercises, technical visits etc.). Assessment and evaluation mechanisms are included in the course structure (definitions and objectives of such mechanisms are provided in Table I.2). The impact evaluation of the present paper refers to the B4 evaluation, i.e. the impact questionnaires (see Figure I.1 and Table I.2).

2. PGEC impact evaluation: Methodology

In 2016, an impact evaluation of the PGEC was initiated, through the collection of data based on self-assessment, to review the impact the course has had in terms of:

- Participants' career and professional development (individual level) (see sections 3.1-3.2);
- Utilization of knowledge and skills towards strengthening radiation safety infrastructures (organizational and/or national level) (see section 3.3).

The impact evaluation also included questions to evaluate the sustainability and effectiveness of the PGEC (see section 3.4). The evaluation of training activities can be divided into four different levels according to the Kirkpatrick Model, namely reaction (level 1), learning (level 2), behaviour (level 3) and results (level 4). The PGEC impact evaluation is based on this model, which was developed by Dr Donald Kirkpatrick, focusing on the training evaluation levels of behaviour, which seeks to demonstrate to what degree the acquired knowledge, skills and attitudes are being implemented on the job, and results, which seeks to establish the organizational outcomes as a result of training efforts [5].

In total, the impact evaluation was conducted for 77 PGECs hosted at the IAEA RTCs in the regions of Africa, Asia and the Pacific, Europe and Latin America and the Caribbean from 1981, when the first course was hosted in Argentina, to the end of 2015. Questionnaires were developed to follow-up with the participants 1, 3 and 5 years after they completed the course. An additional one-off evaluation was made for the PGEC courses that were conducted prior to this time frame (i.e.: more than 5 years after the completion of the course). This is referred to as the 'historic evaluation'. Table 1 provides an overview of the PGEC courses covered by the impact evaluation. The total number of participants eligible for the survey in the 1, 3 and 5 years' time frame is 1404.

The data collection process involved: registering all PGEC participants in IAEA's Moodle platform for e-learning (CLP4NET); distributing the questionnaire in the same language as course implementation (Arabic, English, French, Portuguese, Russian and Spanish) with an initial deadline of three weeks; and following-up with participants who did not respond to the initial questionnaire. The response rates varied across the various RTCs: for surveys conducted 1 year after the end of the PGEC the response rates ranged from 72% to 100%; after 3 and 5 years from 58% to 92%; and for surveys conducted more than 5 years after course completion (the 'historic evaluation'), the response rate was between 33% to 69% (See Table 1).

1 YEAR			3 YEARS			5 YEARS			More than 5 years (historic evaluation)		
RTC	No. of participants (No. of courses)	Response rate	RTC	No. of participants (No. of courses)	Response rate	RTC	No. of participants (No. of courses)	Response rate	RTC	No. of participants (No. of courses)	Response rate
ALG	23 (1)	74%	ALG	20 (1)	70%	ARG	11 (1)	82%	ARG	482 (29)	33%
ARG	12 (1)	92%	GHA	20 (1)	80%	MAL	27 (1)	70%	BYE	142 (7)	38%
BRA	1 (1)	100%	BYE	13 (1)	92%	MOR	20 (1)	75%	GRE	57 (3)	69%
GHA	18 (1)	100%	MAL	47 (2)	58%				MAL	145 (7)	52%
GRE	13 (1)	100%							MOR	121 (6)	48%
MAL	61 (2)	72%							SYR	171 (10)	33%
Total of surveyed participants (courses): 128 (7)			Total of surveyed participants (courses): 100 (5)			Total of surveyed participants (courses): 58 (3)			Total of surveyed participants (courses): 1118 (62)		

Legenda: IAEA RTC hosted in Algeria (ALG), Argentina (ARG), Brazil (BRA), Belarus (BYE), Ghana (GHA), Greece (GRE), Malaysia (MAL), Morocco (MOR), and Syria (SYR).

Table 1: Impact evaluation conducted 1, 3, 5 and more than 5 years (historic evaluation) after course completion.

3. Results

3.1 PGEC participants' work category

The PGEC is run on a regional basis and is open to participants from Member States that are receiving technical assistance from the IAEA. Recognizing that many such Member States need to build or strengthen their regulatory competence in radiation protection and the safety of radiation sources, priority is often given to young professionals who have recently joined a regulatory body. This can be seen in Fig 1 (a), which also shows that while some participants have moved to work in a regulatory body shortly after recently completing the course, this is balanced out in the longer term (Fig 1 (b)). After regulators, the next most common work categories are participants from the medical/health care professions and Radiation Protection Officers. This is show in Fig 1, along with the other work categories of PGEC participants. For all courses, and as shown below, an increase can be observed in the percentage of participants currently working as qualified experts (QE) and radiation protection officers (RPO). However, it should be noted that comments provided by participants indicated that the functions of QE and RPO are often in addition to other responsibilities.

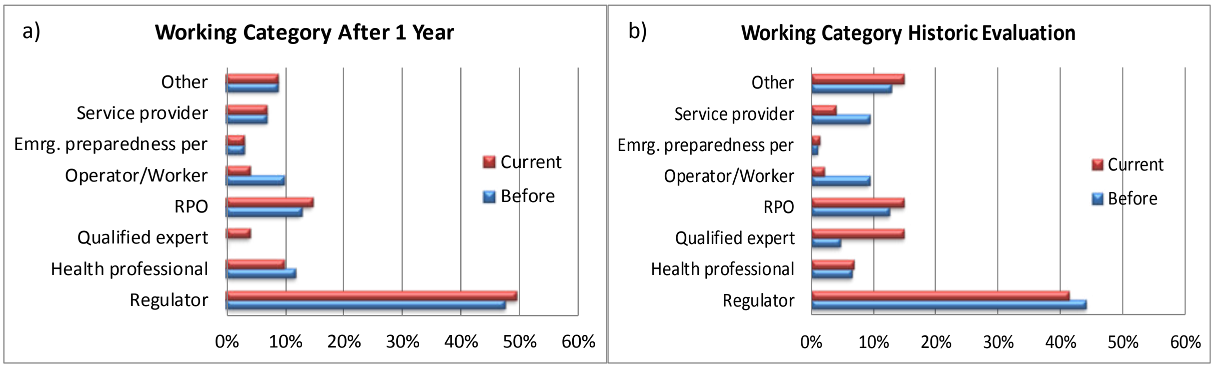

Fig 1. Percentage of participants' working categories, before attending the course and after course completion (1 year (a), and more than 5 years (historic evaluation) (b)).

3.2. Impact of the PGEC on professional career and development

Current and previous professional levels

More than 80% of the surveyed participants were at the staff-level before the course. As can be seen in Figure 2 there is a distinctive shift from staff-level to managerial and senior managerial positions after completion of the course. The percentage of participants gaining a managerial position constantly increases with time after having completed the PGEC. In fact, the total percentage of participants at the managerial and senior managerial level increased by a factor 1.4 after 1 year (from 16% to 23% - Figure 2(a)), 1.9 after 3 years (from 20% to 38% - Figure 2(b)), 2.2 after 5 years (from 21% to 46% - Figure 2(c)), and 3.4 after more than 5 years (historic evaluation) (from 16% to 54% - Figure 2(d)).

Comments provided by participants gave further evidence to support that the PGEC contributed to improving their professional development. Many participants reported that after the course they were assigned additional/new managerial responsibilities and some were promoted to be the Head of Authorizing or Licensing Divisions/Section, Director of the Regulatory Body, or even assigned governmental functions up to the Ministerial level.

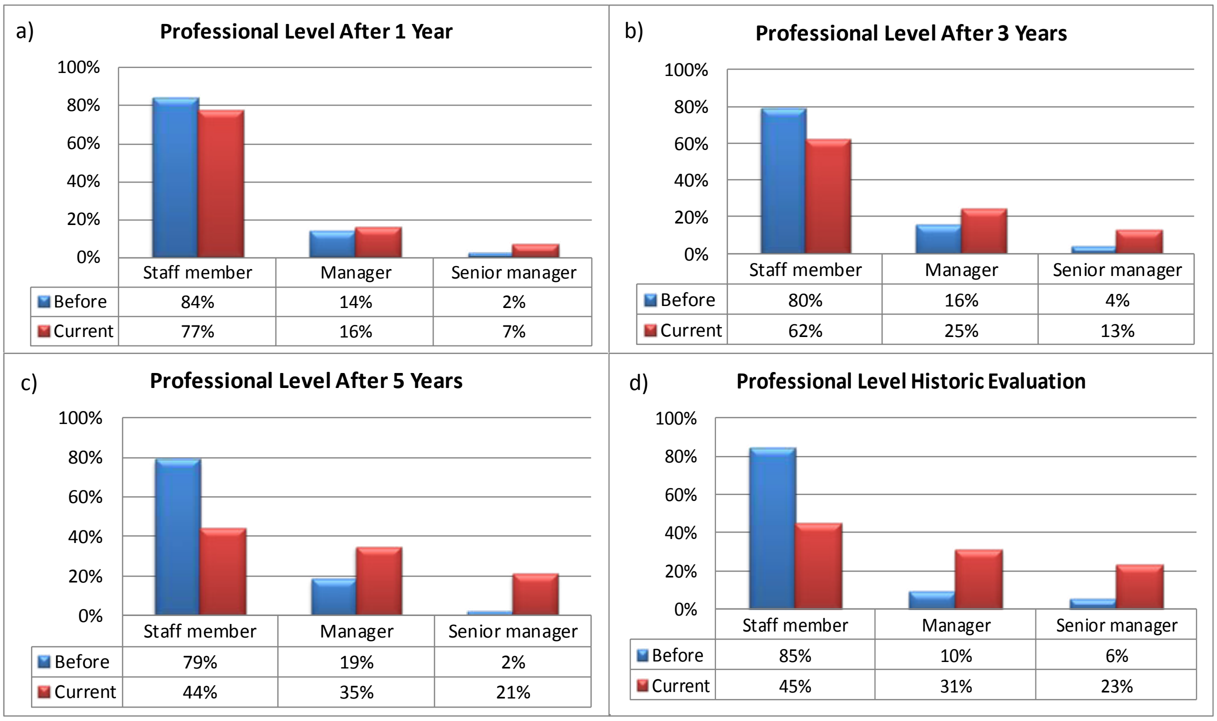

Fig 2. Percentage of participants` professional levels before attending the course and after course completion (1 year (a), 3 years (b), 5 years (c) and more than 5 years (historic evaluation) (d)).

Impact of the PGEC on professional development

Overall, the majority of surveyed participants confirmed that the PGEC has had a positive impact on their professional development irrespective of the time period passed since they completed the course. About 50% of the participants rated the PGEC as having a 'high' impact on their professional development 1, 3, and 5 years after the completion of the course (Figure 3(a) shows the results after 1 year). Longer-term, (more than 5 years after course completion (Figure 3(b)), the percentage of participants rating the impact of the PGEC as being 'high' on their professional development increases up to 74%.

The impact of the PGEC can also be related to the number of participants who acquired additional tasks and/or responsibilities as a direct result of attending the PGEC. This means that even if the participants did not necessarily climb in professional level (Figure 2(a)), the

PGEC still had a significant impact as it assisted participants to attain more responsibilities. As shown in Figure 4(a), this was the case for 51% of the participants. According to participants' comments, additional responsibilities included, for example: the development of radiation safety legislation; engagement in emergency preparedness and waste management projects; conducting medical radiation survey program; and planning training for medical physicists. The impact evaluation for the same period also indicated that the job performance had improved either significantly or partially as a result of attending the PGEC for nearly all of the participants (94% - Figure 4(b)), with the majority (67%) rating the impact to be significant.

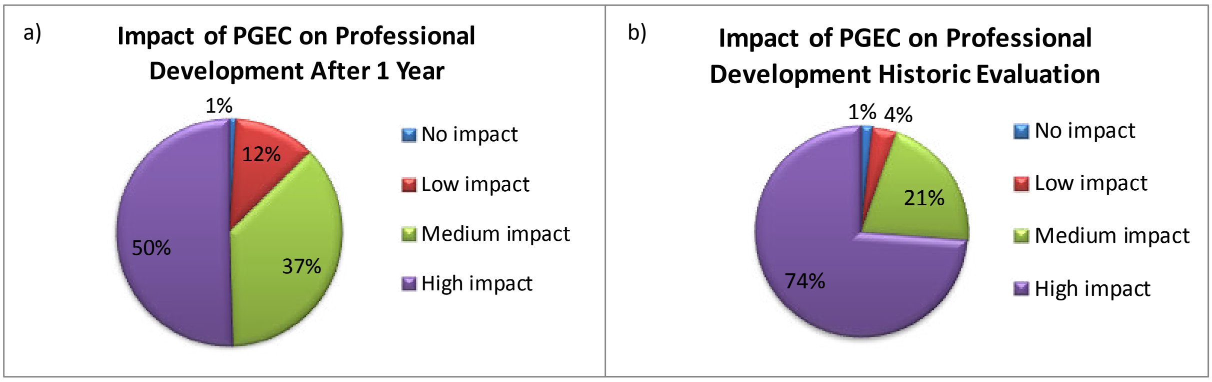

Fig 3. Percentage of participants stating that the PGEC had a positive impact on their professional development (1 year (a) and more than 5 years (historic evaluation) (b) after course completion).

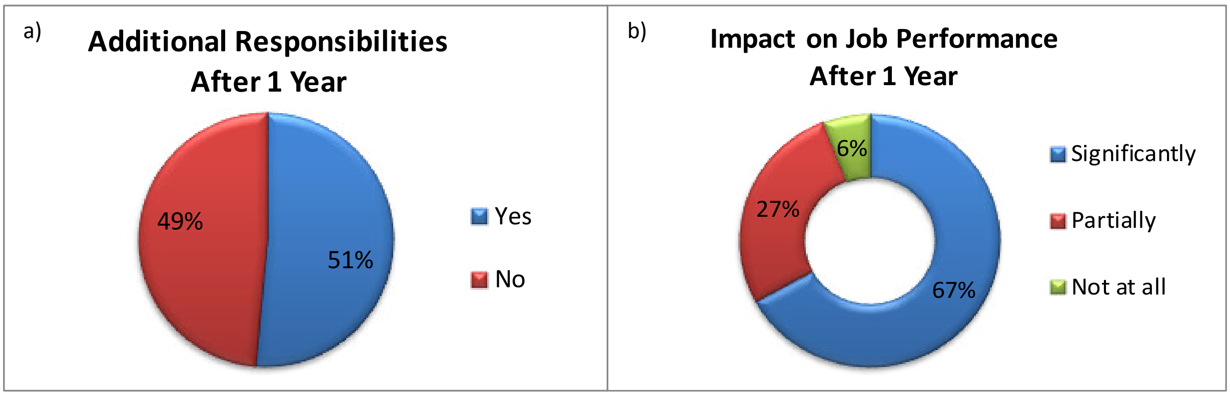

Fig 4. Percentage of participants stating that the PGEC had an impact on acquiring additional tasks (a) and improving job performance (b) (1 year after course completion).

3.3. Impact of the PGEC on Radiation Safety Infrastructure

IAEA categorises Member States' radiation safety infrastructure in terms of 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 Protection; and
- TSA7: Transport safety.

Surveyed participants were requested to rate the extent to which they used their knowledge and skills gained from the PGEC to have an impact in areas pertaining to the various TSAs.

The results of the evaluation show that the impact of the course has been multifaceted in terms of improving the national radiation safety infrastructure. In particular, some correlation has been observed among the job category of the surveyed participants and to what degree they have impacted the various activities associated with each TSA. In the questionnaire, participants were asked to evaluate the extent to which the knowledge and skills gained in the PGEC has had an impact on each TSA. In case of a sample including all participants (Figure 5(a)), there is some evidence that the percentage of answers stating that the PGEC has had a high-moderate impact on TSA1, TSA2 and TSA6 is significantly higher than the percentage of answers for the low-no impact. On the other hand the percentage of answers for the impact on TSA3, TSA4, TSA5 and TSA7 seems to be equally distributed between high-moderate and low-no impact. If the same analysis is conducted for a subsample of participants (regulators), there is clear evidence that the course has impacted on most of the TSAs, with the highest rate associated to TSA1: this reflects the fact that all the TSAs include activities related to the development and establishment of regulations and guidance (often associated to the regulators' functions) and that TSA1 is the TSA specifically focused on regulatory aspects. On the other side, if the same analysis is conducted for a subsample of health professionals, the course seems to have significantly impacted activities related to TSA3: this reflects the fact that TSA3 covers all the aspects related to radiological protection in medical exposure. Some impact of the course on TSA6 can also be pointed out, while all the other TSAs have been significantly less impacted. Similar trends can also be observed for the impact evaluation conducted 3, 5 and more than 5 years after completion of the PGEC.

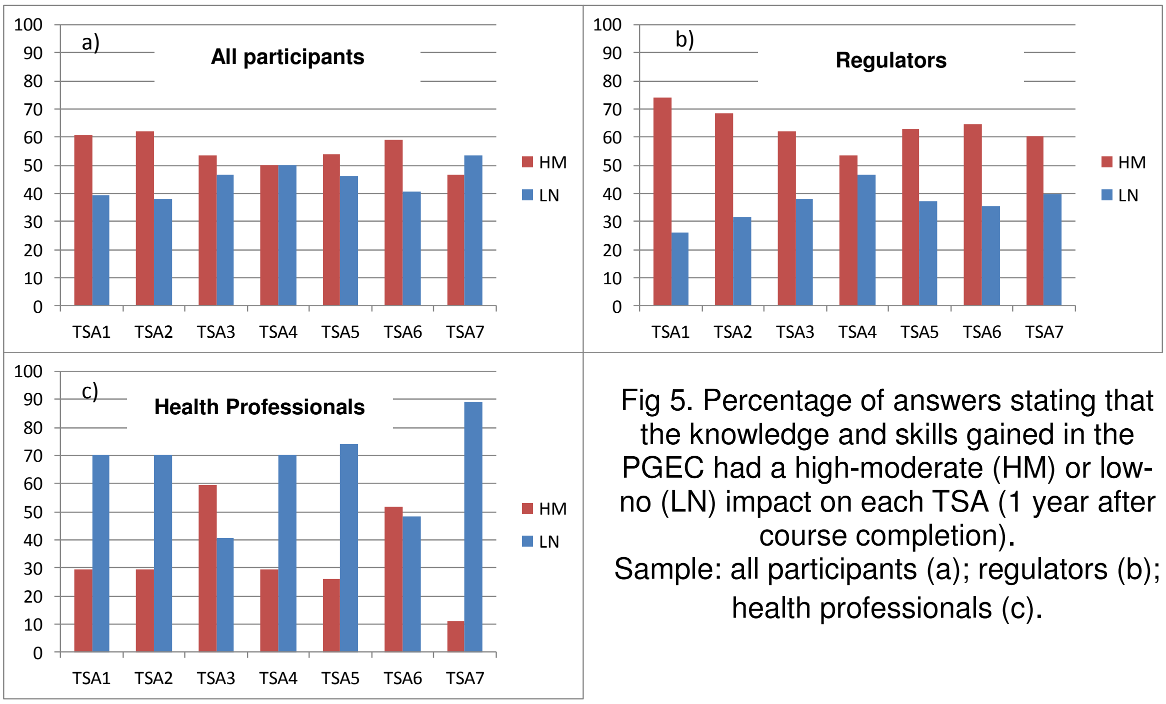

Fig 5. Percentage of answers stating that the knowledge and skills gained in the PGEC had a high-moderate (HM) or low-no (LN) impact on each TSA (1 year after course completion).
Sample: all participants (a); regulators (b); health professionals (c).

3.4. Sustainability and effectiveness of the PGEC

Continuity of the PGEC work project

Participants are required to carry out a work (research) project to demonstrate their ability to apply the knowledge and skills acquired during the course; and to present the results and outcomes of their project at the end of the course. The project should be aimed at solving a specific radiation protection problem in the participant's home country. Suitable ideas/topics for the project should be identified by each participant in consultation with their national authorities. Participants are expected to continue performing follow-up activities related to their work project after they have completed the PGEC.

The fact that many participants reported that they do continue with their work project when they get home is a good indicator of the sustainability of the course. The results of the impact evaluation show that 1 year after completing the PGEC, 56% of the participants confirmed that they have been able to conduct follow-up activities planned in their work project.

Sharing knowledge and skills

Acquiring the necessary basic skills to become trainers in radiation protection is one of the objectives of the PGEC, as the sharing of knowledge and skills acquired during the course is a key factor in supporting sustainability. The majority of the participants confirmed that they have used the knowledge and skills acquired during the PGEC to organize and/or implement a training event in radiation protection and the safe use of radiation sources. The affirmative response tends to increase with time completion of the PGEC, from 54% after 1 year, to 64% after 3 years, and 72% after 5 years (Figure 6).

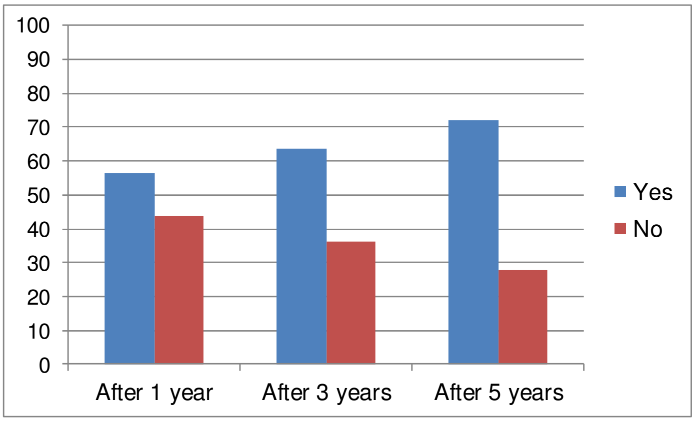

Fig 6. Percentage of participants sharing knowledge and skills gained in the PGEC, by organizing or implementing training events (1, 3 and 5 years after course completion).

Contribution towards academic and/or professional development

The sustainability of the PGEC can also be attributed to the development of the professional and/or academic development of the participants. Feedback from the participants confirms that the knowledge and skills acquired during the PGEC enabled them to attend specialized training courses (35% of answers), train-the-trainers events (26%), and high-level academic programmes (26% for masters and PhD).

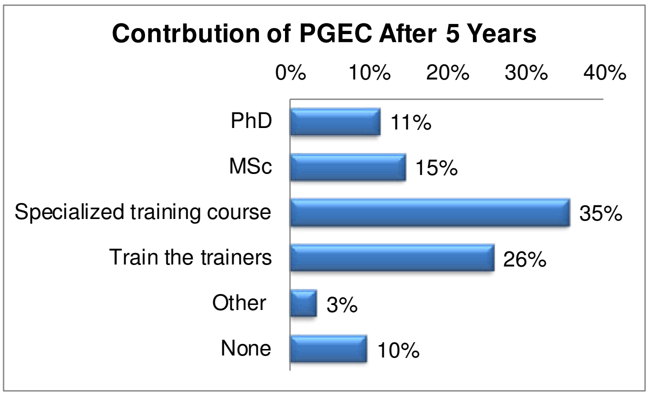

Fig 7. Percentage of affirmative answers for the contribution of the PGEC towards specific professional and/or academic development (5 years after course completion).

On-going success of the PGEC

More than 90% of participants recommended attending the PGEC to their colleagues and/or employees, irrespective of the time passed since course completion. This reflects the usefulness, value and relevance of the course.

4. Conclusions

The responses from the PGEC participants, confirmed that the course has had a positive impact on their professional careers. Furthermore the utilization of knowledge and skills acquired during the course has made a significant contribution towards strengthening the radiation safety infrastructure in their home country or institution.

The course is clearly highly valued and well-respected. Completion of the PGEC has helped participants gain additional responsibilities and duties, and it has had a substantial impact on their personal development, irrespective of the time passed since they completed the course. The PGEC has also contributed towards their academic advancement in terms of attaining an MSc or PhD.

Moreover, the impact evaluation confirmed the sustainability of the PGEC in several aspects, such as continuation of the work project, sharing knowledge and skills through implementation of training events in radiation protection, and an ongoing recommendation from participants to their colleagues to attend the course.

In conclusion, the impact evaluation of the PGEC confirmed that the course plays an important and remarkable role by building a core of competent professionals in radiation protection and in strengthening the radiation safety infrastructure at the institutional and/or national levels.

Annex I: PGEC: assessment and evaluation; blended learning approach

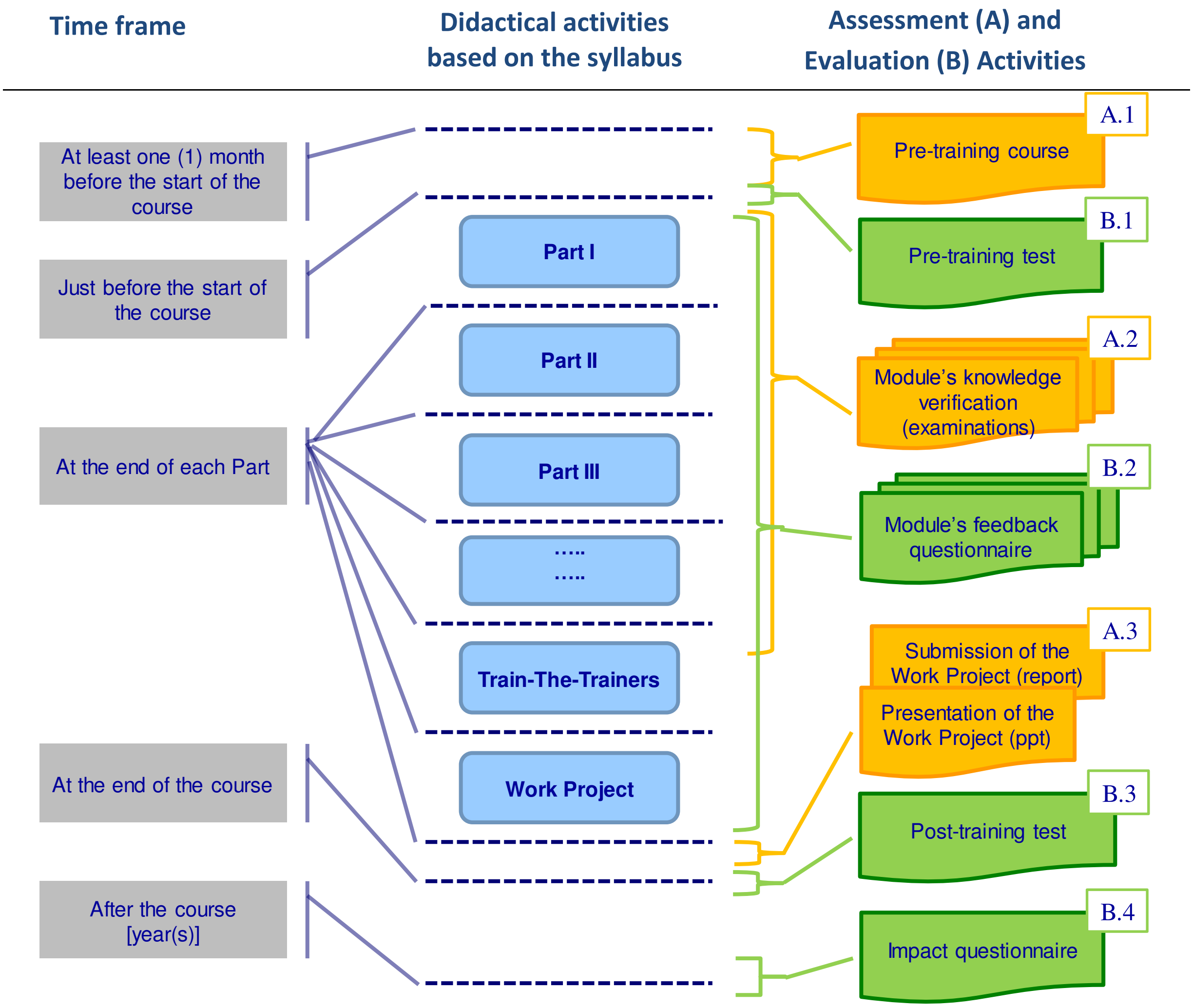

Fig. I.1 Structure and time frame for the conduction of the PGEC (see also Table 2 for definitions and objectives of the evaluation and assessment mechanisms)

Activity	Blended learning components of PGEC			
	Current		*Future*	
Didactical				
All Parts	CR		CR	DL (e-learning)
Assessment				
A.1		DL (e-learning)		DL (e-learning)
A.2	CR		CR	
A.3	CR		CR	
Evaluation				
B.1, B.3	CR			DL (e-learning)
B.2		DL (e-learning)		DL (e-learning)
B.4		DL (e-learning)		DL (e-learning)

Tab. I.1 Current status and future initiatives to expand the blended learning approach for the PGEC (CR: class room/face-to-face; DL: distance learning)

ASSESSMENT A structured activity by which the knowledge and/or skills and/or attitudes of an individual are measured using one or more methods. Assessment is often conducted at the end of a training session or course to determine the extent to which trainees have met the training objectives **Objectives:**	
A.1	To refresh the knowledge of the participants on basic subjects to facilitate their attendance at the PGEC To get information on possible gaps in participants competence
A.2	To evaluate participants' knowledge and understating of the subject presented in each Module
A.3	To evaluate participants' capability to make use of the knowledge gained in the course to address a specific issue of radiation protection, relevant to the national contest To provide an opportunity to evaluate participants' knowledge and understanding of the subject presented in the Module "Train-the-Trainers (TTT)'
EVALUATION A series of activities used to measure the *adequacy and effectiveness* of a training session, course or programme (Evaluation is of "things" in contrast to an Assessment which is used as a measure of individuals). **Objectives:**	
B.1	To have an overall evaluation of the gain of knowledge (coupled with B.3)
B.2	To collect participants' (and lecturers') feedback on the delivery of the Module and on Lecturers' performance
B.3	To have an overall evaluation of the gain of knowledge (coupled with B.1)
B.4	To evaluate the long-term impact of the course (*cold assessment*)

Table I.2: Evaluation and assessment mechanisms: definitions and objectives.

References

[1] EUROPEAN COMMISSION, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Building Competence in Radiation Protection and the Safe Use of Radiation Sources, IAEA Safety Standards Series No. RS-G-1.4, IAEA, Vienna (2001).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Training in Radiation Protection and the Safe Use of Radiation Sources, Safety Reports Series No. 20, IAEA, Vienna (2001).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Postgraduate Educational Course in Radiation Protection and the Safe Use of Radiation Sources, Standard Syllabus, Training Course Series No. 18, IAEA, Vienna (2002).

[5] KIRKPATRICK, DONALD L. & KIRKPATRICK, JAMES D., Evaluating Training Programs: The Four Levels, Berrett-Koehler Publishers; 3rd edition (2006).

INITIATIVES TO INTEGRATE NUCLEAR SECURITY WITH RADIATION PROTECTION EDUCATION AND TRAINING

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ABSTRACT

Extensive efforts in developing robust and sustainable educational and training programs in nuclear security have become an international priority due to the growth and interest in the use of nuclear and radiological technologies, coupled with the growing threat of global terrorism since the events of September 11, 2001. Many of these efforts are driven by the activities of the International Atomic Energy Agency (IAEA). Specifically, the IAEA International Nuclear Security Education Network (INSEN) was established in 2010 to enhance global nuclear security by developing, sharing and promoting excellence in nuclear security education. One of the goals of INSEN is to better integrate nuclear security education with other areas of nuclear and radiation science. The integration of safety, security, and safeguards (when applicable) is paramount in this regard. Health physics or radiation protection is often included in safety and is one area where better integration with nuclear security concepts is needed. Many radiation protection professionals have very little knowledge or experience in radiological or nuclear security matters. However, more and more of these professionals are facing increased job responsibilities that include some aspect of security. The role of the radiation protection professional in nuclear security matters is not clearly defined despite the fact that a fundamental understanding of radiological hazards of adversary target material is required for understanding the total risk to the facility and/or material. The authors have begun a program of developing materials and providing professional development workshops specifically for the purpose of integrating nuclear security with radiation protection. Since 2014 the authors have developed 8-hour, 4-hour, and 2-hour workshops catering to radiation protection students and professionals in the medical, industrial, and nuclear energy sectors. The workshop modules range from introductory nuclear security topics to more detailed content. These workshops have been presented at a number of professional conferences and even provided at dedicated workshops throughout the world. Future courses will continue to be offered with the hope of developing even more specialized content to different radiation protection stakeholder groups (i.e. the healthcare industry, nuclear power, etc.). In addition, a dedicated nuclear security curriculum has been developed in the health physics baccalaureate and masters programs at Purdue University. This program, in cooperation with the nuclear engineering and political science departments, will educate these students in nuclear security principles.

1. Introduction

The need for human resource development in nuclear security has been underlined at several International Atomic Energy Agency (IAEA) General Conferences and Board of Governors' Meetings. In successive IAEA Nuclear Security Plans, high priority has been placed on assisting member States in establishing educational programs in nuclear security in order to ensure the sustainability of nuclear security improvements. The current Nuclear Security Plan, covering 2014-2017, emphasizes the importance of existing capacities at international, regional and national levels while designing nuclear security academic programs [1].

One key component in helping member States establish educational programs came about in 2010 when the International Nuclear Security Education Network (INSEN) was formed during an IAEA workshop by a group of experts from academia, international organizations, and professional nuclear material management associations [2]. The INSEN mission is to promote excellence in nuclear security education in pursuit of the identified need for highly qualified nuclear security professionals [3]. INSEN objectives are to promote among universities and other educational institutions worldwide the IAEA Nuclear Security Series No 12 (NSSS-12) – *Educational Programme in Nuclear Security* setting out a model of a Nuclear Security Master of Science curriculum by (1) assisting in the development of comprehensive and up-to-date educational materials; (2) assisting in the development of faculty members in the area of nuclear security; and (3) promoting professional careers in nuclear security as the means of attracting the best and the brightest into the discipline [4].

The achievements and progress made by INSEN since its inception has been nothing but remarkable. INSEN has grown from an initial membership of about 20 to over 150 (159 members as of April 1, 2017). Fifty-six IAEA member states are represented and over 90% of the members represent academic institutions. Of the educational institution members, most have developed a nuclear security program or added a nuclear security component to an existing program. No less then 15 institutions have actual programs leading to a degree or concentration in nuclear security. Through its three working groups (WGs), INSEN has developed a number of textbooks, presentations, and other educational materials, has taught or developed several dozen professional development workshops and courses, and has presented at least 100 papers on nuclear security topics. [5] The seeds of nuclear security educational infrastructure were planted not long ago, yet the growth has already been significant. [6]

Although nuclear security education infrastructure development has been established and expanded throughout the world, its integration in areas of overlap with related disciplines has been slow or nonexistent. One particular area where overlap and integration is crucial and missing is in radiation protection or health physics. In a recent published paper, Waller and van Maanen discuss the advantages that health physicists would have in a nation's overall nuclear security programme. In this article they present how health physicists can contribute expertise in the roles of establishing the threat assessment and design basis threat, informed risk management, response force strategies in light of potential radiation exposure, dose guidance, training and demonstrable competence for the nuclear security response force and with effective communications of the radiological component of an event [7]. Using this paper as a springboard, members of INSEN, including the authors of this paper embarked on a program to integrate nuclear security education with radiation protection. The first phase of this program involves developing and presenting professional enrichment courses to introduce radiation protection professionals to nuclear security.

2. Background

Radiation protection, also known as health physics or the physics of radiation protection, is the science concerned with the recognition, evaluation, and control of health hazards to permit the safe use and application of radiation [8]. Health physics professionals promote excellence in the science and practice of radiation protection and safety and have broad experience in physics, biology and environmental science that can be used in nuclear security. These professionals principally work at facilities where radionuclides or ionizing radiation are used or produced, including medical institutions, government laboratories, academic and research institutions, nuclear power plants, regulatory agencies and industrial manufacturing plants. Worldwide, it is estimated that there are over 15,000 individuals that hold the title of health physicist or radiation protection professional.

Radiation protection is an essential function in most nuclear and radiological facilities and the primary responsibility is a safety function. Nuclear security is, however, extremely important in the post-9/11 environment for all of these facilities. The role of the radiation protection professional in nuclear security matters is not clearly defined despite the fact that a fundamental understanding of radiological hazards of adversary target material is required for understanding the total risk to the facility and/or material. Radiation protection can be integrated into nuclear security culture during design basis threat definition, through risk management exercises, participation in response force activities, developing dose guidance criteria, radiological training and in communicating hazard and risk to security personnel, facility operators and regulatory bodies. When integrating radiation protection into nuclear security culture, it is important that radiation protection management or the responsible/senior health physicist establish dialogue early with nuclear security personnel in generating the design basis threat. The dialogue must include the advantages of considering radiological hazard as part of the comprehensive response plan. Health physicists and other radiation protection professionals are multi-capable scientists, engineers and systems integrators that can contribute greatly at multiple levels for effective and efficient nuclear security. To be an effective partner in the nuclear security objective, health physicists must embrace the nuclear security culture but they also must be aware that it exists.

3. Methods

3.1 Motivation

The authors of this paper have education and professional experience in both health physics and nuclear security. Along with Dr. Craig Marianno from Texas A&M University in the USA, the authors began by developing professional development, awareness, and enrichment courses to be taught to health physics / radiation protection professionals and students alike. The course materials were taken from the authors' own materials developed at their universities and integrating them with materials developed by INSEN. Additional information about the process and delivery of these professional meetings can be found in an article recently accepted by the *International Journal of Nuclear Security* [8] and a paper and presentation delivered at the 2016 IAEA International Nuclear Security Conference [9]

Health physicists are a motivated group for professional development, and courses in nuclear security that cover both nuclear and radiological material management are desirable. The reason for this is that many of these professionals hold some sort of credential that requires continuing education. For example, in North America, the American Board of Health Physics (ABHP) offers the Certified Health Physicist (CHP) credential and requires a certain number of credits per certification cycle (5 years) in order to retain the certification. Eligible professional development courses are an ideal and often preferred way for these individuals to obtain their credits. Other bodies offering certification credentials, such as the World Institute for Nuclear Security (WINS) Certified Nuclear Security Professional (CNSP), have similar requirements for certification maintenance.

Professional enrichment course offerings for societies, such as the Health Physics Society (HPS) in the USA, have a competitive selection process in which proponents of a topical course must submit an abstract and proposed duration of the training. For the offerings of professional enrichment program courses at HPS meetings, the ABHP assignment is generally 4 continuing education credits (CEC) per 2 hr. course. The ABHP requires 80 CEC be obtained over a 5 year recertification cycle. It is important to note that there are other ways to obtain CEC aside from attending a course.

3.2 Professional Development Course Offerings

Since 2014, the authors, individually and in tandem, have offered a total of eight professional enrichment courses to health physics and radiation protection professionals, both nationally and internationally. Five have been through the Health Physics Society (HPS) meetings, two through the International Radiation Protection Association (IRPA) meetings, and one (1) at the Massachusetts Institute of Technology (MIT). Not included in this list are the dozens of presentations given at meetings and conferences throughout the world by the authors on this topic.

The first three course offerings were introductions to nuclear security and nuclear security for the health physicist. Subsequent courses provided more specific topics in nuclear security such as physical protection, cyber security, and consequence management. A summary of the courses offered is presented in Table 1.

COURSE TITLE	VENUE, LOCATION, YEAR	DURATION (HR.)	COURSE PARTICIPANTS
1 Introduction to Nuclear Security I & II	47th HPS Midyear Meeting, Baton Rouge, Louisiana, USA, 2014	4	20
2 Introduction to Nuclear Security for the Health Physicist	59th HPS Annual Meeting, Baltimore, Maryland, USA, 2014	8	40
3 Workshop on Strengthening Security of Radioactive Sources in Medical and Industrial Facilities	4th Regional Congress of IRPA for Africa Region (AFRIRPA04), 2014	4	50
4 Physical Protection for Nuclear and Radiological Security	60th HPS Annual Meeting, Indianapolis, Indiana, USA, 2015	2	25
5 Terrorist Threat and Consequence Management in Radiological Security	60th HPS Annual Meeting, Indianapolis, Indiana, USA, 2015	2	25
6 Introduction to Nuclear and Cyber Security for the Health Physicist	60th HPS Annual Meeting, Indianapolis, Indiana, USA, 2015	2	25
7 Nuclear Security, Alternative Technologies and Consequence Management for the Health Physicist	MIT, Cambridge, Massachusetts, USA, 2015	20 (3 DAYS)	25
8 Nuclear Security for the Health Physicist	14th IRPA Congress, Cape Town, South Africa, 2016	4	50

Table 1: Summary of Nuclear Security Courses Offered to Radiation Protection Professionals from 2014-2016.

Mapping of lectures against specific course offerings in nuclear security are presented in Table 2. The modules taught for these courses reflect the time available and the approved course proposals to the venue organizers. For formatting purposes, the eight courses are represented by the numerals presented in Table 1. These numerals correspond to the sequence in which they were offered, starting with the first course offered and moving forward in time.

MODULE	COURSE							
	1	2	3	4	5	6	7	8
Basic elements & definitions of nuclear security	X		X					
Introduction to nuclear security		X	X			X	X	X
Interrelationships between safety, security and safeguards (S^3)	X	X	X			X		X
International nuclear security framework								
Threats by non-state actors & terrorism	X	X			X			
Planning nuclear security at the state level	X							
Role of the health physicist in nuclear security	X	X	X			X		X
Design Basis Threat (DBT)		X		X				
Physical protection systems		X		X			X	X
Consequence management		X			X			
Facility, border and source security		X		X				
Exercise on detection		X			X			
IT/Cyber security		X	X					X
US NRC and DOE nuclear security regulations		X				X		
High Activity Sources and Alternatives in Medicine							X	
Alternative Technologies: Policies and Paths Forward							X	
Nuclear security culture			X					X

Table 2: Modules Taught in Nuclear Security Courses Offered to Radiation Protection Professionals from 2014-2016.

3.3 Lectures and Presentations

As mentioned earlier, the authors have given a number of individual presentations and lectures not associated with the professional development courses described in Section 3.2. For these presentations, the intent was to raise general awareness of nuclear security issues that may be pertinent to their jobs and duties. Although not exhaustive, presentations have been given at the following workshops, meetings and conferences on nuclear security for radiation protection:

- HPS Annual Meeting (2014-2016, USA)
- HPS Midyear Meeting (2014, USA)
- NATC ISOE ALARA Symposium (2015, USA)
- AFRIRPA04 (2014, Morocco)
- 14th IRPA Congress (2016, South Africa)
- John Horan Memorial Symposium: Topics in Health Physics (2015, USA)
- INSEN Annual Meeting (2015, Austria)

3.4 Nuclear Security Curriculum at Purdue University

Purdue University (Purdue) offers world-class undergraduate and graduate programs in nuclear science and engineering, specifically in nuclear engineering and health physics. The School of Nuclear Engineering (SNE) in the College of Engineering administers baccalaureate, master, and doctoral degrees in nuclear engineering. The School of Health Sciences (HSCI) in the College of Health and Human Sciences administers baccalaureate, master, and doctoral degrees in health physics. Currently the School of Nuclear Engineering has approximately 75 declared undergraduate (junior and senior level) and 50 graduate students. There are 16 tenured/tenure-track faculty and 2-research faculty. The School of

Health Sciences has 13 tenured/tenure-track faculty and a number of lecturers and adjunct faculty that contribute to Radiological Health Sciences (RHS) at Purdue. Within RHS are the programs of health physics, medical physics, and imaging science. In RHS, there are approximately 25 graduate students and 20 undergraduate students.

With the recent hiring of key faculty in both Schools, including the author, Jason Harris (2015), Purdue has committed itself to build its programs in nuclear nonproliferation and nuclear security. Both Schools are creating educational tracks or minors in nuclear nonproliferation and nuclear security and have established relationships with faculty in the Political Science Department that have teaching and research interests in nuclear nonproliferation, terrorism and counter terrorism, and arms control. Recently Purdue University has also committed to these important areas by establishing a Policy Research Institute, starting a new Master's degree program in Security Policy, and announced the creation of the Institute for Global Security and Defense Innovation. All three of these endeavors will include nuclear and radiological source security.

Due to these initiatives, Purdue University was chosen in 2017 to implement the US Department of Energy (DOE) Defense Nuclear Nonproliferation (DNN) Office of Radiological Security (ORS) Nuclear Security Education (NSE) program. The program includes six courses in nuclear security: Introduction to Nuclear and Radioactive Source Security, Nuclear Security Threat Assessment and Analysis, Nuclear Security Science, Nuclear Detection Technologies, Nuclear Nonproliferation and Arms control, and Nuclear Security Systems Design. These courses will become the core of a new graduate major in the School of Nuclear Engineering, a new undergraduate track in the School of Nuclear Engineering, a new track in the RHS program in the School of Health Sciences, and a new graduate certificate in nuclear nonproliferation and security. Although four other universities have this program already in place, Purdue was chosen so that it can implement this program specifically within health physics. Also, Purdue will develop the first of its kind module on Alternative Technologies. The module will be available to other universities to incorporate into their programs. The program at Purdue will offer its first course starting in August 2017.

4. Results

Since 2014, a number of courses and presentations have been delivered focusing on introducing nuclear security concepts to radiation protection professionals. A key emphasis that was presented in all of these endeavors was the importance of integrating nuclear and radiological source security with radiation protection (or more broadly, radiological safety). From importance and usefulness standpoints, it is crucial to know how the participants valued the content. Ideally all the courses would have required participant feedback, but only three of the courses offered (all from the Health Physics Society courses) included any formal evaluation process.

The Health Physics Society has standard course evaluation forms that are distributed to course participants. Completion of the form is voluntary and as is often the case, course evaluation and feedback tends to suffer from low participation (therefore poor statistics) and weak inferences. The most useful feedback is often obtained by talking with participants after the training; however, this is highly unscientific and may suffer from bias (selective presentation of feedback). Overall, across several categories, the instructors and course content was generally viewed as “Excellent” or “Very Good”.

A consistent message that was relayed to the instructors very early was that the course participants were very pleased that a course in nuclear security was being offered to them in the context of health physics. The authors perceived this had as much to do with a general interest in the subject material as it did with the introduction of a new topic to the continuing education training cohort. One might infer that there is, therefore, a general desire for radiation protection professionals to increase their awareness about nuclear security and determine where they may actively participate. This was determined as a very good indication because it demonstrated a willingness of health physicists and others involved primarily in radiation protection to broaden their horizons and look beyond a “safety silo”. Similar feedback was received for many of the separate presentations given at meetings and conferences.

Feedback and course evaluations will be utlizied as well for the nuclear security courses to be offered at Purdue University. Disseminaiton of results will be presented at a future date.

5. Future Work

Since 2014, several nuclear security courses, lectures, and presentations have been developed and delivered for radiation protection professionals. It is the intent of the authors to continue to provide these valuable offerings to the radiation protection community. In addition to covering the more introductory topics, the authors intend to develop more advanced topics including:

- integration of nuclear security and radiation protection/safety culture;
- radiation protection roles in nuclear and radioactive source emergency management and insider threat;
- nuclear security management for the health physicist;
- radiation detection design and use for safety and security applications; and
- health physicist’s role in safety and security design of facilities

While most of the courses and presentations have been delivered at general health physics/radiation protection meetings and conferences (i.e. HPS meetings, and IRPA congresses), the authors have also begun to target their deliveries to specific sectors that use nuclear and radioactive materials. The sectors that have the least amount of experience and knowledge of nuclear security matters and integrating radiation protection include the medical and educational/academic communities.

Up to this point, lecture and course development and delivery has been seen as very valuable to both the authors and the participants. But, since both authors are professors, they recognize the need for incorporating this content into educational programs to better integrate the two disciplines of radiation protection and nuclear security. The authors will look into developing content to be distributed to educational radiation protection programs across the world. Finally, from an academic perspective, research needs to be performed within and across these two areas. Both authors have begun to look into research opportunities that tie the two areas together. For example, assessment of nuclear security and its integration with safety/radiation protection culture among different sectors (i.e. nuclear power, health care, academia) is an area of research not explored. There is also a need to look into alternative technologies in health care to evaluate the safety and security benefits and risks of source vs. device use. The latter two initiatives have already begun at Purdue University. For example, the author and his research group are performing a nuclear security culture assessment among authorized users of radioactive materials at the University (using about 600 subjects). Results will be published and an assessment tool will be developed to use at other universities and eventually extended to other sectors, such as health care.

6. Conclusions

Health Physicists and radiation protection professionals, with their diverse experience in radiological sciences, can play vital roles in nuclear security. To reach out to this community eight enrichment courses were presented at both national and international professional society meetings since 2014. These courses were focused on giving the health physics professional a greater insight into the many challenging areas of nuclear security and how they might participate. In conjunction to these activities, a number of presentations and lectures have also been given. This paper described the courses, their objectives and how they were delivered. These courses were well received by the attendees. However, there was limited documented proof of the success of these courses. The authors acknowledge that a more active effort should be used to distribute and collect course evaluation. In the future, presentations and courses are being considered for more targeted audiences and with more specialized content. From an educational perspective, this content should be incorporated into both nuclear security and radiation protection programs and expanded to research activities for faculty and students. Such a program has begun at Purdue University.

7. References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Plan 2014-2017 GOV/2013/42-GC(57)/19, IAEA, Vienna (2013).

[2] BRAUNEGGER-GUELICH, A. et al., International Nuclear Security Education Network, INMM Annual Meeting, Proceedings of the 52th Annual Meeting of the INMM, 2011.

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, International Nuclear Security Education Network (INSEN). Available at https://nusec.iaea.org/portal/UserGroups/INSEN/AboutINSEN/tabid/627/Default.aspx. Accessed on 1 October 2016.

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Educational Programme in Nuclear Security, IAEA Nuclear Security Series No. 12, Vienna (2010).

[5] HARRIS, J., HOBBS, C., STERBA, J., Course Material and Curriculum Development Activities of the International Nuclear Security Education Network (INSEN), Proceedings of the 54th Annual Meeting of the INMM, 2013.

[6] HARRIS, J., International Trends in Nuclear Security Education, Proceedings of the 55th Annual Meeting of the INMM, 2014.

[7] WALLER, E., VAN MAANEN, J., The Role of the Health Physicist in Nuclear Security, Health Phys. 108(4): 468-476 (2015).

[8] WALLER, E., HARRIS, J., MARIANNO, C., Experiences with Teaching Nuclear Security Professional Development Courses for Health Physicists. International Journal of Nuclear Security. 2(1): 89-97 (2016).

[9] HARRIS, J., WALLER, E. Educational Initiatives to Integrate Nuclear Security and Radiation Protection. In: Proceedings of the IAEA International Conference on Nuclear Security: Commitments and Actions, Vienna, Austria, December 5-9, 2016. (IAEA, Vienna, 2016). Paper 125.

RADIATION PROTECTION WORKER (RPW) COMPETENCE BASED QUALIFICATION DESIGN. PILOT IMPLEMENTATION OF ECVET APPROACH IN RPW TRAINING

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ABSTRACT

Lifelong learning requires common EU approaches for assessing and validating the learners' qualifications by respective authorities. Borderless mobility implies mutual recognition of learners' qualifications, thus supporting the free circulation of service providers amongst the EU Member States. The European Credit system for Vocational Education and Training (ECVET) is one of the latest European instruments promoting mutual trust and mobility in vocational education and training.
The development of the competence based design of Radiation Protection Worker qualification is part of the work done for pilot implementation of ECVET, which is one of the objectives of CORONA project. CORONA project is established to stimulate the transnational mobility and lifelong learning amongst VVER end users. It aims to provide a special purpose structure for training of specialists and to maintain the nuclear expertise by gathering the existing and generating new knowledge in the VVER area.
CORONA Project consists of two parts: CORONA I (2011-2014) "Establishment of a Regional Center of competence for VVER technology and Nuclear Applications", co-financed by the Framework Program 7 of the European Union (EU) and CORONA II (2015-2018) "Enhancement of training capabilities in VVER technology through establishment of VVER training academy", co-financed by HORIZON 2020, EURATOM 2014-2015.[1]
The methodology for competence based qualification design is based on the methodology developed by JRC-IET for the ECVET implementation in the Nuclear Energy Sector. The approach includes selection of one particular job for pilot implementation, which is subject to increased mobility; definition of competence requirements for this qualification; selection of appropriate training scheme for this qualification, conductance of pilot training on at least one selected course; recognition of acquired learning outcomes (LO); evaluation of the results and proposal of corrective measures.
The paper presents the process of selection of qualification, development of units of LOs, development of knowledge, skills and competence items, development of ECVET based training courses and the results of the evaluation of the pilot training, which will be provided from 30 January till 3 February in Budapest by the CORONA project partners.

1. Introduction

European cooperation in education and training has amongst its objectives the development of common instruments (European Qualifications Framework (EQF), European Credit System for Vocational Education and Training (ECVET), European Quality Assurance for Vocational Education and Training (EQAVET), European Credit Transfer and Accumulation System (ECTS), etc.) to support lifelong learning and mobility. These instruments were developed and should complement each other in their implementation.
The European principles for validation of non-formal and informal learning will benefit from the introduction of ECVET as it will facilitate the validation of non-formal and informal learning in view of achieving qualifications.
ECVET aims to facilitate the transfer, recognition and accumulation of assessed learning outcomes of individuals on their way to achieving a qualification. ECVET implementation is essential for the development of VET and qualifications systems, but it is also a complex and

[1] This project is co-financed by "Euratom research and training", for the period 2015 - 2018, Grant Agreement № 662125".

challenging process. ECVET concepts and principles should be tested and introduced to ensure that conditions for the gradual application of ECVET are in place. EC recommends that member states create the necessary conditions and adopt measures, in accordance with the national legislation and practice and on the basis of trials and testing for ECVET to be gradually applied to VET qualifications at all level of the EQF and used for the purpose of transfer, recognition and accumulation of individuals' learning outcomes, achieved in formal and where appropriate non-formal and informal contexts [1].

ECVET implementation in the nuclear energy sector is coordinated at EU level by the Joint Research Centre (JRC). It is based on the strategy and road map developed by European Human Resources Observatory for the Nuclear Energy Sector (EHRO-N), and is on-going since 2011.

The current status of ECVET implementation in the nuclear energy sector at the end of 2016 is the following:

- the ECVET infrastructure, as a prerequisite for starting the development of training programs-qualification oriented, is in place;
- the ECVET infrastructure encompasses tools, customised for nuclear energy sector, such as: Nuclear Job Taxonomy; 140 jobs were identified within three phases of a NPP life cycle (new built; operation and decommissioning; Classification of occupations, qualifications and jobs in the NPP life cycle; Methodology for flexible qualifications design (unit based qualifications; ECVET approach) and Methodology for training program-qualification oriented design;
- Because in most cases qualifications are under the responsibility of a Ministry or a national competent body, there is not a standard legal solution at EU level for solving the problems associated with workers mobility and qualification achievement. That is why the most effective tool for solutions identification to the problem of workers mobility and qualification achievement is the sectorial pilot projects.
- The major on-going nuclear pilot projects that are currently testing different ECVET features are listed in Table 1.
- It should be mentioned that only two nuclear pilot projects (CORONA II and ELINDER) address the issue of qualification achievement in the context of mobility abroad.

Pilot project	Topic addressed		ECVET feature tested
ANNETTE	Education design	-	Defining LO for nuclear courses EQF 6
CORONA II	Training design	Qualification achievement in the context of mobility abroad	- training scheme for a qualification EQF 4 - acquiring LO during mobility
ENETRAP III	Training design	-	Training Scheme for a RPE qualification EQF 7
PETRUS II	Training design	-	Training Scheme for a qualification EQF 7
ELINDER	Training design	Qualification achievement in the context of mobility abroad	- turning TP-disciplines oriented in TP-qualification oriented - acquiring LO during mobility

Table 1: Nuclear pilot projects testing ECVET features

In the light of the facts emphasised above, we can state that CORONA II project is:

- A "net beneficiary" of ECVET infrastructure and guidance provided by JRC;
- Integrated in the European mainstream of ECVET implementation.

2. Pilot implementation of ECVET approach in CORONA II project

The development of the competence based design of Radiation Protection Worker qualification is part of the work done for pilot implementation of ECVET, which is one of the objectives of CORONA project. CORONA project is established to stimulate the transnational

mobility and lifelong learning amongst VVER end users. CORONA Project consists of two parts: CORONA I (2011-2014) "Establishment of a regional center of competence for VVER technology and Nuclear Applications", co-financed by the Framework Program 7 of the European Union (EU) and CORONA II (2015-2018) "Enhancement of training capabilities in VVER technology through establishment of VVER training academy", co-financed by HORIZON 2020, EURATOM 2014-2015.
The pilot implementation of ECVET system is planned as part of the work on the CORONA II project and includes the following steps:

- Select one particular job for pilot implementation, which is subject to increased mobility;
- Define competence requirements (KSCs and LO) for this qualification;
- Select appropriate training scheme for this qualification, based on the defined units of LO;
- Select two utilities playing the roles of sending and host provider and organization playing the role for competent authority;
- Perform at least one pilot training on selected course;
- Recognise LO, perform validation. Validation means a process of confirmation by an authorised body that an individual has acquired learning outcomes measured against a relevant standard. Introduce training passport/certificate;
- Evaluate results and propose corrective measures.

This paper describes the selection of the qualification of Radiation Protection Worker (RPW) and its design and the development of the Competence based training scheme for PRW.

2.1. RPW qualification selection

ECVET adopts an approach based on learning outcomes as key element for the definition and description of qualifications. Learning outcomes are defined in terms of competences and can be a result of a learning process of any nature, i.e. formal, non-formal, informal or incidental. Accordingly, the typical structure of an ECVET qualification would be as illustrated in Figure 1 [2].

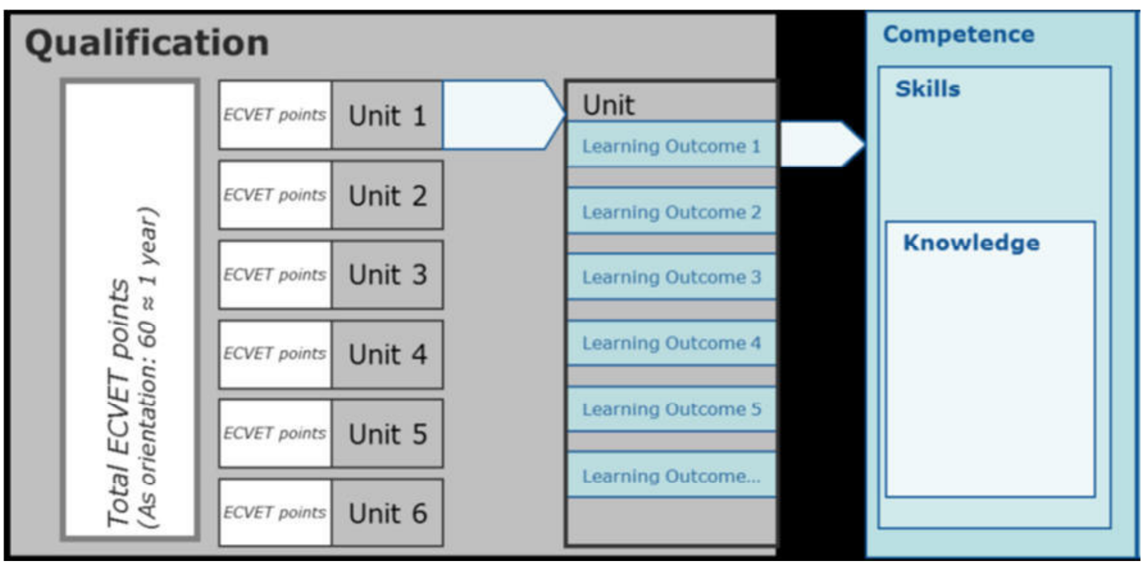

Figure 1: The ECVET qualification

The methodology was developed based on the methodology proposed by JRC-IET for the Workshop for Qualifications in Nuclear Decommissioning held in October 2015 in Lisbon, under the supervision of ECVET team [3]. This methodology is focused on the ways to be followed in order to fulfil the ECVET requirements for nuclear qualifications design and to develop the competence based qualification system (CB-QS).
Competence-based qualification is fundamentally a statement that a person is qualified to work in a specific field or occupation [4].

Before implementing a mobility action, the partner institutions were faced with the challenge of agreeing on a common language and common terminology regarding the contents and objectives of a mobility project. The basis for this agreement were both the EQF system and the use of ECVET instruments for describing learning outcomes as well as for assessing, documenting and validating units of learning outcomes [5].

The first task in the application of the methodology is the development of general criteria for selection of a qualification. The general selection criteria were initially developed in CORONA II project proposal and are listed below. The selected for the pilot project qualification had to meet the following requirements:

- Safety related;
- Low level with respect to the EQF;
- Not very wide job profile;
- Clear and easy to define competences;
- Mutual recognition is possible;
- Require only internal approval by the competent authority.

After initial proposal and discussion of several qualifications amongst the partners the following specific criteria were defined in order to facilitate the selection of the qualification and the design of the training scheme at a later phase:

- Availability of training programs and training materials amongst the partners;
- Language of the developed training materials (should be English);
- Complexity of the job profile and of the training programs for the selected qualification (should be not very complex);
- Availability of training provider;
- Availability of trainees.

The qualification of RPW was selected amongst five shortlisted candidates as the one matching most of the specific criteria. It meets the established criteria to the more complete extent than the other qualifications. The complete set of training courses was available and more than half of them were available in English language. Different types of training are ready to be held – theoretical, practical and e-learning training.

The next step was development of a Classification of occupations, qualifications and jobs in NPP Operation (Table 2. From jobs to occupations), which is done in order to distinguish between jobs and qualifications. The Classification of occupations, qualifications and jobs in nuclear Decommissioning, developed during Lisbon Workshop was used as a model [3].

From jobs to occupations		
Occupations	**Qualifications**	**Jobs**
Waste Management and Radiation Protection	Waste Management and Radiation Protection Manager Radiation protection Officer Radiation Protection Worker	2.4.01. WM&RP Manager 2.4.02. Radiation Protection Officer 2.4.03. Radiation Protection Worker

Table 2. From jobs to occupations

After having the Classification of occupations, qualifications and jobs in NPP Operation the qualifications that correspond to chosen jobs were identified.

2.2. RPW competence based qualification structure design

The qualification design was initiated and leaded by Risk Engineering Ltd. and was developed with active participation of MEPhI (Russia), BME (Hungary) and Kozloduy NPP (Bulgaria).

A unit of learning outcomes (ULO) is a component of a qualification consisting of a coherent set of knowledge, skills and competence that can be assessed and validated. The units of learning outcomes for RPW qualification were designed in such a way as to provide a consistent and structured learning process, with agreed coherent learning outcomes and clear criteria for assessment [6].

ECVET requirements for Units of Learning Outcomes/ULOs design are emphasized in the Table 3.

No	ECVET requirements	Remarks
1	Unit of Learning Outcomes/ULOs = a set of knowledge, skills, and competences that represents the smallest part of a qualification that would be assessed and validated independently.	The qualification becomes more flexible/adaptable to the market changes
2	The title of the ULOs correspond to the main functions/role of the job/qualification	The qualification becomes transparent and understandable for someone who has no nuclear background.
3	Number of the ULOs would be between 5- 10	
4	Choosing the size of the ULO = problem of optimizing the time spent for assessment and validating of ULOs accumulated by an individual	

Table 3 ECVET requirements for ULOs

To design the structure of the selected qualification of RPW the partners examined in details the job profile of the Radiation Protection Worker, developed by JRC and based on the role and functions, as well as on the knowledge, skill and competences that are required for this qualification, the following ULOs were defined [6]:

ULO 1 Introduction to nuclear power technology
ULO 2 Radiation protection
ULO 3 Radiation monitoring
ULO 4 Nuclear fuel and Radioactive waste
ULO 5 Accident and emergency issues
ULO 6 Decontamination
ULO 7 Safety and security

Each Unit was expressed via Learning Outcomes, each of which were defined in the terms of knowledge, skills and competence items.

The Table 4 presents an example of construction of ULO 2 Radiation protection.

ULO 2 Radiation protection		
ULO 2K	Knowledge (Cognitive competence)	EQF level (1-8)
K2.1	Main characteristics of atoms (electrical charge, nuclei, mass and dimension)	3
K2.2	Interaction of ionising radiation with matter	4
K2.3	Dosimetry (absorbed dose, equivalent dose and effective dose)	4
K2.4	Biological effects of ionising radiation	3
K2.5	Physical principles of detection and the interactions of radiation with matter	3
K2.6	Methods and tools for radiation protection for internal and external radiation exposure	3
K2.7	Detection and measurement of ionising radiation	4
K2.8	Natural and artificial sources of ionizing radiation	3
K2.9	ALARA principles and their implementation	4
K2.10	General EU occupational health and safety regulations	3
K2.11	Dose limits for occupational and public exposure	4
K2.12	Personal protective equipment for occupational radiation protection	4

K2.13	Basic principles of surface and air contamination and decontamination	3
ULO 2S	Skills (Technical and functional competence)	EQF level (1-8)
S2.1	Explain the composition of any nuclei (p, n and e) and use the chart of nuclides and nuclear data and find important constants.	3
S2.2	Choose the appropriate protective equipment according to the working environment.	3
S2.3	Propose a suitable active or passive dosimeter for different radiation protection situations.	4
S2.4	Calibrate device for external dose measurement.	3
S2.5	Measure the level of contamination of the package.	3
S2.6	Apply the rules of shielding.	4
S2.7	Perform different dosimetry calculations.	4
S2.8	Decontaminate and/or commission the decontamination of a surface.	4
ULO 2C/A	Competence (Attitude; behavioural and personal competence)	EQF level (1-8)
C2.1	Be able to inform on radiation protection issues.	3
C2.2	Communicate effectively with staff.	4
C2.3	Adopt a proactive and cooperative attitude.	3
C2.4	Take the human factor into consideration.	4
C2.5	React appropriately when a device indicates a measure.	3
C2.6	Be a collaborative team worker.	4

Table 4 Example of RPW qualification design, Unit 2. Radiation protection

2.3. Development of the Training programme, which is to be delivered to test the RPW qualification design

The Training program was organised in Training courses (units), which correspond to the Units of LO. Each training course was organised in modules, which aim to cover all Knowledge, Skill and Competence items belonging to the corresponding unit. The training course was focused on skills, because the knowledge is embedded in the learning process. The classroom lectures and laboratory exercises were organised to cover the skills necessary to be achieved after attendance of the training.

The recommendations from the Second Workshop on Qualifications for Nuclear Decommissioning, which was held in Bergen in October 2016, were taken into account during preparation of the training program [7].

The training program was prepared to support ECVET based qualification design and was focused on skills and knowledge. The purposes of learning activities were presented clearly. Modules were oriented towards occupational activities and tasks. Job oriented learning activities were in the focus of the learning process.

Training course No. 2: RADIATION PROTECTION ACTIVITIES

Autonomy/Responsibility

MODULE 2.1 Ionizing radiation

Skills	Knowledge
S.2.1. Explain the nuclei composition (p, n and e)	K.2.1. General characteristics of atoms (electrical charge, nuclei, mass and

S.2.2. Use the chart of nuclides and nuclear data and find important constants. S.2.3. Perform different dosimetry calculations.	dimension) K.2.2. Interaction of ionising radiation with matter K.2.3. Biological effects of ionising radiation K.2.4. Physical principles of detection and the interactions of radiation with matter K.2.5. Natural and artificial sources of ionizing radiation

MODULE 2.2 Radiation protection activities

S.2.4. Choose the appropriate protective equipment according to the working environment. S.2.5. Propose a suitable active or passive dosimeter for different radiation protection situations. S.2.6. Calibrate device for external dose measurement. S.2.7.Measure the level of contamination of the package. S.2.8. Apply the shielding procedures. S.2.9. Decontaminate and/or commission the decontamination of a surface. S.2.10. Apply international legislation S.2.11. Apply ALARA principle of individual and collective doses	K.2.6. Dosimetry and dose types (absorbed dose, equivalent dose and effective dose) K.2.7. Methods and tools for radiation protection for internal and external radiation exposure K.2.8. Detection and measurement of ionising radiation K.2.9. ALARA principles and their implementation K.2.10. General EU occupational health and safety regulations K.2.11. Dose limits for occupational and public exposure K.2.12. Personal protective equipment for occupational radiation protection K.2.13. Basic principles of surface and air contamination and decontamination

Assessment criteria (used by the trainer to assess the trainees): Capability in application of the ALARA implementation strategy Proper behaviour in emergency situations Ability in implementation of radiation protection program Nuclear safety and radiation protection culture behaviour Compliance with national legislation in radiation protection area	Precision of dose measurements evaluation Precision of calibration of the equipment Pertinence and precision of procedures implementation Accuracy of interpretation and reporting of radiological parameters

Recommended assessment methods (used by the Competent institution to recognize the training): Written test - case study, problem solving Practical test - simulation exercises Oral test (interview) Multiple choice questionnaires (MCQ)	Face to face examination, etc.

The development of ECVET based training course was essential part of the preparation of ECVET oriented qualification and its pilot testing. The target was to transfer ECVET oriented competence based qualification to an ECVET oriented competence based training course for Radiation Protection Worker. During one of the project meetings the partners discussed the content of the Training programme for PR worker and took decision to keep the number and content of the training courses equal to the number and title of the ULOs [6].

For each training course within the training programme the following information is provided:

- Objectives of the training course;
- Requirements to the target audience;
- Content of the training course (topics);
- Suggested duration of the course (in working days and in academic hours);
- Type of training – theoretical, practical, simulator / initial, refreshing;
- Methods for evaluation.

The partners reviewed the opportunities and capacities of the Consortium's organisations in order to assign the responsibilities for the pilot training course. The main aspects that were considered are:

- Experience in the education and training in Radiation Protection;
- Availability of training courses and training materials in English language;
- Possibilities to organise practical/laboratory exercises;
- Fluency of the lecturers English;
- Location of the training facilities.

Two universities: BME – Hungary and MEPhI – Russia were chosen to play role of host provider. The rest of the Consortium's partners played role of a sending provider.

The target audience was established for non-nuclear professionals or students, which are graduated at least to the level of bachelors or are currently bachelors' students, with negligible prior knowledge or without knowledge and experience in nuclear field could be trained. The pilot training was aimed to students or professionals working in support of nuclear facilities as civil engineers, physical protection employees, government employees, secondary school teachers, journalists, etc. The course was expected to provide competences necessary for trainees to participate in further nuclear course(s) or to perform works related to VVER NPP, radiation monitoring and radiation protection of places of ionizing radiation for medicine and industry applications, radioactive waste management, custom offices, etc.

The training course aimed to give competencies at EQF Level 3 and 4. It was intended to cover different aspects needed to start working in the nuclear related area with sufficient general nuclear knowledge and culture.

3. Pilot training and the evaluation of the pilot training

The pilot training was organised from 30.01. till 03.02.2017 at Budapest University of Technology and Economics premises in Budapest, Hungary. The announcement of the pilot training was issued in a timely manner and established aim of the pilot training, topics to be covered, duration of the training, target audience, working language, preliminary program and registration form. No registration fee was requested from trainees.

Eight (8) trainees: three (3) from Bulgaria, three (3) from Czech Republic and two (2) from Russia participated in the training.

Main field of activities during the last three years of the trainees were:

- nuclear technology and nuclear engineering;
- radiation protection and radiation monitoring;
- material science study;
- dosimetric control in hot cells;
- training (rad. protection, industrial and fire safety, first aid).

During the pilot training two (2) observers from Bulgaria and Czech Republic participated. The main tasks of the observation of conductance of the pilot training were to assess the training organisation and effectiveness and to evaluate whether learning outcomes have been achieved.

The evaluation of obtained knowledge and skills and the training programme effectiveness were organized at the end of the training by the use of two (2) questionnaires:

- Final Test questions about the content of the whole pilot training;
- Participants Satisfaction Survey for the Radiation Protection Worker Pilot Training

The assessment was focused on evaluating whether the learning outcomes have been achieved or not. The key aspects observed were:

- Organisation and management of the pilot training;
- Training materials – content, quality, use of laboratory equipment;
- Fulfilment of requirements for ECVET oriented training;
- Assessment of trainee's achievements- types, criteria, alignment with LO;
- Overall course evaluation.

At the end of the training the trainees were awarded certificates for attendance and achieved competencies within the pilot training course. The obtained results will be used for development of the criteria and the procedure for mutual recognition of curricula, courses and training sessions supporting the training [6].

4. References

[1] Recommendation of the European parliament and of the council of 18 June 2009 on the establishment of a European Credit System for Vocational Education and Training

[2] JRC Scientific and policy reports, IET-JRC, Mihail Ceclan, Cesar Chenel Ramos, Towards the implementation of the European Credit System for Vocational Education and Training (ECVET) in the nuclear energy sector, EU, 2013

[3] Methodology for Nuclear Qualifications Design, prepared for Workshop on Qualifications for Nuclear Decommissioning, Lisbon (Portugal) 6 – 9 October 2015, JRC_IET

[4] Using Learning outcomes, EQF series, Note 4

[5] Geographical Mobility in Vocational Education and Training: Guidelines for describing units of learning outcomes; www.ecvet-info.de

[6] GA 662125, CORONA II, Deliverables 3.1, 3.2 and 3.3.

[7] JRC Technical Reports, Second Workshop on Qualifications for Nuclear Decommissioning, Bergen, 24-28 October 2016

EDUCATION AND TRAINING OF WORKERS FOR DEVELOPMENT OF A SAFETY CULTURE IN A RADIOACTIVE FACILITY

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ABSTRACT

The analysis of radiological occurrence in the Centre of Isotopes (CENTIS) of the Republic of Cuba shows 54 % of registered events happen due to human fails during 1997-2015. Then this requires the promotion of safety culture and the systematic labor of education of staff with responsibilities for protection and safety is the key tool for this purpose. Since beginning, a conceived education system included three basic courses and taking into account the CENTIS' functions as importer, producer, carrier and exporter, are designed courses for all practices and technologic working means. In addition, it is executed every 2 years an updating activity. However, this last activity take place annually and maintain analysis of lesson learned from events, with the combined adoption of measures for avoid their repetition, contribute to increase the adoption of better attitudes for security. The trainers are three specialist of the Radiation Protection Department of this center that have between 10 and 22 years of experience in this plant, received the International Atomic Agency, and participate as teachers in initial courses in 1998 and in the updating courses. Following themes considered are state of the art for studies of biologic effects of ionizing radiations, new national regulations, and operational experiences and in the transport of radioactive materials and those obtained from radiological occurrence and the management of radioactive wastes. The preparation and execution of education should respond to results of assessment of safety culture in the facility for to be able to impact in the significant reduction of the negative paper of the human factor.

1. Introduction

The purpose of this paper is to share our experiences from the education and training system of a radioactive facility in Cuba (Centre of Isotopes (CENTIS)) which is focusing in development of safety culture.

The Culture is a combination of habits and knowledge. Among them, there are beliefs, values, and assumptions of the founders of an organization, learning experiences of group members as the organization evolves (Groups of people who have shared significant problems, solved them, observed the effects of their solutions, and who have taken in new members) and beliefs, values, and assumptions brought in by new members and leaders.

Safety Culture is "the assembly of characteristics and attitudes in the organizations, its managers and workers which assures that, as an overriding priority, safety issues receive the attention warranted by their significance". Safety is understood "as the protection of people and environment against the associated risks of ionizing radiation and also the radiological safety and the security of radiation sources", assuming that they are inextricably linked [1].

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Monitoring the safety culture through indicators identifies trends that are very beneficial for an early alert on potential or imminent deterioration of safety in the organization.

Education and training of staff is an internal action to promote safety culture in our organization itself.

2. Materials and Methods

Taking into account the Regulatory Body regulation and IAEA recommendations [2-3] is created and maintained an education and training system for the staff of CENTIS. The analysis of this for improvement is carrying out with safety performance indicators (SPI) and does not concern the method reported in [4].

3. Results

In the Table 1, show the list of courses executed in CENTIS. The CNSN recognized their competence and elaborated the respective certificates with permanent validity [5-6]. Two conferences on security of radioactive sources and security in the transport of radioactive material were 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, it is required a highest 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 five 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 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 highest value 98 man-mSv y^{-1} in 2011 due to the increment of ^{131}I activity.

Table 2 allows seeing the highest figure of S is 0.49 times lower than estimated annual collective dose [7]. This is caused by CENTIS yet does not reach to the maximum activity of the basis its design for ^{99}Mo and ^{32}P. The highest contribution to occupational exposure belongs to production of Technetium generators. 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) is adopted [8]. In 1996 and 1997 it is indicated as not controlled (NC) for Hp(3). The highest 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 E higher than the limit as average for 5 years [9]. The workload 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 highest value of Hp(0.07).

The Cuban Regulatory Body established its point of view on safety culture [10]. In that document appears 10 basic elements of the safety culture among them there are following culture on the continuous learning, report and communication on safety. With our education and training activities, allow to improve the conduct respect safety of the staff in CENTIS.

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

Number	Year	Course	Time (hours)	Amount of participants
15	2013	Workshop on Safety Culture and Good Practices	32	30
16	2014	Workshop on waste water management in the radiopharmaceuticals production	20	30
17	2015	Current in radiation safety aspects for workers (including them related with the transport of radioactive material)	60	30

Tab 1: CENTIS' radiation safety courses.

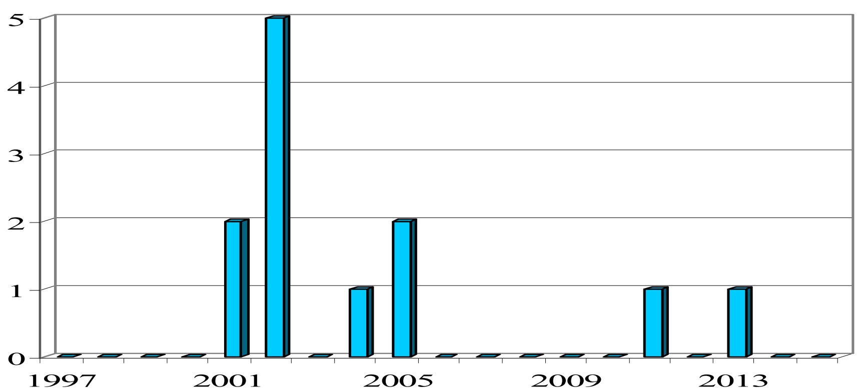

Fig 1: Amount of radiological incidents by year in CENTIS.

Year	Activity ^{131}I (Bq y^{-1})	Activity ^{99}Mo (Bq y^{-1})	Activity ^{32}P (Bq y^{-1})	S (Man Sv y^{-1})
1996	Not handled	3.20E+11	Not handled	0.025
1997	7.33E+11	5.92E+11		0.016
1998	4.90E+12	5.39E+11		0.039
1999	4.87E+12	6.60E+11	1.19E+10	0.030
2000	4.84E+12	5.35E+11	**3.64E+11**	0.054
2001	4.88E+12	1.38E+12	3.43E+11	0.036
2002	4.60E+12	1.59E+12	2.35E+11	0.063
2003	3.94E+12	1.49E+13	2.35E+11	0.075
2004	4.71E+12	2.73E+13	1.93E+11	0.026
2005	4.08E+12	2.77E+13	9.75E+10	0.035
2006	3.28E+12	2.29E+13	5.45E+10	0.022
2007	4.91E+12	2.52E+13	8.27E+10	0.017
2008	4.33E+12	2.32E+13	2.03E+11	0.018
2009	5.76E+12	4.01E+13	2.24E+11	0.042
2010	7.09E+12	3.19E+13	3.17E+11	0.055

2011	1.05E+13	3.19E+13	3.12E+11	0.098
2012	1.54E+13	**4.42E+14**	1.68E+11	0.095
2013	1.86E+13	6.79E+13	2.65E+11	0.077
2014	**2.13E+13**	6.77E+13	1.16E+11	0.047
2015	2.02E+13	1.19E+14	1.58E+11	0.057

Tab 2: Annual activities of the main radionuclides and collective doses (S).

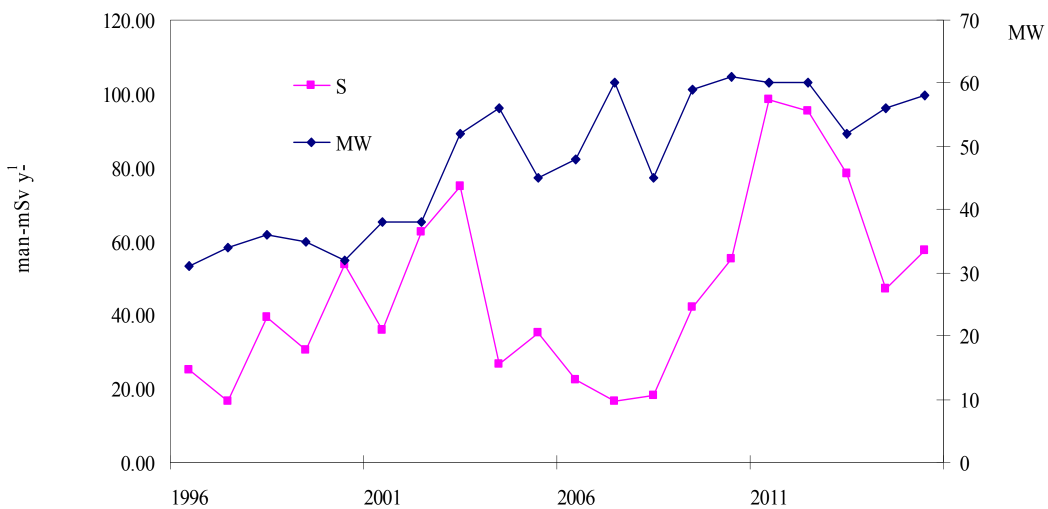

Fig 2: Collective doses and annual monitored workers.

	E (mSv)	Hp(0.07) (mSv)	Hp(3) (mSv)
Dose constrains	12	200	15
1996	4.73	8.15	NC
1997	4.02	8.56	NC
1998	10.27	17.85	2.60
1999	4.85	49.38	4.38
2000	**25.77**	65.43	1.27
2001	3.22	117.97	1.90
2002	7.06	97.94	8.47
2003	5.89	91.47	**12.09**
2004	4.17	73.41	5.14
2005	6.52	145.17	5.89
2006	6.09	**232.71**	3.49
2007	2.96	117.70	3.86

2008	4.28	168.38	2.18
2009	5.32	172.49	4.85
2010	5.14	60.68	3.85
2011	9.13	194.60	12.05
2012	12.56	116.59	9.95
2013	13.23	159.23	7.49
2014	5.46	97.00	6.95
2015	6.68	125.14	8.75

Tab 4: Maximum values of dosimetric magnitudes and relationship with the dose constrain.

4. Conclusions

The education and training system described in this paper allows maintaining the preparation of the staff in radiation safety in accordance with its safety function and the Regulatory Body in Cuba certified it. Assessment of the efficiency and effectiveness of education activities requires analyzing the behaviour of SPI related with occupational exposure and radiological events.

The objective focusing in a safety culture is permanent in our organization since this is a lingering process.

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. The education and training system is a tool for the achievement of safety culture in the organization and accomplishment and maintaining of the ALARA principle in the diary labor of CENTIS. Culture on the continuous learning, report and communication on safety are continuously improved.

5. References

[1] Association of Nuclear and Radiological Regulators FORO, Project on Safety Culture in organizations, facilities and activities with sources of ionizing radiation, Vienna (2014).

[2] Ministry of Science, Technology and Environment, Regulations for the Selection, Education y Authorization of the Staff Involved in the Practices of Using Radioactive Ionizations, Havana (2003).

[3] International Atomic Energy Agency, Building Competence in Radiation Protection and the Safe Use of Radiation Sources, Safety Guide, No. RS-G-1.4, IAEA, Vienna (2001).

[4] International Atomic Energy Agency, Mean of Evaluating and Improving the Effectiveness of Training Nuclear Power Plant Personnel, IAEA-TECDOC-1358, IAEA, Vienna (2003).

[5] National Centre of Nuclear Safety, Certificate for Recognizing of Competences for: Courses 'Radiation safety for Staff with Safety and Protection Responsibilities in CENTIS', 'Basic Course of Radiation Protection for Workers in CENTIS', 'Elements of Radiation Protection' and 'Current in Radiation safety Aspects in CENTIS', CH25-S6(002)07, Havana, Cuba (2007).

[6] National Centre of Nuclear Safety, Certificate for Recognizing of Competences for: 'Course of Radiation safety for the Transport of Radioactive Material' and 'Current in Radiation safety Aspects in CENTIS for the Staff Related with the Transport of Radioactive Material, CH25-S6(004)07, Havana, Cuba (2007).

[7] Perez S., Gatti A.M., Reyes R., Radiation safety and Protection in the Design of the Centre of Isotopes for the Production of Radiopharmaceuticals an Labelled Compounds in Cuba, Nucleus No. 24, p.36-44, Havana, Cuba (1998).

[8] http://radioproteccionsar.org.ar/downloads/traduccion-articulo-icrp.pdf, International Commission of Radiation Protection, Declaration on Tissues Reactions (approved by the Commission in 21th of April 2011), CIPR ref. 4825-3093-1464, authorized translated by CIPR to Society of Radiation Protection of Argentina.

[9] European Commission, Food and Agriculture Organization of The United Nations, International Atomic Energy Agency, International Labour Organization, OECD Nuclear Energy Agency, Pan American Health Organization, United Nations Environment Programme, World Health Organization, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3, IAEA Safety Standards Series No. GSR Part 3, Vienna (2014).

[10] National Centre of Nuclear Safety, Regulatory Body´s Points of View on Nuclear Safety in the Organizations which Making Activities with Ionizing Radiations Sources, Resolution No.3, Havana (2015).

MALAYSIA STRATEGY TOWARDS ESTABLISHING NATIONAL POLICY FOR E&T IN RADIATION, TRANSPORT AND WASTE SAFETY

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ABSTRACT

The usage of ionising radiation in Malaysia encompasses of diverse usage such as medical, industry, agriculture, research and others for national well-being. Education and training in Radiation, Transport and Waste Safety is a vital component to maintain sustainability and to ensure the safety of radiation workers, members of the public and the environment from radiation hazards.This paper present the initiatives taken for the establishment of the nuclear education & training strategy and policy in Malaysia. It analyzed current status of Human Resource Development (HRD) and nuclear education and training framework of Malaysia and conducting TNA (Training Need Analysis) and benchmarking exercises. The features of the current nuclear education & training in Malaysia are independent, dispersed and unintegrated within stakeholders. Linkages and cooperation systematically integrated between institutions are not visible. As a result, duplicated programs and resource allocation, and inefficiency have been identified. Therefore, this paper proposed the national nuclear education & training system model as a policy initiatives and establishment of national steeering committee to oversees that manages and centralise overall nuclear education & training.

1. Introduction

IAEA has introduces the concept of a national strategy for building competence in protection and safety in Member States in order to address educational and training needs in the field of radiation protection and the safety of radiation sources in IAEA Strategic Approach to Education and Training in Radiation, Transport and Waste Safety, 2011–2020.[1].

In line with IAEA statute and commitment as Member States, Malaysia has taken steps towards building competences and establishing strategy for education and training RTWS. The introduction of the Atomic Energy Licensing Act, followed by the establishment of the Atomic Energy Licensing Board (AELB) in 1984 were serious initiatives taken by the Malaysian Government to regulate, safeguard and monitor the ionizing radiation activities in Malaysia. In addition, AELB is to complement the functions of Malaysian Nuclear Agency (Nuclear Malaysia) that focuses on the application and promoting the peaceful uses of nuclear and related technologies for national development. Its follows with steps of participating in EDUTA mission in 2005 and 2015 and ETRES mission in 2014. Nuclear Malaysia has been running a very detailed and comprehensive annual programme for education and training in radiation protection in collaboration with AELB and other relevant institutions. A formal national strategy for building competence in radiation protection has not been formally finalised. However, some elements of this strategy are believed to be available, e.g. a well-designed annual training programme with a realistic time frame has been developed and it has been successfully implemented.[1].

The overall aim of establishing the strategy is to develop a human capital development programme required to sustain an adequate level of national capability and competency on RTWS for sustainable development and societal wellbeing.

2. Current Status of E&T in RTWS in Malaysia

Nuclear Malaysia has been providing training courses on radiological protection for more than 30 years and has extensive experience in the development of training materials. A wide range of training courses in radiological protection are currently provided by training organizations, both nationally and internationally, and significant effort has been devoted in determining appropriate levels of training, methods of training provision, course content and training infrastructure. The occupational level training courses currently vary from one-day courses for operators of straightforward equipment such as X-ray baggage inspection cabinets, to week-long courses for radiation protection supervisors in a wide range of practices. The number of participants increases each year, and in 2016 around 2845 participants from several sectors, i.e. Radiation Safety and Health (64.5%), Medical X-ray (16.5%), NDT (10.1%) and Environmental Safety and Health (8.9%) were trained [2]. Through this courses, radiation workers will able to understand and apply the concept of radiation protection at workplace. This will certainly benefit an organization with ultimate goals of continuously striving for a healthy, accident-free and environmentally sound workplace and community, while providing the technical support needed to meet the national mission. Beside Nuclear Malaysia, there is 7 other training centre accredited by regulators to conduct training in radiation protection [3].

Since 1970s, there are nuclear-related subjects being taught at local universities . Table 1 show that eight universities conduct programmes related to non-power applications of nuclear science and technology; four of them offer such programmes at postgraduate level.

These are results of progress and development in the non-power sector of the application of nuclear science and technology in the country. As can be seen, the courses are largely concentrated in the medical applications, which is consistent with the growing number of nuclear medicine centers in the country.

INSTITUTES	LEVEL OF STUDY	PROGRAMME
UKM	Undergraduate	Bachelor in Nuclear Science
	Postgraduate	Diagnostic Imaging and Radiotherapy Master of Medicine (Radiology) Master of Science (Radiation Safety)
	Postgraduate	Master of Science (Safety, Security and Safeguard)*
UM	Undergraduate	Bachelor of Biomedical Technology (Nuclear Medicine)
	Postgraduate	Master in Medical Physics (coursework)
USM	Undergraduate	Bachelor of Applied Science in Medical Physic Bachelor in Medical Radiation
	Postgraduate	Master of Science in Medical Physic (coursework) Master of Medicine (Radiology)
UPM	Undergraduate	Bachelor in Applied Radiation (research subject in Radiation Synthesis and Medical Physics)
UTM	Undergraduate	Bachelor in Health Physics Bachelor in Nuclear and Energy Engineering
UiTM	Undergraduate	Bachelor in Basic Nuclear Technology and Application of Radioisotope and Radiation (major subject in 3th year)
UNITEN	Undergraduate	Bachelor in Mechanical Engineering with elective courses (i) Introduction to Nuclear Engineering, (ii) Radiation Detection and Nuclear Instrumentation, (iii) Introduction to Reactor Physics, (iv) Reactor Thermal-hydraulics, (v) Radiation Safety and Nuclear Waste Management, and (vi) Nuclear Policy, Security and Safeguard
UNIMAS	Postgraduate	Condition Monitoring and Non-Destructive Testing (PhD)

Table 1: University Offering Nuclear Related Courses

Since 1980s, nuclear education outreach for secondary schools was successfully implemented in Malaysia. The programme is well collaborated between Malaysian Nuclear Agency (Nuclear Malaysia), Ministry of Education (MOE) and Ministry of Science, Technology and Innovation (MOSTI). The nuclear education outreach are known as Nuclear Science and Technology (NST) Talk and Exhibition for Secondary Schools, Nuclear Camp *Veni Vidi Vici* and Scientist Icon Roadshow and IAEA Technical Cooperation Program in Compendium of NST for Secondary Schools Pilot Programme [4]. By participating in this programme, Malaysia has enriched the new method in outreach activities so that the students become more engaging with science. Besides all the programmes mentioned, Nuclear Malaysia has also organised few programmes which indirectly promoting NST to students; nuclear facilities visit, public exhibitions and nuclear talk.

2.1 Policy Framework

The legal and regulatory framework for atomic energy in Malaysia is provided through the Act 304, which provides for the regulation and control of atomic energy, for the establishment of standards on liability for nuclear damage and for matters connected therewith or related thereto. The regulatory body, Atomic Energy Licensing Board (AELB) within the Ministry of Science, Technology and Innovation (MOSTI), is responsible for regulation in the area of radiation and nuclear safety, nuclear security, safeguards and liability except for medical applications which are regulated by the Ministry of Health on behalf of AELB.

Requirements and provisions are established calling for all persons associated with work with ionizing radiation to be suitably trained and qualified. Sub-Regulations 15(8), of the Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010 require that *"the licensee or the employer to provide appropriate training, retraining and facilities for updating the skills and knowledge of their workers"*.[5] The regulatory body has established guidance specifying which persons should have particular qualifications and the process to be employed for the recognition of such qualifications. Such requirements and guidance are enforced by the regulatory body.

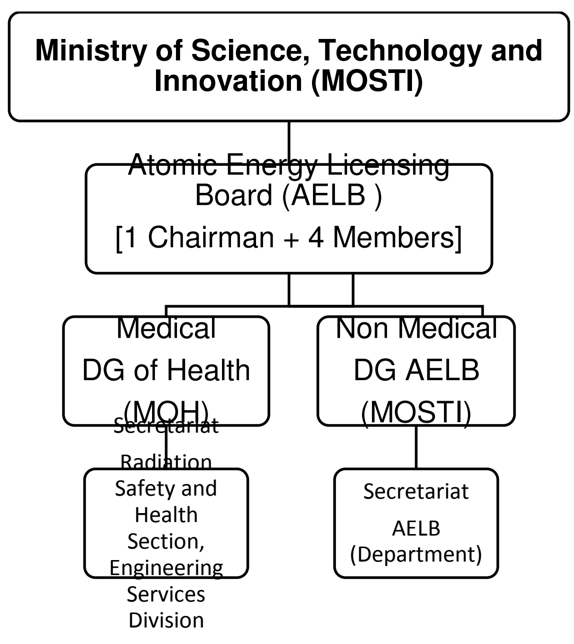

Fig 1: Regulatory Function

2.2 Nuclear Infrastructure and Stakeholders

For a successful education and training strategy, all relevant stakeholders must be identified and involved. Stakeholders' identified are regulatory body, research agency, utilities, education institution i.e. universities and training center, certification body and scientific/professional organization and government. However, needs of leading organization to spearhead and coordinate the strategy is very importance.

The establishment of a national nuclear research institute in 1972, now known as the Malaysian Nuclear Agency, catalyzed the development of nuclear science and technology in Malaysia. The institute was set-up as a research and training facility to develop the manpower and technical capability for the introduction of nuclear power program in Malaysia. A 1 megawatt thermal nuclear research reactor was built and commissioned in 1984. However the discovery of oil fields and subsequent development of petroleum industry in Malaysia in the middle of 1980s set the program back. The diversity of nuclear science and technology enables the institute to instead focus in its non-power applications. Currently, Nuclear Malaysia has a total of 815 personnel, of which 313 are researchers having tertiary degrees. The figure comprises of 64 with PhD and 90 with Master Degree (MSc) representing 21% and 27% respectively. The remaining 159 personnel with bachelor's degree (BSc) qualification are mainly the newly recruited personnel [6]. Hence, Nuclear Malaysia involvement in setting up the E&T landscape in Malaysia are undeniable.

The administrative infrastructure for further growth of the technology in Malaysia was completed with the setting-up of the Atomic Energy Licensing Board (AELB) in 1985. The board is the regulatory agency that implements the Atomic Energy Licensing Act which was enacted in late 1984.

For nuclear safety training, stakeholders identified includes Malaysia Nuclear Power Corporation (MNPC) and Tenaga Nasional Berhad (TNB). On January 2011, (MNPC) in its capacity as the country's Nuclear Energy Program Implementing Organization (NEPIO) was established to spearhead Malaysia's nuclear power program. The government is studying the possibility of deploying nuclear energy to meet future demand and diversify the energy mix for Peninsular Malaysia

TNB is the largest electricity utility in Malaysia with RM117.1 billion in assets and capital expenditure of RM10.8 billion in power plants and system improvements [6]. Its core businesses are generation, transmission and distribution of electricity throughout Peninsular Malaysia, the state of Sabah and the Federal Territory of Labuan. TNB owns and operates a total 10,818 MW of installed capacity comprising of thermal generation facilities and major hydro-generation schemes in Peninsular Malaysia. Other TNB businesses include operation and maintenance services, manufacturing of electrical equipment such as switchgears, transformers and cables, and higher education and research services. TNB employs approximately 36,000 staff group-wide to serve an estimated 8.9 million customers nationwide [7]. TNB also owns its education and training infrastructures which is ILSAS and UNITEN.

3. Strategy Initiatives for Building Competence in RTWS

3.1 Dissemination of Information

The first action taken by Malaysia Nuclear Agency is to conduct Special Meeting & Briefing on the Establishment of Steering Committee for the Preparation of National Strategy on Education and Training in Radiation, Waste and Transport Safety. This meeting was conduct in 2013 at Nuclear Malaysia with targets to disseminate information to stakeholders, gained support and established linkage.

Stakeholders invited were Atomic Energy Licensing Board Ministry of Health, Ministry Of Education, USM and UKM. Mr John S. Wheatley, Head, Technical Assistance and Information

Management Unit, IAEA Division of Radiation, Transport & Waste Safety was invited to conduct the briefing.

However, the commitment from the stakeholders to the next steps was very slow due to issue of responsible lead agency, source of mandate and availability of current committee for RPO certification (JKPPPS).

3.2 Commitment and Support from Stakeholders

In 2015, IAEA has conducted Regional Workshop addressing on Establishing National Policy in Education and Training at Kuala Lumpur Malaysia. This workshop has trigger the importance of needs assessment and national strategy by sharing other countries experience. Therefore Nuclear Malaysia has taken the initiatives to lead the interim committee and conduct national workshop.

The workshop has been conducted on 19-21 October 2015 with attendance of several key person from regulatory body, certification body and public university. Participants conduct needs assessments about the capacity, skills and responsibilities of regulators and radiation workers in RTWS. Acquisition of information on facilities and activities related to RTWS was available from regulatory body database. Analysis on education and training requirements specified in the legal and regulatory framework and defining the skills and levels of education and training required for RTWS stake holders was carried during the workshop. Information necessary for the analysis of training needs including feedback on implementation is described in the Safety Guide on Building Competence in Radiation Protection and the Safe Use of Radiation Sources (RS.G-1.4) para [4.11]. However, without information sharing within stakeholders, the task will be not accomplished as the data is confidential and only can be access by subjected officer.

From the TNA results, there has been a significant increase in the industrial applications of radiation sources in Malaysia. In 2015 there were about 4444 workplaces involved with ionizing radiation from 3 categories of job activities, namely medical, industrial and non-destructive testing, NDT. As results, the number of workers in this field is steadily increasing, with around 18,820 radiation workers in 2008 and 21,113 in 2015. Approximately 40.9% of the total workers are from the industrial, 52% from medical and 7.1% from NDT sectors. Below is the latest data of number of radiation facilities and radiation workers in Malaysia.

NO	TYPE OF CERTIFICATION	TOTAL
1	Radiation Protection Officer	1043
2	Supervisor	635
3	Workers	16335
4	Trainee	465
5	Radiation Protection Consultant	511
6	Qualified Expert	10
	TOTAL	**21,113**

Table 2. No. of Radiation Workers in Malaysia

PRACTICES USING RADIATION SOURCES	NUMBER OF FACILITIES		
	EXISTING	FORESEEN (< 5YRS)	TOTAL
Industrial Radiography	83	15	98
Irradiating Facilities including Research Reactor	5	1	6
Gauging	778	60	838
R&D	46	5	51
Mineral	23	5	28
Nuclear Medicine	30	8	38

Radiotherapy	34	9	43
Dental	1598	400	1998
Radiology	1851	463	2314
Veterinary	82	21	103
Laboratory	2	1	3
TOTAL	**4444**	**988**	**5520**

Table 3. License Radiation Application in Malaysia

Source: AELB Database until October 2015

3.3 Policy Suggestion

Draft of the policy/strategy has been prepared during the National Workshop on 19-21 October 2015. Strengthening collaborations among the stakeholders and establishing working committee to support the steering committee were taken to formalise the national strategy. Commitment and support from relevant authorities to establish the policy/strategy to formalize/endorse the related documents were needed. Members of the WG including all stakeholders i.e Atomic Energy Licensing Board (AELB), Ministry of Health, Department of Skill, USM and Nuclear Malaysia. The visions of the policy are transforming education and training in radiation, transport and waste safety (RTWS) for national well-being and sustainable development. The strategies includes Development of a National RTWS Education and Training Programme, Continuous Training Programme, Development of a National RTWS Competency and Certification Scheme and Development of Educational Institution. The policy also suggested for establishing a network of training provider for coordinated and integrated nuclear education and training programme. The policy still under review before submitting to the relevant authorities for endorsement.

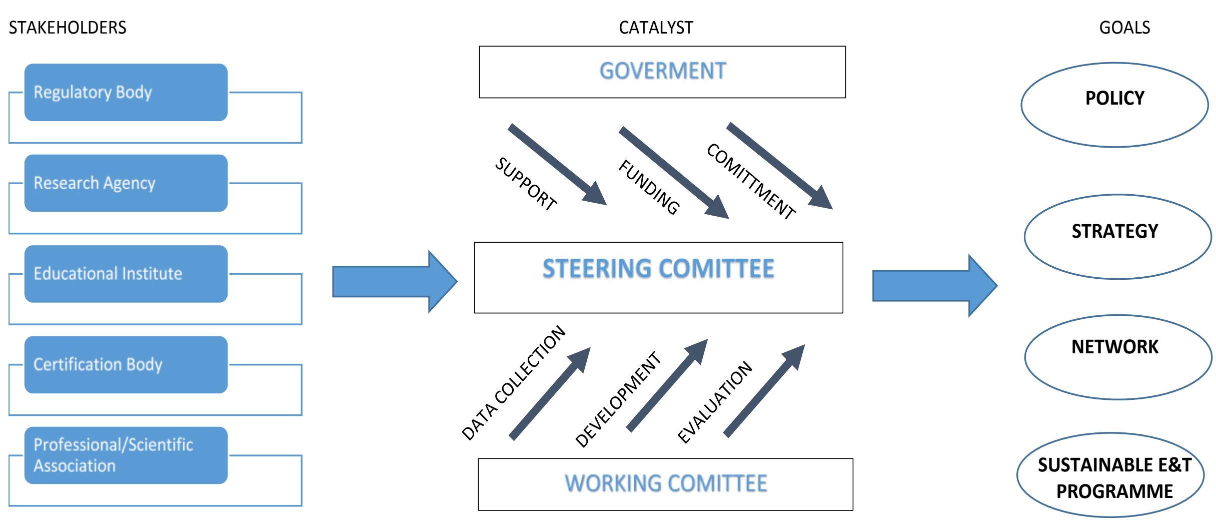

Figure 2: Strategy Model for Establishing National Policy

4. Conclusion

Comprehensive and integrated planning and implementation to develop national strategy on E&T in RTWS shall involve all relevant stakeholders within the HRD framework of Malaysia (industry, educational institutions, etc.). Cooperative partnership and collaborative efforts can assist in strengthening the national E&T programme on RTWS and must be expanded beyond borders to enable sharing of expertise and experiences for a better and balanced global development. The needs of formalized E&T policy/strategy deem fits to Malaysia E&T objectives for sustainable societal well-being.

Having discussed about the status of nuclear education and training in Malaysia, it is concluded that Nuclear education and training in Malaysia has contributed importantly to the country's self-reliance on nuclear technology for peaceful use; it is expected to take a more innovative role to meet the need of attracting young scientists to the nuclear field, preserving nuclear knowledge as well as advanced nuclear energy technology development. The community of nuclear education and training in Malaysia is making an extensive efforts to strengthen its capability at national level including established linkage, networking and sharing information and resources.

5. References

INTERNATIONAL ATOMIC ENERGY AGENCY, Building Competence in Radiation Protection and the Safe Use of Radiation Sources, IAEA Safety Standards Series No. RS-G-1.4, IAEA, Vienna (2001)

EDUCATION AND TRAINING APPRAISAL MISSION IN MALAYSIA REPORT, 26-30 September 2011.

List of Agencies Accredited by AELB - Consultant Radiation Protection (JPS), Leak Test and Training Agency, 2017.

FNCA Workshop on Human Resources Development, Country Reports 2016

INTERNATIONAL ATOMIC ENERGY AGENCY, Regulatory Authority Information System — RAIS, (2014), http://www-ns.iaea.org/tech-areas/regulatoryinfrastructure/rais.asp

Tenaga Nasional Berhad, Annual Report 2015 (TNB, Kuala Lumpur, 2015).

COURSE ON “RADIATION PROTECTION EXPERT. CONVERGENCE TOWARDS THE EUROPEAN STANDARD

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ABSTRACT

The revision of the basic safety standards of EURATOM has tried to homogenize the figure of the Radiation Protection Expert (RPE) all around Europe. Although the Directive transposition is scheduled for 2018, measures are being taken in favor of the implementation of new education and training requirements for RP experts, with the funding of projects such as ENETRAP.

CIEMAT has participated in these projects from the beginning (2005) up to now; and since the eighties is the Spanish organization that traditionally delivers this training course as part of the main education and training programs. In this context, the Course of “Radiation Protection Expert” is updated, following the ENETRAP RPE scheme, ensuring compliance with all the criteria established by the Spanish Nuclear Regulatory Body (CSN) and introducing the new educational trends demanded by society.

This paper presents the new course format and the results of the first editions. Now it is a blended learning course (on-line & face to face) structured into five modules, three of them correspond to a mandatory common part, and the other two are part of the speciality. One of them, Research Laboratories and Medical Facilities or Nuclear Facilities and of Nuclear Fuel Cycle is mandatory. It also includes the completion of an end-of-course project.

The educational tools kit for the first modules has been prepared in multimedia format, to be managed in an educational platform. This phase lasts three months. In this phase of learning, the contents are organized in didactic units of one or two weeks and all the multimedia material has been developed by experts in these subjects and includes interactive theoretical content, exercises, animations, videos, etc.

The face-to-face classroom part lasts one month and a half and includes the practical sessions and discussion and calculation seminars belonging to the first two modules, as well as part of module III, and all modules IV & V. This phase is developed on daily sessions, which are taught in CIEMAT and other facilities by collaborating entities.

Finally, we have been working on improving the teaching methodology, developing methodological guides to harmonize and support the tasks of the teachers involved with the objective to achieve greater dynamism improving learning efficiency.

This new version of the Course “Radiation Protection Expert” is the result of the natural evolution of any training action driven by the current educational, social and technological situation: adaptation and modernization.

It aims to further evolve into the Common European Training Space without forgetting compliance with the requirements and conditions stablished and enforced of the CSN.

1. Introduction.

The revision of the basic safety standards of EURATOM has tried to homogenize the figure of the Radiation Protection Expert (RPE) all around Europe. Although the Directive transposition is scheduled for 2018, measures are being taken in favor of the implementation of new education and training requirements for RP experts, with the funding of projects such as ENETRAP (European Network on Education and Training in Radiological Protection) (6PM and 7PM).

CIEMAT has participated in these projects since the beginning (2005) up to now; and since the eighties is the Spanish organization that traditionally delivers this training course as part of the main education and training programs.

In Spain, the figure of the Radiation Protection Expert (EPR) is defined in the technical instruction IS-03 of the CSN. This document establishes the requirements to be able to obtain the qualification and to be recognized as EPR; To do this, the applicant must have a university degree, pass a 300-hour training course, 3 years of experience in the field of radiation protection (six months in the case of RX facilities for diagnostic purposes) and certified medical fitness.

In this context, the Course of "**Radiation Protection Expert**" is updated, following the ENETRAP RPE scheme, ensuring compliance with all the criteria established by the Spanish Nuclear Regulatory Body (CSN) and introducing the new educational trends demanded by society.

This paper presents the new course format and the results of the first editions.

2. Innovations performed.

Taking into account that educational and training needs are changing and that the society demands a different structure, from the beginning CIEMAT Training Unit proposed a type of course completely renovated but maintaining the technical contents that characterize it. The first part of the renovation took place in the first edition of the course during 2014-2015 and the second part in the 2016 edition, where some improvements were introduced that were planned as secondary but also necessary and important. These are:

2.1. - Modulation of the program.

The course has been modulated according to the ENETRAPII scheme for RPE (Radiation Protection Expert), common practice in the new training plans of masters. It has been structured into five modules: three of them correspond to a mandatory common part (Basic Concepts, Fundamentals of Radiation Protection and Operational Radiation Protection), and the other two are part of the speciality. One of them, Research Laboratories and Medical Facilities or Nuclear Facilities and of Nuclear Fuel Cycle is mandatory. It also include the completion of an end-of-course project.

This design of modular system would allow to including, in future editions, up to three more optional modules. This, together with the completion of an end-of-course project to be developed in a job, would make it possible, in the future, to turn the course into a master's degree if this were of interest.

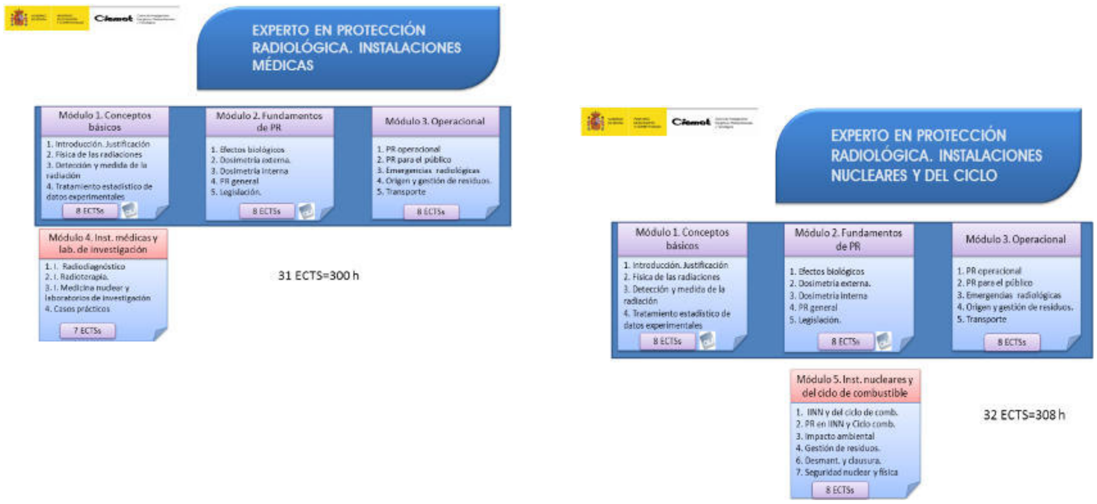

Fig. 1. Modules of the course

2.2. - Methodological changes

Perhaps the most relevant change in Education and Training in this century has been the incorporation of new teaching methodologies, not only consolidation of information and communication technologies (ICTs) but also the way of student-teacher relationship. The introduction of these tools mainly affects (although we try to spread them to the whole course) to the phase of online study that has had a great importance in this phase and is in which more changes and improvements have been introduced.

Since its first edition, the course has been developed by implementing a "blended learning" methodology, that is, the combination of face-to-face and on line learning. The chosen learning methodology efficiently combines different teaching methods, teaching models and learning styles, based on a transparent communication of all the areas involved in the course. The didactic resources used are alternated in a balanced way, using tools based on technology - appropriate for a more individualized learning - combined, in the same format with the more traditional version, the master class. This basic format of presentation of the information is powered by face-to-face, theoretical and practical sessions and group work dynamics (round tables, seminars, group work in the resolution of practical cases or in the elaboration of end of course projects), that help to the understanding, recovering gaps and misconceptions, and finally, to a deeper consolidation and fixation of learning. Thus, a methodology that uses all the available tools to achieve a dynamic, participative and effective teaching, reaching the proposed objectives.

The implementation of this blended learning modality has allowed us to save time moving from a three-month stay in Madrid, expensive in time and money for students and also for companies and institutions, to a five weeks face-to-face, plus three months online, of course with all available resources made available to the participants through our internet platform "Virtual Classroom".

The improvements have been:

- Development of methodological guides to unify and support the tasks of the teachers involved (authors, online tutors and face-to-face teachers) with the aim of achieving greater dynamism that results in the efficiency of learning.

Fig. 2. Different teaching guides

- Incorporation of tutors. Each module is structured in different teaching units coinciding with specific themes. Each unit has a virtual tutor to support students. Among its activities have been: attention to students and resolution of doubts concerning the content of that unit; the proposal of exercises to be solved and their monitoring and evaluation; the proposal of innovative actions that help the understanding of the contents by other non-standard ways, different from the traditional exercises.
- Change in the evaluation system, introducing online exams, practical cases, exercises, etc.

3. - Results

The new format of the Radiation Protection Expert course is based on a blended learning methodology (on-line & face to face course) and it has a teaching load equivalent to 465 hours summarized:

- ✓ 365h general part (258h online and 107h face-to-face) and
- ✓ 100h per specialty (70h face-to-face and 30h End-of-Course Project)

Structuring the course modularly has allowed us to identify those modules that can be carried out at a distance, due to its more general or easier to study theme through this system, and to bet on the face-to-face methodology for those modules in which the subject is more experimental, operational or must be updated annually.

- **On line part**

Educational tools kit for the first modules has been prepared in multimedia format, to be managed in an educational platform. This phase lasts three months. In this phase of learning, the contents are organized in didactic units of one or two weeks and all the multimedia material have been developed by experts in these subjects and include interactive theoretical content, exercises, animations, videos, etc.

Each module consists of:

- Program of the module. Document in html in which the teaching team (teachers and coordinators) makes a recommendation on the study of the corresponding module and that includes the start and end dates of all the activities of the module.
- Online content multimedia interactive, self-learning, including theoretical explanations, flash animations of the most and less complex physical phenomena, self-evaluation exercises, graphics, drawings, videos…
- Complementary material, formed in all cases by a manual in pdf (practical cases, examples, videos, legislation....)
- Mandatory exercises. In all modules there is at least one compulsory exercise proposed by the corresponding teaching staff, which must be delivered and evaluated within the duration of the module.
- Forums of contents where students can ask any questions related which must be answered within a maximum of 24 hours by the teacher or can even be answered by other students. This forum can also be used for discussions on topics proposed by the teacher or open debates to resolve the proposed exercises.
- Evaluation. The evaluations consist of 10 test questions to answer in 30 minutes. Students are allowed to make a maximum of two evaluations being assigned the best note of the two trials.

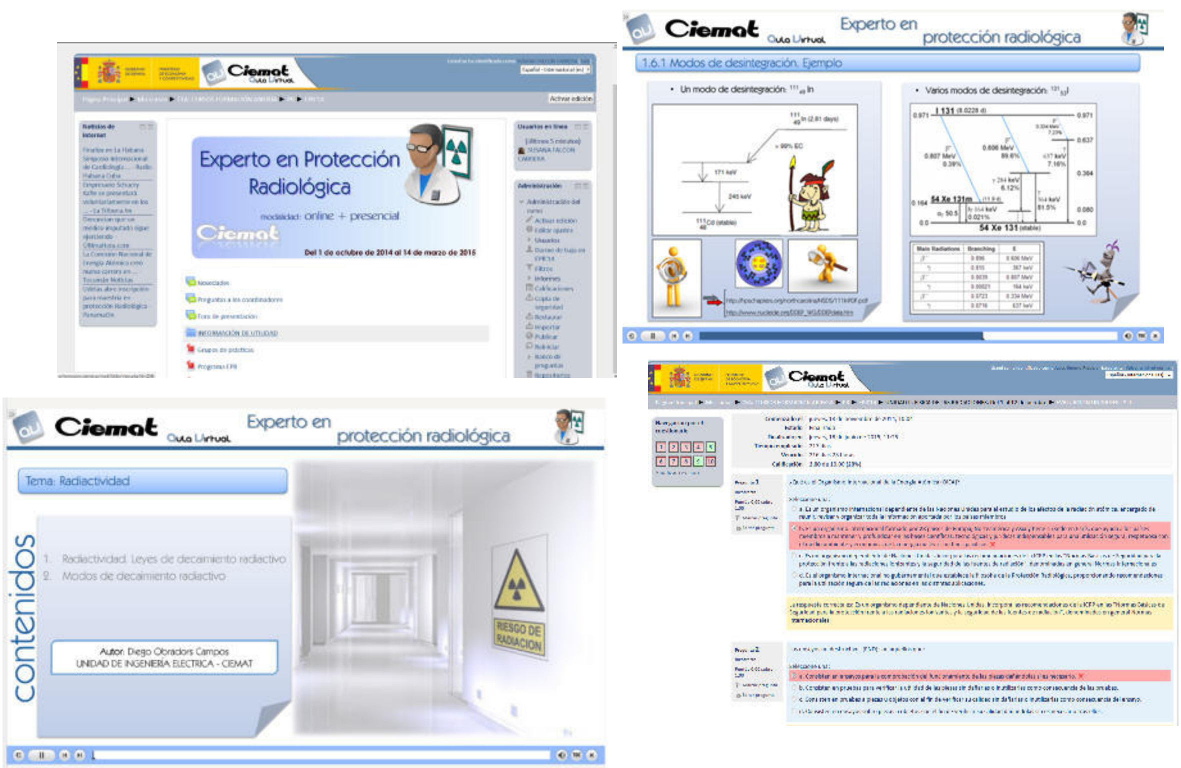

Fig. 3. Multimedia material through the Virtual Classroom

- **The face-to-face classroom part** lasts one month and a half and includes the practical sessions and discussion and calculation seminars belonging to the first two modules, as well as part of module III, and all modules IV & V. This phase is developed on daily sessions, which are taught in CIEMAT and other facilities by collaborating entities.

The material provided to the students follows the online material and consists of written documentation of each of the topics and practices as well as the presentations of the teachers. The virtual space in which the online part is developed, also serves as support for the face-to-face part, providing support for didactic materials in digital format, use of forums for questions, debates, news, and valuation surveys.

- **Evaluation system**

The evaluation of the course is carried out through elements on both parts:

- **On line part:**

1. Online content and records on the platform. The platform records all the actions, as well as the time dedicated to each of them. It produces complete reports of dedication. It is mandatory to visualize all multimedia content (SCORM) to pass the modules
2. Activities proposed by teachers, personal or group, compulsory or optional, in order to assist in the learning process. These activities are an integral part of the assessment of learning, accounting for 40% of the module score.
3. Student-tutor communication. The student-tutor communication, through forum, mail, etc., provides an indicator of the progress of the learning process. Participation in the forums is a very positive element in the final assessment.
4. Questionnaires. The student must pass the assessments of all the modules. The minimum mark is five on all questionnaires. There are two attempts for each questionnaire. The higher of the two attempts is maintained. This represents 60% of the final mark.

The students must surpass 90% of the online content in order to attend the face-to-face part of the course.

- **Face to face part:**

5. Face-to-face classes and practices. They are surpassed attending them and they are registered by means of signature control, being necessary a minimum attendance of 90%.
6. Face-to-face assessments. There are two face-to-face evaluations for the common modules and one more evaluation for each of the specialty modules. The specific weight of each evaluation in the final grade is 35% each one of the common modules and 30% the evaluation of the specialty.
7. End of course project. A project must be completed at the end of each specialty.

4. - Conclusions

This new version of the Course “Radiation Protection Expert” is the result of the natural evolution of any training action driven by the current educational, social and technological situation: adaptation and modernization.

It aims to further evolve into the Common European Training Space without forgetting compliance with the requirements and conditions stablished and enforced of the CSN.

The choice of a blended learning format for this course (on line & face to face) it has been successfully proven with a good reception by the students and their results comparable to those of previous editions.

This course is constantly updated so that, without losing sight of the high quality standards achieved, it adapts to current national and international requirements.

In this two editions, CIEMAT has continued the efforts begun in previous years to improve the initial project, following the ENETRAP RPE scheme, changing the learning format, reviewing the contents, both offered on-line and in face-to-face mode, consolidating both parts in a more inclusive course format, avoiding redundancies and investing in improving the pedagogical and methodological skills of our teachers, with special emphasis on the most complex subjects. In order to achieve this, reinforcement materials have been developed in a digital format that is more accessible to the participants, familiar with new technologies, and guides have been edited for classroom teachers and on-line tutors to help them to stimulate the learning of the student. The system for assessing students' knowledge has also been revised and updated.

Finally, it has been tried to guarantee a friendlier environment of the course in which its own development, relation with the tutors and other participants as well as the resolution of exercises and problems act in themselves as catalysts of the motivation to obtain a calmer learning, being more efficient at the same time.

5. - References.

1.- Falcón S, Fernández J, Llorente C, Marco M. Aplicación del esquema europeo de Formación al EPR.1er curso de Experto en Protección Radiológica. SNE, 2015

2. - Llorente C, Falcón S, Fernández J, Marco M. Spanish course for the radiation protection expert. A new approach in the methodology. EUTERP, Grecia, 2015.

3.- Falcón S, Fernández J, Llorente C, Marco M. Curso de Experto en Protección Radiológica. Esquema europeo de Formación del EPR. SEPR, Valencia 2015.

ARRANGEMENTS FOR EDUCATION AND TRAINING WITHIN THE FRAMEWORK OF THE 2013/59/EURATOM DIRECTIVE TRANSPOSITION IN GREEK LEGISLATION.

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ABSTRACT

Greek Atomic Energy Commission (EEAE), as the competent authority in aspects related to radiation protection, nuclear safety and security, has the main responsibility for the transposition of the Council Directive 2013/59/EURATOM in the national legislation. Based on the Directive's provisions concerning education and training, its main goal is to further strengthen their role within the national radiation protection system, ensuring that all the personnel dealing with ionizing radiation or having functions related to radiation safety are adequately qualified and competent.

This work emphasizes on education and training as well as refreshment training requirements for the Radiation Protection Experts (RPEs) and Radiation Protection Officers (RPOs), in order to fulfill their role and duties. Moreover, it presents challenges faced during the transposition of the Directive, such as the establishment of an appropriate recognition procedure with the consensus of the relevant stakeholders. To deal with these challenges, the policy, the strategy and the goals of EEAE, the related recommendations of the IRRS and EduTA missions in Greece, the operational experience from the implementation of the current regulatory framework as well as the common approaches among the EU member states were taken into account.

As concluded, a strategic plan at national level, based on the graded approach, is considered to be an efficient and effective way to deal with the educational and training needs of RPEs and RPOs. The implementation of this plan is also presented in this work.

Keywords: Education and Training, RPE, RPO

Introduction

The Greek Atomic Energy Commission (EEAE) is the national regulatory authority, competent for the control, regulation and supervision in the fields of nuclear energy, nuclear technology, radiological and nuclear safety, and radiation protection. In this respect, EEAE attaches great importance to its educational and training activities, showing a strong commitment to building competence on radiation protection which is acknowledged internationally. Additionally, it places a great effort to the provision of regular education, training and retraining courses and knowledge dissemination to occupationally exposed workers, in order to ensuring their competence in radiation protection. This effort is further strengthened by the established national education and training (E&T) strategy which is based on the IAEA suggested methodology and the implemented quality management system for E&T in accordance to ISO 29990:2010 (Learning Services for Non-Formal Education and Training [1, 2].

The current national regulatory framework for E&T is based on the following legislative documents:

a) The radiation protection regulations [3] according to which EEAE is authorized, among others, to provide education and training on radiation protection and to issue certificates of competency on radiation protection or to recognize the corresponding diplomas or certificates awarded on the basis of approved curricula
b) The EEAE establishment and organizational laws [4,5] according to which EEAE is authorized, among others, to provide education, expertise and training on radiation protection to scientists and technicians and to the personnel of special groups dealing with emergencies. Additionally, EEAE has the responsibility to issue certificates of competence and skills for those providing E&T on radiation protection and to recognize relevant educational courses.

Council Directive 2013/59/Euratom [6], which must be transposed to the MS legislations by February 2018, gives particular emphasis on education and training aspects. Additionally, it introduces the Radiation Protection Expert (RPE) which could be considered the evolvement of the former “Qualified Expert” [7] and the role of the Radiation Protection Officer (RPO) which is not mandatory.

The RPE is defined as an individual or, if provided for in the national legislation, a group of individuals having the knowledge, training and experience needed to give radiation protection advice in order to ensure the effective protection of individuals, and whose competence in this respect is recognized by the competent authority. In the light of the above definition, the Council Directive 2013/59/Euratom provides also a detailed description of RPE role and responsibilities. MS shall include appropriate provisions within their national legislative framework to establish and define a recognition system for the RPEs. However, the Directive does not define minimum requirements for the design and implementation of this recognition system.

Additionally, the Directive defines the RPO as the individual who is technically competent in radiation protection matters relevant for a given type of practice to supervise or perform the implementation of the radiation protection arrangements. According to the described tasks the RPO seems to be generally involved in supervising or performing the day-to-day radiation safety arrangements in an ionizing radiation facility.

This work emphasizes on E&T as well as refreshment training requirements for the RPEs and RPOs, in order to fulfill their role and duties. Moreover, it presents challenges faced during the transposition of the Directive, such as the establishment of an appropriate recognition procedure with the consensus of the relevant stakeholders.

Methodology for the transposition of the Council Directive 2013/59/Euratom

The transposition of the Council Directive 2013/59/Euratom to the Greek legislation, is based on the IAEA's Basic Safety Standards [8-13], the recommendations of the 2012 IAEA IRRS Mission, the EEAE's long (more than 15 years) operational experience and goals as well as on the common approaches of the EU MS, as expressed in various fora (e.g. HERCA working groups). For the transposition of articles related to E&T issues the recommendations and suggestions received during the 2015 IAEA EduTA mission are also considered. Furthermore, in order the transposition procedure to be efficient and effective, the involvement of the relevant stakeholders will be ensured through a number of activities, such as setting up a dialogue process, information events, thematic meetings and consultation on draft documents.

The Council Directive 2013/59/Euratom provisions will be transferred to the Greek legislation through a set of legislative documents, the scope and correlation of which is described here below:

- A Presidential Decree to transpose the Directive articles to the national legislation. The Decree will establish the functions of RPEs and RPOs and define their main responsibilities and tasks.
- A Common Ministerial Decision getting the mandate from the above mentioned Presidential Decree and the EEAE establishment law [4]. This document will include the main provisions for the legislation implementation.
- For flexibility purposes, the details regarding the implementation of both the Presidential Decree and the Ministerial Decision will be described in individual EEAE decisions.

The set of the above documents will constitute the national radiation protection regulations.

The role and recognition of the RPEs

The role and the responsibilities of the RPE will be described within the Presidential Decree and in accordance with the respective provisions of the BSS Directive. The RPE may be assigned, if approved by EEAE, the main task of ensuring the radiation protection of the workers and the members of the public. The assignment of the RPE will be mandatory for high and medium risk radiation practices (radiotherapy, brachytherapy, use of open sources for diagnostic or therapeutic purposes, etc.) as they are categorized in the new legislation.

The competency of an individual to act as RPE will be recognized by the EEAE Board after the suggestion of a 3-members committee which will include 2 EEAE "scientists" and 1 academic or researcher, whose scientific profile and experience will lie upon the corresponding field of recognition. Additionally, an individual could be recognized as RPE in more than one radiation practice; however for each practice an individual recognition will be required.

The arrangements for the recognition of the RPEs will be explicitly described within the Common Ministerial Decision and the corresponding EEAE decisions. The criteria for the recognition include among others: education and training on radiation protection, postgraduate training, working experience on the specific field of recognition; on-the-job-training as RPE under the supervision of an RPE, competency to provide advice on aspects related to radiation protection, etc. The recognition will be valid for 7 years and then a similar re-recognition procedure should be followed based on the experience gained by the individual and his/her continuous education and retraining.

The role and designation of the RPO

The role and responsibilities of the RPO will be described within the Presidential Decree and they will be directly transposed from the Council Directive 2013/59/Euratom. According to the Common Ministerial Decision, the RPO will be designated by the undertaking and his/her designation will be approved by the EEAE. The procedure and the criteria for the approval of the designation will be described in detail in a corresponding EEAE decision.

For the approval of an individual as RPO, several parameters will be considered among which education and training on radiation protection, working experience on the specific radiation practice, and on-the-job-training as RPO under the supervision of an RPO or RPE. The approval criteria and the frequency of the required retraining will differ according to the nature of the practice and the associated risk thereby applying the graded approach.

The national programme for E&T

In 2013 EEAE developed a 3-year national E&T programme on radiation protection. The programme was successfully completed in 2016. Its establishment was based on the IAEA suggested methodology and the results of the assessment of national E&T needs.

For the assessment of national E&T needs data from the National Radiation Protection Database (NRPD) was used regarding the types and the number of occupationally exposed workers as well as estimations of their number in next five years. The design and the implementation of the programme were based on the requirements of the quality management system of EEAE according to ISO 29990:2010 (Learning Services for Non-Formal Education and Training), while the sustainability of the program is ensured by its continuous evaluation and the interaction with the involved third parties during the phases of design and implementation.

The transposition of the Council Directive 2013/59/Euratom into the national legislation will bring significant changes in E&T requirements, especially with the introduction of the functions of the RPE and RPO. These changes should be considered appropriately for the revision of the national E&T programme within the next years. The challenges which are expected to be faced include among others the assessment of the new E&T needs, the design of specialized training courses to address these needs, the effective involvement of the stakeholders and the optimized distribution of resources.

Conclusions

In this work the arrangements made by EEAE for the transposition of the E&T requirements of the 2013/59/EURATOM Directive in the Greek legislation were presented and discussed. The introduction of the functions of RPEs and RPOs will bring significant changes in terms of E&T requirements at national level which should be faced appropriately. The legislative documents under preparation will describe in detail RPEs and RPOs roles and responsibilities. Moreover, they will set specific E&T requirements as well as procedures and criteria for their recognition and designation respectively in accordance with the graded approach. However, for the efficient and effective implementation of these new requirements, the re-evaluation of the national E&T needs and the establishment of a national strategy in accordance to these needs are considered necessary.

References

1. Dimitriou, P.; Pafilis, C.; Karfopoulos, K.; Kamenopoulou, V.; Housiadas, C., Establishing a national strategy for education and training in radiation protection, 5th international

conference on education and training in radiological protection, ETRAP2013, Vienna 12 - 15 March 2013

2. Dimitriou, P.; Pafilis, C.; Stassinopoulos, I.; Ntalles, A.; Karfopoulos, K.; Carinou, E.; Kamenopoulou, V., Implementation of ISO 29990:2010 management system for providers of learning services in non-formal education and training on radiation protection., 5th international conference on education and training in radiological protection, ETRAP2013, Vienna 12 - 15 March 2013
3. Greek Radiation Protection Regulations, Ministerial Order No1014, Official Gazette of the Greek Government No 216B; 2001.
4. Law for the Research, Technological Development and Innovation and other provisions (2014), Law No. 4310 / Government gazette, Issue 1 – Folio No. 258
5. Organization of the Greek Atomic Energy Commission (1993), Presidential Decree No.404/Government gazette, Issue 1– Folio No. 173
6. Council Directive 2013/59/EURATOM (2013) Basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/EURATOM, 90/641/EURATOM, 96/29/EURATOM, 97/43/EURATOM and 2003/122/EURATOM 05.12.13.
7. Council Directive 96/29/EURATOM (1996) laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation.
8. IAEA, Governmental, Legal and Regulatory Framework for Safety: International Basic Safety Standards, Safety Standards Series No. GSR Part 1, Vienna 2016.
9. IAEA, Leadership and Management for Safety: International Basic Safety Standards, Safety Standards Series No. GSR Part 2, Vienna 2016.
10. IAEA, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Safety Standards Series No. GSR Part 3, Vienna 2014.
11. IAEA, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Safety Standards Series No. GSR Part 3, Vienna 2014.
12. IAEA, Safety Assessment for Facilities and Activities: International Basic Safety Standards, Safety Standards Series No. GSR Part 4 (Rev. 1), Vienna 2016
13. IAEA, Preparedness and Response for a Nuclear or Radiological Emergency: International Basic Safety Standards, Safety Standards Series No. GSR Part 7, Vienna 2015.

RADIATION PROTECTION AWARENESS CHALLENGES AT CERN

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ABSTRACT

At CERN (European Organization for Nuclear Research), physicists and engineers are probing the fundamental structure of the universe. They use the world's largest and most complex scientific instruments - particle accelerators and detectors - to study the basic constituents of matter: the fundamental particles.

Safety is a key concern and is based on raising workers' awareness of the multiple hazards they might face in a working environment as complex as that of CERN. Due to the rich professional and cultural diversity of CERN's population, developing safety courses and, in particular, radiation protection awareness, is a challenge with more than 33 000 persons trained over the last 20 years (online course and classroom training).

With the aim of continually improving quality and to meet the requirements of the demanding long technical shutdowns, CERN has modified the radiation protection awareness master plan and revised the methodology behind its design. This presentation traces the history allowing us to reach these objectives, gives an assessment of the current situation and outlines the future challenges for the upcoming years.

1. Introduction

CERN, the European Organization for Nuclear Research, is one of the largest scientific laboratories in the world. Founded in 1954, the CERN laboratory sits astride the Franco-Swiss border near Geneva. It has become an example of international collaboration for a "Science for Peace". Today CERN counts 22 member states, collaborates with some 600 institutes and universities and its vocation is fundamental physics, the discovery of the ultimate constituents of the matter and the laws of the Universe. For this, it uses scientific instruments such as purpose-built particle accelerators and detectors. By studying what happens when these particles are made to collide together at close to the speed of light, physicists are exploring the fundamental laws of nature. The operation of particle accelerators results in the creation of radioactivity. The accelerator complex includes experimental areas, fixed targets and about 45 km of tunnels harbouring the beam lines. These areas are designated by radiological risk and controlled by approximately 50 access points.

2. Safety courses

2.1 Some numbers

General safety is a key concern, it is based on workers' awareness of the risks they face in a working environment such as CERN. Because of the great professional and cultural diversity of the CERN population, safety awareness amongst employees is a real challenge: 2500 employees, 1,300 contractors and 12,000 scientific users for 120 nationalities are working daily onsite.

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Since 2013, safety training at CERN is shared between the experts in the various safety domains and the Safety Training Unit. The experts are responsible for the technical content of the courses and for keeping abreast with legal developments in their area of expertise. They work closely together with CERN's Safety Training Unit which manages and promotes the safety training program, advices the learners and their supervisors, creates courses with regards to didactic, graphics and organization, operates the safety training centre and is responsible for the traceability of the sessions held.

Today, CERN counts 77 in-house training sessions and 30 online courses for a total of about 36,000 participations per year on safety topics such as fire hazards, self-rescue masks, electrical hazards, etc. To deal with the diversity of the employees to be trained, the practical part of classroom training is an imperative. Consequently, the CERN training centre is equipped, in addition to the usual rooms, with practical workshops and simulators, such as a model of the LHC accelerator tunnel. These facilities make it possible to be trained in real conditions which is a real advantage for illustrating the pedagogical content of the safety courses.

2.2 Radiation protection regulations

CERN is an inter-governmental organisation. CERN' radiation protection legislation is based on European directives and needs to ensure a similar level of protection against ionising radiation as applied by the two Host States. To ensure compatibly, the "Tripartite" agreement between CERN and the Host States, France and Switzerland, was signed in November 2010. According to the European regulations (Directive 2013/59/EURATOM), French regulation (Article R4451-47 du code du travail) and the Swiss regulation (Ordonnance sur la Radioprotection 814.501 Article 10), CERN has a legal obligation to train its personnel on radiological hazards. Therefore, no equivalence is accepted because it provides in situ radiological awareness training. At CERN radiation protection awareness is given to people working in designated areas so that they can work without compromising their own safety, that of others or the radiological integrity of the installations. The awareness training is also a prerequisite for obtaining dosimeters and access to designated areas. In total, more than 6200 people have been trained on 2016 (online course and classroom training).

3. Evolution of radiation protection awareness

3.1 2012 revision

Initially, radiation protection awareness was based on a half-day training session with no practical part. During 2012, the Radiation Protection Group Leader proposed to the Host State Authorities to adapt the courses according to the risks. It was agreed within the framework of the "Tripartite".

A distinction was made between people working in controlled areas and those operating in lower risk areas, called supervised areas. The annual dose limit in a supervised area is 6 mSv whereas in the controlled area it is 20 mSv and in some cases, in addition to the personal dosimeter, the operational dosimeter is required. A "Supervised area" online course and a one-day "Controlled area" classroom training including a practical part have been created. If a person fails the online course "Supervised area" 3 times they will be invited to follow a "Controlled area" classroom training.

In 2012, the Radiation Protection Group created a Steering Board for radiation protection training. This board is composed of group members and the Head of the Radiation Protection Group.

At that time, the Radiation Protection Group was responsible for all aspects related to radiation protection training, with the exception of registration on these courses. In the following years, the Safety Training Unit took on more responsibilities and nowadays the Radiation Protection

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Group is mainly concerned with the technical content (including the practical part). The Steering Board has been kept – today mainly dealing with the content of these courses and ensuring that legal and technical changes (e.g. changes in laws, procedures, facilities, etc.) are taken into account.

3.2 ISOLDE

ISOLDE is an on-line isotopic mass separator dedicated to the production of a wide variety of radioactive ion beams for experiments in the fields of nuclear and atomic physics, solid state physics, material sciences and life sciences. This installation presents a risk of contamination in addition to the irradiation risk and, in 2014, classroom training was created with the aim of alerting the users to these two risks thanks to a predominantly practical part.

3.3 Modular approach

In 2016, a new approach was considered by the Safety Training Unit and the Radiation Protection Group in order to sensitize the whole CERN population and avoid redundancy within radiological awareness training. A "modular" approach emerged and is currently being implemented. This approach alleviates some existing awareness courses and adds two new courses:

• The online course "Radiation Protection Awareness" to inform the whole CERN population about radiological risks, whether or not they access a designated area. Amongst other things, this course raises awareness of the risks associated with the industrial radiographies that take place every day within CERN's perimeter. It also answers the various questions asked by personnel who are not under dosimetric follow up regarding the radiological risks that may be present in the vicinity of their workplace.

• The online course "Physics / Theory" to avoid redundancy of information on the theoretical and nuclear physics aspects between the different awareness courses.

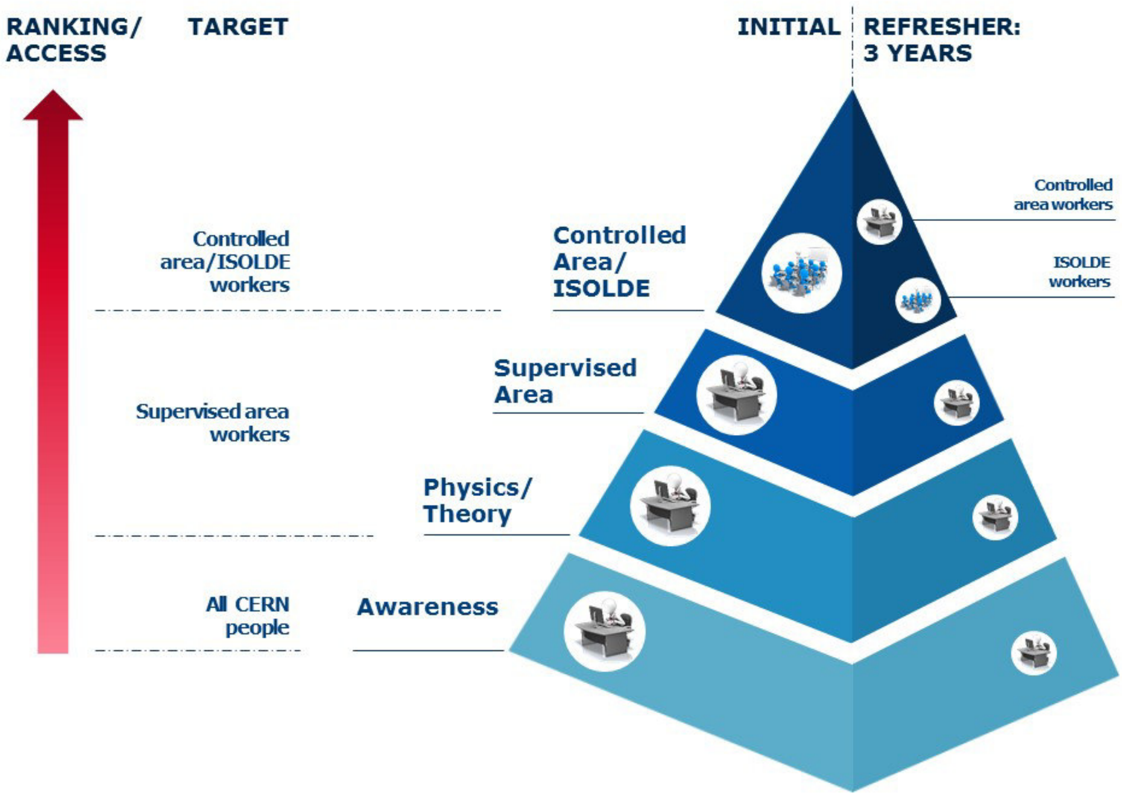

Fig 1. Modular approach for the radiation protection awareness courses

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As described above in Figure 1, each awareness course is a prerequisite for the succeeding one. Awareness courses will soon be coupled with access to allow a system that is structured and designed so that each person is aware of the absolute necessity to follow an awareness course before going inside a designated area.

Each awareness course concerns a clearly identified target population, enabling each supervisor to guide newcomers to an awareness course appropriate to their duties and the risks inherent in their workplace.

The Radiation Protection Group is also involved in the development of all other installation specific safety courses, in particular with regards to the radiation protection part. It is of utmost importance that there is a close collaboration between the experiments, the Safety Training Unit and the Radiation Protection Group as this allows harmonization, the absence of redundancy as well as the communication of the appropriate messages. The whole contributes to maintaining the quality of CERN's awareness courses.

4. Interactivity and tools

Online courses, treating the main theoretical concepts, are prerequisites for classroom training. For the latter, the practical exercises are favoured and make up at least 50% of the total time. The training is interactive thanks to the two adjoining rooms, with one dedicated to the theoretical part and the other one to the practical part. Alternating between the practical room and the theoretical room allows trainees to stay concentrated whilst illustrating the concepts in a playful, concrete and visual way. The acquired skills are therefore better memorised over time. The Radiation Protection Group has equipped the practical room with the same equipment used in the field at CERN. In addition, CERN has also acquired teaching aid instruments such as a Digital Particle Camera MX-10 © which is a detector allowing the visualisation of the different radiation-matter interactions and an STS 800 ©, a contamination detector simulated by a chemical agent. These tools allow trainees to carry out exercises in real conditions, to familiarize them with their working environment in designated areas at CERN, and to show them the way to behave and the reflexes to be acquired. The whole, without artificial or natural radioactivity. All these exercises are done within small groups to encourage interaction and stimulate reflection, which animates the training. For the theoretical part, participation is a major point, stimulated by the use of an interactive board. This facilitates exchanges and gives training courses tailored to the audience and makes it more attractive.

5. Specificity

The frequency of classroom training varies with the rate of experiments and technical stops. At least a weekly awareness course is ensured to offer newcomers the opportunity to take the required course, according to their very strict time constraints, in particular for scientific users or maintenance personnel. The duration varies from half a day to a day for classroom training and is about half an hour for online courses. Awareness training is provided in French and English, the two official languages at CERN (except for ISOLDE training which is in English only). Finally, each awareness course ends with a knowledge test to verify the key messages have been correctly understood. For the knowledge tests following the classroom training, thanks to the system of voting by remote control, it is possible to visualize the results immediately and to validate the session. In case a person fails, an interview is proposed by the trainer in order to judge the knowledge of the trainee and ask him to redo the test. Concerning the validity of the awareness training, after 3 years it is necessary to follow a recycling course. Because of the number of people to be trained, this is an online course.

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6. Methodology and tools

CERN's approach is not in itself innovative from the point of view of radiation protection awareness, but it seeks to have and maintain a high degree of quality for all aspects of awareness training, namely: the methodology of creation and the learning process, the system of continuous improvement and quality insurance and, in addition, for the classroom training alternating between theory/practice, the equipment used, the trainers' tools, the support material and the audits.

For the effective management and follow-up of the actions to be done, the JIRA Agile © tool is used. It streamlines the exchange of information and makes it possible to optimize the collaboration between the various actors by giving greater visibility on the progress of a project.

6.1 Development methodology, continuous improvement and quality insurance

The methodology for the development of awareness training consists of issuing key messages, in collaboration with the members of the Steering Committee and the experts of the Radioprotection Group. These experts are appointed by the Radiation Protection Group with the mission of validating key messages for the development of the content of a new course and performing an "expert surveillance" by tracking developments in terms of practices in the field to update awareness training with a review every 6 months. The graphic and pedagogical communication expert in the Safety Training Unit will illustrate these key messages. This visual and graphic design work is a competence in its own right and it is an important element because it is necessary to touch all the CERN population to promote the assimilation and understanding of key information. Dialogue with the trainers is not neglected in the development process because of their expertise on how to capture the attention of their CERN audience and their point of view is an important asset to exploit. Finally, when the first version is finalised, a test session is organised in real conditions to perform the final checks.

A system of continuous improvement and revision is set up for the awareness courses, based on the collection of feedbacks from audits and trainers, the analysis of the test results and the satisfaction questionnaires at the end of each classroom training. Moreover the regulatory surveillance and the update of practices in the field are also taken in account. All of this makes it possible to continually improve safety awareness to provide up-to-date information as close as possible to reality in the field.

6.2 Immersion and trainers' tools

Following their recruitment, the CERN trainers follow an "immersion" for a few days, this consists of visiting the various facilities and learning about CERN's procedures and rules supervised by the Radiation Protection group members to better understand the problems and to be able to communicate on these facilities with the trainees. This allows them to be confronted, like the trainees, with environments with a radiological risk and to better assimilate the safety rules. They are also better trained to understand the issues that can be addressed by trainees and thus better respond to their questions. They also receive "Train the Trainer" sessions, which consists of receiving technical information from an expert on a specific subject. The trainers rely on support material such as the pedagogical documents which gather all the technical information about the training such as the timeline and the key messages to be mentioned to the trainees for both the theoretical and practical parts. A website is available for trainers: it gathers general information on radiation protection at CERN and information e-mails are also sent regularly to circulate updates on radiation protection at CERN and what is new in classroom training.

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Finally, the Radiation Protection Group uses support materials, including a service charter, a charter for trainers and various procedures associated with classroom training and how to use pedagogical material.

7. Challenges

CERN's main challenge in terms of awareness training concerns setting up performance indicators to quantify the impact of awareness training, particularly in the field, which would make it possible to further improve the quality of the training.

Other practical questions arise such as the need to find a way to make the new online courses "Radiation Protection Awareness" mandatory for persons who do not have dosimetric follow-up.

8. Conclusion

At CERN, radiation protection awareness remains a key topic for promoting and improving safety at work. Thanks to methodologies based on the collaboration of skills, communication with trainers as well as the use of new technological means, it becomes more attractive and easily memorized in time; its impact will therefore be strengthened. The safety awareness of radiation protection for newcomers is their first contact with CERN and is a reflection of the work and organisation of radiation protection at CERN.

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RADIATION PROTECTION INFORMATION FOR PATIENTS AND WORKERS INVOLVED IN NUCLEAR MEDICINE PROCEDURES

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ABSTRACT

The lack of knowledge about ionizing radiation in nuclear medicine procedures may be a source of concern; in order to minimize doses to public and professionals, information and education adjusted to the level of risk associated is essential.
The aim of this study is to analyse and update the information and education in radiation protection provided to patients undergoing nuclear medicine procedures and to those professionals who are somehow involved in the care of those patients.
The present study has been performed in the Nuclear Medicine Department at a University Hospital. Written generic information prior to the procedure and if necessary, further oral information are provided to the patient. Besides, radiation protection requirements for individual patients in treatment procedures are evaluated.
On other hand, periodical training sessions for exposed workers implicated as well as sessions on demand are given by Medical Physics and Radiation Protection Department, which also elaborates written radiation protection protocols available to any professional.
Distribution and clarity of information has been assured to patients and professionals.
Information prior to the procedure is a helpful tool to improve risk understanding among patients and carers and comforters. Additionally, management of nuclear medicine patients has been enhanced by means of radiation protection training and education to different professionals outside the Nuclear Medicine facility.

1. Introduction

Nuclear Medicine procedures involve medical exposures, including patient, families, carers and comforters, as well as occupational and public exposures. All of them must be evaluated for each diagnostic or therapeutic procedure, estimating the level of radiological risk.
The lack of knowledge about ionizing radiation may be a source of concern in patients who undergo nuclear medicine procedures, and also in professionals who are not considered exposed workers, but occasionally take care of them. Besides, the great availability of unreliable information on the media contributes to generate an inadequate perception of radiological risk.
The 2013/59/Euratom Directive highlights the importance of education in radiation protection in the field of medical exposures [1]. In the same way, the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO) identifies ten main actions, and related sub-actions, as essential for the strengthening of radiation protection in medicine over the next decade. The application of harmonized criteria for the release of patients after radionuclide therapy, and developing further detailed guidance as necessary, enhances the implementation of the optimization of protection principle. Moreover, strengthening radiation protection education and training of health professionals has also been considered a priority [2].
Education and training to professionals in the field of medical exposures is mandatory, both to exposed and non-exposed workers [3]. Medical Physics and Radiation Protection Department (MRPD) is responsible for this education, which is organised based on the level of risk and responsibility of each professional collective [4].

Nuclear Medicine Department (NMD) and MRPD must provide the patient with information prior the procedure [5], and particularly with written instructions in therapy procedures, in order to restrict doses to persons in contact with them as low as reasonably achievable (ALARA) [6]. Within some institutions and NMD, there is some disparity in radiation safety instructions provided to the patient [7].
As each diagnostic or therapy procedure implies noticeable differences in the radioisotope and activity administrated, to reduce radiation exposure [8] the radiation protection information provided to the patient and health professionals needs to be slightly different, adjusted to the level of risk associated [8].
Radiation protection in the treatment of thyroid disease by I-131 requires to individualise the recommendations to patients, taking into account their social situation but also the activities of I-131 received and rates of clearance from the body, to ensure radiation exposure reductions to carer and comforters, family members and the general public [9, 10].
The aim of this study is to analyse and update the information and education in radiation protection provided to patients undergoing nuclear medicine procedures and to the professionals who are somehow involved in the care of those patients.

2. Material and method

The present study has been performed at the NMD of a University Hospital, without paediatric patients, performing a wide number of diagnostic procedures with noticeable differences in the radioisotope and activity administrated. Therapy procedures represent a minor percentage of procedures in NMD, specifically 3%.
Hyperthyroidism therapy (I-131), radioembolization therapy (Y-90) for liver cancer and Ra-223 treatment for metastatic prostate cancer are the main therapies performed at our NMD. Due to the higher radiation doses involved in these therapies, patients attend a consultation with the nuclear medicine specialist prior to the date of the treatment, receiving both oral and written information elaborated by the MRPD.
Periodical training radiation protection sessions to exposed workers are programmed and performed by the MRPD, according to our national regulation. Subjects included in the training programmes for exposed workers, cover radiation protection requirements in daily practice and those arising from the implementation of new procedures [11, 12]. Furthermore, emergency drills are periodically conducted as part of the training programme.
Although most of patients in nuclear medicine procedure are outpatients, in some cases due to their pathology they are hospitalized or assisted at other departments, like dialysis, intensive care unit…Consequently, in addition to Nuclear Medicine staff, other health professionals, considered non-exposed workers, are somehow involved in the care of patients who have undergone some nuclear medicine procedures.
Information sessions to those professionals are provided on demand by the MRPD. These sessions are not periodical but mean to be an answer to the questions and concerns of those professionals improving the clinical practice. Radioembolization therapy constitutes a special case, which requires radiation protection guidelines, both for irradiation and contamination risks.
Additionally, different protocols have been elaborated by MRPD, taking into account any situation at the hospital, like manipulation of non-capsuled sources outside NMD (injection of patients at cardiology facilities for stress tests, or radioembolization at vascular radiology facilities) or hospitalization of patients outside the nuclear medicine facility. These protocols are available to every professional who requires them at any moment.

3. Results

Prior general information provided to every nuclear medicine patient has been assured (Figure 1), as a consequence of the collaboration of MRPD, NMD and prescribers. When necessary, due to the particular situation of a patient, more detailed oral information is provided by the nuclear medicine specialists.
Explorations with Tc-99m are the most common procedures among diagnostic procedures (90% out of the total explorations), and information provided to the patient requires no further radiation protection restrictions.

Hospital Universitario de La Princesa

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INFORMATION TO PATIENTS ABOUT NUCLEAR MECINE EXPLORATIONS

What is Nuclear Medicine?

Nuclear Medicine is a medical modality in which diagnostic imaging and therapeutic procedures are performed using radioactive material.

What are the radiopharmaceuticals?

They are compounds which allow for studying the morphology and functionality of organs by its assimilation and emission of small amount of radiation. The equipment consists on a special camera (called gamma camera) which detects the radiation escaping from the patient's body and creates pictures offering information about the location and distribution of the radiopharmaceutical. Nowadays, Computer Tomography (TC) is integrated in the majority of the gamma cameras.

How is the procedure performed?

Nuclear Medicine explorations are noninvasive procedures in which the necessary dose of radiation is administrated by, generally, intravenous injection of a radiopharmaceutical. A determined interval of time, which depends on the type of procedure, is necessary between the administration and the performance of the exploration; ranging from few minutes (10min) until several hours (5h) or even days (1-5d). Some procedures require several explorations during the same day and others even different days, you will be informed if this is your case. Due to those different intervals of time, some patients may be attended before you although they had reached the faculty later. Once that waiting time is finished, you will be addressed to the room where the gamma camera is placed and the exploration will be performed. During the exploration is extremely important that you stay motionless in order to obtain a good diagnostic image quality.

Do I need some preparation?

Generally not; in case you did need, you will be informed previously by the Nuclear Medicine Department. If necessary, you will also be asked for information about the medication you are taking.

May I be accompanied by people?

Yes, you may; it is convenient though, that you no children or pregnant women come with you.

What happens if I am pregnant or breastfeeding?

In case you are pregnant or think that you can be it, please tell it to the professionals of the Department; do the same if you are breastfeeding. The communication of this information is **extremely important** previous to the administration of the radiopharmaceutical.

Is the procedure painful?

Absolutely not. No effect will appear because of the injection of the radiopharmaceutical, you will be able to return to normal life. The only annoyance may be caused by staying motionless during the exploration.

Is the exploration safe?

The radiation dose you might receive, in order to obtain good imaging diagnostic, is very small, so the radiation risks are quiet low compared to the major benefits of the diagnostic.

Is some special issue need to be done after the procedure?

It may be convenient to drink water or juices, in a bigger amount that usually done, in order to eliminate the radiopharmaceutical easily; as well as it is to urinate more frequently. Generally, there is no need of taking additional care in personal hygiene (washing hands…)

In case further indications are required, you will be informed in the Nuclear Medicine Department. For any question, please contact with the Nuclear Medicine Department 91 520 25 80 and Medical Physics Department 91 520 22 94

Fig 1. Prior general information provided to every nuclear medicine patient

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PATIENT INFORMATION IN HYPERTHIROIDISM THERAPY IN NUCLEAR MEDICINE

What is Nuclear Medicine?
Nuclear Medicine is a medical modality in which diagnostic imaging and therapeutic procedures are performed using radioactive material. In hyperthyroidism therapy radioactive Iodine (I-131) is used

What is radioactive iodine?
Stable Iodine is part of our usual diet, and it is uptaken in the thyroid gland. I-131 is a radioisotope of Iodine, which emits radiation and is used for medical purposes.

What does the treatment consist of?
Dose of I-131 is going to be administrated to you, in a capsule form. The dose will be concentrated in your thyroid gland. As a consequence, it will receive some radiation dose which will allow to reduce its activity and enhancing your symptoms. Due to the relatively small dose administrated, this is an outpatient treatment.

Do I need some preparation?
In case you are taking antithyroid medication, you must discontinue that medication within 5 days before the treatment.

What happens if I am pregnant or think I may be?
YOU MUST INFORM ABOUT IT TO THE NUCLEAR MEDICINE SPECALIST BEFORE THE RADIOISOTOPE IS ADMINISTRATED.

What happens if I am breastfeeding?
YOU MUST INFORM ABOUT IT TO THE NUCLEAR MEDICINE SPECALIST and you will have to discontinue breastfeeding during some period of time you are told.

May I be accompanied by people?
Yes, you may, but in NO case by children or pregnant women.

Which are the precautions after treatment?
I-131 is eliminated mainly by the urinary tract and also by faeces, saliva and other biological fluids, so once it has been administrated, YOU ARE NEED TO ADOPT DURING A PERIOD OF TIME SOME RADIATION PROTECTION PRECAUTIONS.

- As far as possible, try not to stay at the same house with small children and pregnant women during the time you are told. If you have to keep contact with them, try to stay at more than 1 metre distance and for a short period of time.
- In the toilet sit down to avoid splashing, then double flush the tank and then wash hands carefully.
- Drink a normal amount of liquids.
- Don´t share glasses, plates, towels, sheets or clothes with other people, but it are not necessary to wash it separately.
- If possible, avoid sleeping at the same bed with anybody.
- Avoid getting pregnant at least within 6 months.
- Discontinue breastfeeding during some period of time you are told.
- You will be informed whether you need to stay out of work, and how much time it will be. Mainly if it involves contact with pregnant women, children or food handling.
- You must inform in case you planned a trip in the following days.

For any question, please contact with the Nuclear Medicine Department 91 520 25 80 and Medical Physics Department 91 520 22 94

Fig 2. Patient information in hyperthoroidism therapy prior to the administration of radionuclide

Hyperthyroidism therapy patients receive radiation protection information based on the dose rate and also on a quick survey carried out by the MRPD about the social circumstances, working and living conditions of the patient, and in particular if these situations involve prolonged contact with small children or pregnant woman. Mean time to follow instructions is 5 days, but some patients require until 14 days in order to comply with dose constraints established for pregnant woman and small children. Other patients (mainly people over 65) need no instructions to follow, taking into account their social circumstances and lower radiological risk [10, 11].
The distribution of information to patients has been improved, taking special care on the fact that information is provided in a reproducible format and likewise the content is expressed clearly so that it can be perfectly understood by any patient (Figure 2).
Radioembolization therapy for liver cancer has required educational sessions for the exposed workers because of the implication of both nuclear medicine and vascular radiology professionals. In the same way, due to treatment for metastatic prostate cancer with Ra-223, education and training about radiation protection and disposal waste of α-emitters has been required.

The lack of information about the radiation risk when assisting nuclear medicine patients in clinical departments has been a great concern within health professionals. Information sessions have been provided by the MRPD in Nephrology Department, about the management of dialysis patients who undergo a nuclear medicine exploration; Cardiology Department, about stress tests performed at their facility; Endoscopy Department, and the operating theatre.

The protocols and procedures available at the MRPD specifically applied to Nuclear Medicine (Table 1) are constantly updated as new nuclear medicine procedures are implemented or different situations arise at the hospital (Figure 3).

Radiation Protection (RP) Protocols in Nuclear Medicine (NM)
RP for childbearing, pregnant or breastfeeding patients of NM
RP for patients undergoing a whole-body-scanning procedure
RP for professionals performing ergometry test
RP for professionals performing sentinel node technique in multifocal breast cancer
RP for assistance of hospitalised patients undergoing diagnostic procedures in NM
RP for hospitalised patients undergoing diagnostic procedures in NM with In-111
RP for hospitalised patients undergoing diagnostic procedures in NM with Ga-67
RP for outgoing patients undergoing hyperthyroidism treatment with I-131
RP for hospitalised hyperthyroidism patients
RP in radioembolization therapy for liver cancer procedures using Y-90
RP for professionals assisting hospitalised patients undergoing radioembolization therapy with Y-90
RP in Ra-223 treatment procedures for prostate cancer

Tab 1: Protocols available for workers and patients of nuclear medicine at the Medical Physics and Radiation Protection Department (MRPD)

4. Conclusions

Information prior to the procedure is a helpful tool to improve risk understanding among patients and also carers and comforters.
Evaluating the radiation protection requirements for individual patients in therapy procedures, so as to customise recommendations after the treatment according to dose rate and social conditions, allows to reduce radiation exposures and implies better quality and life conditions for patients and family.
By strengthening education and training of health professionals, the management and care of nuclear medicine patients outside NMD has been improved.

Medical Physics and Radiation Protection Department	Hospital Universitario de La Princesa SaludMadrid Comunidad de Madrid	Edited: 3/2017 Writted: 1/01/09 Revised: 01/03/2017
	RADIATION PROTECTION FOR PROFESSIONAL ASSINTING HOSPITALIZED PATIENTS UNDERGOING DIAGNOSTIC EXPLORATIONS IN NUCLEAR MEDICINE WITH GALLIUM-67 Protocol: PMN-14	Page: 1/1 Archive: **Protocols/Nuclear medicine/PMN-14**

Object and scope: Optimising healthcare professionals radiation protection during the period from the radioisotope Ga-67 administration through the exploration performance.

H.U. La Princesa

Responsible: Nuclear Medicine Department and Medical Physics and Radiation Protection Department.

Method:
Excretion of this radionuclide is through urine and faeces.

Radiation protection standards during the 24 hours after the administration

1. Handling patient's urine shall be performed using gloves and long-sleeved gown. Once it is finished, gloves must be disposed.
2. In case the patient has a Foley catheter, the urine bag shall be emptied through the toilet tube while maintaining the tap open in order to increase the dilution.
3. Self-sufficient patients shall be indicated to urinate sat down and double flush the tank after urinating, washing their hands carefully.
4. Picking the faeces is not necessary
5. Gloves will be the only protection material for workers, in case they need to manipulate the urine of the patient.

Every nursing role is able to be performed.
Special care needs to be taken during the 6 first hours, optimizing the time spent close to the patient.

During the 6 first hours, it is recommended that an average distance superior to half a metre is kept by visitors.

Presence of pregnant women, both relatives and workers, shall be avoided wherever possible.

Dose received by cause of contact with those patients is very low, 11,9 complete days would be necessary to stay closer than 1metre from the patient to overcome the 1mSv dose limit established for public.

In case of questions or suggestions, please call Medical Physics and Radiation Protection Department 13154/13131

Fig 3. Radiation Protection protocol elaborated by MRPD

5. References

[1] European Commission. Council Directive 2013/59/EURATOM of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom; 13:14-15

[2] International Atomic Energy Agency (IAEA), World Health Organization (WHO). Bonn call for Action. 10 Actions to improve Radiation protection in medicine in the next decade.2013.

[3] Ministerio de la Presidencia, Gobierno de España. Real Decreto 783/2001, de 6 de julio, por el que se aprueba el Reglamento sobre protección sanitaria contra radiaciones ionizantes. 26/07/2001. 14555, 178: 27284-27393

[4] Ministerio de Sanidad y Consumo, Gobierno de España. Resolución mediante la que se acuerda incorporar en determinados programas formativos de especialidades en ciencias de la salud, formación en Protección Radiológica.21/04/2006

[5] Ministerio de Sanidad y Consumo, Gobierno de España. Real Decreto 1841/1997, de 5 de diciembre, por el que se establecen los criterios de calidad en medicina nuclear. 19/12/1997. 27260, 303: 37137-37143

[6] International Comission on Radiological Protection, ICRP Publication 103. The 2007 Recommendations of the International Commission on Radiological Protection. 2007. Ann. ICRP 37, 2-4.

[7] Sisson J.C. et al. Radiation Safety in the Treatment of Patients with Thyroid Diseases by Radioiodine 131I: Practice Recommendations of the American Thyroid Association. 2011. Thyroid, 21, 4.

[8] International Atomic Energy Agency, IAEA. Applying Radiation Safety Standards in Nuclear Medicine. 2005. Safety reports series 40.

[9] European Comission. Radiation Protection 97. Radiation Protection following Iodine-131 therapy (exposures due to out-patients or discharged in-patients). 1998

[10] Foro sobre protección radiológica en el medio sanitaria, CSN/SEPR/SEFM. Criterios de alta de pacientes y medidas para la protección radiológica del público después de tratamientos metabólicos con I-131. 2011

[11] Dauer, L.T. et al. Radiation Safety considerations for the use of 223RaCl2 DE in men with castration-resistant cancer. 2014. Health Physics Society

[12] Seza, A. et al.Posttherapy Radiation Safety Considerations in Radiomicrosphere Threatment with 90Y-Microspheres. 2007. J Nucl Med. 48: 2080-2086.

MASTER'S DEGREE APPLIED TO RADIOLOGIC PROTECTION IN RADIOACTIVE AND NUCLEAR INSTALLATIONS

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ABSTRACT

The master is focused on radiation protection (nuclear safety culture and radioactive waste management; radiation protection in radioactive facilities: industrial, medical and research). In addition, it will contribute to improve the safety and radiation protection culture and hence, the safety of nuclear and radioactive installations. The master is managed by the Chemical and Nuclear Engineering Department, of the Universitat Politècnica de València (UPV) and its coordination is carried out by Titania Servicios Tecnológicos (Titania), which is a UPV spin-off. There are many entities collaborating in the master with wide experience in radiologic protection and in the nuclear field, such as the regulator, hospitals, research centres, industrial facilities, nuclear power plants. All these entities collaborate giving theoretical and practical lessons in the master modules and allowing the use of their installations for carrying out applied sessions. It is a 65 ECTS course that lasts a full academic year. The sixth edition started on 3rd October 2016 and will end on July 14th, 2016. The master is divided into 4 modules, one general, two specific and one advanced.The general module covers the basic concepts of radiological protection. One of the specific modules is applied to “Radioactive Installations”, which is divided into Industrial Facilities, Nuclear Medicine, Radiotherapy, Radio-diagnosis, and Research Installations. The other specific module, “Nuclear Installations and Fuel Cycle”, regards to Safety and Radiation Shielding, Nuclear Safety, Processing, Storage and Disposal of Nuclear Wastes, Decommissioning and Environmental Management. The last module, the Advanced Module, is focused on advanced concepts of radiation and radiological protection. The course is mostly e-learning based. It is implemented on PoliformaT platform of the UPV with online resources as guided presentations, teaching videos, remote tutoring sessions, online exercises, temporized evaluations. 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. This master qualifies its students to carry out tasks related to that of a Radiologic Protection Expert (RPE) and Radiologic Protection Officer (RPO), working in Radiologic Protection Services, so during this year it is planned to carry out a project jointly with a consortium of prestigious entities for its future internationalization.

1. Introduction

The aim of this work is to present the “Master in Radiation Protection for Radioactive and Nuclear Facilities”. This is a postgraduate training in Radiological protection managed by Universitat Politècnica de València (UPV), applied to nuclear and radioactive facilities. It is based on e-learning methodology and designed to cover various contents and applications in different areas and sections, related to Radiological protection general concepts, specific skills for radioactive facilities and nuclear facilities [1,2].

The master is managed by the Chemical and Nuclear Engineering Department, of the UPV while it is coordinated by Titania Servicios Tecnológicos (Titania), which is a UPV spin-off. Several entities, such as hospitals, research centers, industrial facilities, and nuclear power plants, collaborate in the master as they have a wide experience in Radiological Protection and in the nuclear field, such as Iberdrola and Enresa (the Spanish company in charge of radioactive waste management), and the Spanish Nuclear Safety Council (CSN), which coordinates the Nuclear and Radioactive Emergency area. All these entities collaborate giving theoretical and practical lessons in the master modules and allowing the use of their installations, such as hospitals or research centers, for developing practical exercises.

2. Material and Methods

The Master in Radiological Protection for Radioactive and Nuclear Installations has a duration of 65 ECTS. It lasts for a whole academic year and it is divided into four modules, one general, two specific and one advanced.

The general module covers the basic concepts of Radiological Protection. One of the specific modules is dedicated to “Radioactive Installations”, which is divided into Industrial Facilities, Nuclear Medicine, Radiotherapy, Radiodiagnostic, and Research Installations. The other specific module, “Nuclear Installations and Fuel Cycle”, refers to Safety and Radiation Shielding, Processing, Storage and Disposal of Nuclear Wastes, Decommissioning and Environmental Management. 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 topic. The last module, the Advanced Module, is focused on advanced concepts of radiation and Radiological Protection.

The course is mostly e-learning based. It is implemented on the *PoliformaT* platform of the UPV, by presentations, explanatory practical videos, interactive tasks, self-assessments, to facilitate self-learning by students. Advanced technological methods have been employed, so they allow to adapt the training with flexibility to the experience provided by the expert professionals and make a follow-up of the students.

Once the students have access to the platform, there is a main menu.The environment of the *PoliformaT* platform is friendly, which makes it easy to use. It has various tools with different functions depending on whether one is an administrator with a wider management capacity, or whether one is a student, in which case permission is restricted to those authorized by administrators. For this reason, the existence of control tools is important as they guarantee efficient follow-up and control by the entity providing the course.

There are many tools and resources in *PoliformaT* platform for students to follow the contents of the master. They can see the course timetable and important dates such as those of examinations. Students can view the latest news about the progress of the course. In the Program option, they can download the list of materials that will be followed during the course. There is a specific tool for Contents, with 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.

Therefore, to facilitate the training of the students several on-line sessions are planned. They include remote reviews and the resolution of doubts 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 Internet, a webcam, headphones and a microphone. Moreover, in these sessions the students can make an examination to control their progress. The access to these sessions may be performed online too. Figure 1 shows an example of one of these sessions.

Fig.1: Policonecta session.

At the end of each module the students must complete their training by attending a classroom seminar, to help them as a final revision of the module and to solve any queries related with the module contents. There are also some practical sessions as visits to specific industrial facilities, laboratories, research centers and nuclear installations and a classroom examination to check the knowledge of students.

These practical sessions take place at UPV and at the dependencies of the entities that collaborate to the master. As an example in Figure 2 there is a picture of the prctaical sessions at Cofrentes Nuclear Power Plant, concretely in refueling building.

Fig. 2: Practical session in Cofrentes Nuclear Power Plant.

Some statistics tools can be used by the administrator to quickly follow up the steps that each student takes on the platform. He has at his disposal many automatic reports. Figure 3 shows an example. The administrator can see the visits that have been made by different students over a period of time as well as the resources and contents accessed by students during the visits.

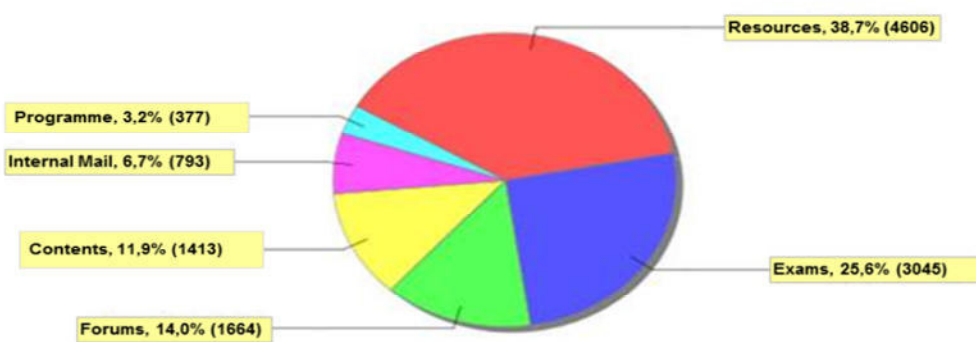

Figure 3: Screen in which can be appreciated a visit and event report.

3. Results and Discussion

The Master in Radiation Protection for Radioactive and Nuclear Facilities has been consolidated through its six editions as a powerful training in the field of Radiation Protection. Some highlights could be remarked in this sense:

- In the first editions of the master, it has been achieved a high level in the satisfaction of students, as showed the surveys carried out during the course.

- There has been an increase of the number of interested people during these years. The master webpage registered 21,500 visitors since the beginning of the first edition and 800 people interested have contacted with the master Direction/Coordination asking for more information.

- Several professional experts from the collaborating institutions participate in the master so its connection with practical approach is essential. One of the most important collaborators to the master is the Spanish Regulator CSN, of Radiological Protection and Nuclear Safety. This organization coordinates the area of nuclear and radiological emergencies in the advanced module.

- There are many students coming from different countries taken into account that the official language of the master is Spanish. In the last edition (2015/2016) there were students from Colombia, Panama, Italy..

- The structure of the master has been updated with other e-learning tools included as in the fifth edition (2015/16) of the Master where a new area was included about internal dosimetry in the advanced module with new practical sessions.

4. Conclusions

The experience during these editions of the Master in Radiation Protection for Radioactive and Nuclear Facilities shows the importance of this type of professional training using e-learning tools. A flexible and balanced training system can be achieved, which is more personalized for each individual.

The implementation of the Master provides training in Radiological Protection and Nuclear Safety mostly e-learning based, covering general and specific topics of nuclear power plants, radioactive installations, as well as industrial, research and medical facilities. It has been analyzed to carry out its internationalization to be accessible in English worldwide.

4 References

1. Directive 2013/59/EURATOM, 2013.

2. IS-03: Reconocimiento de experto en protección contra las radiaciones ionizantes.Consejo de Seguridad Nuclear, 2002.

DEVELOPMENT OF THE ERASMUS+ BLENDED LEARNING TRAINING MODULE 'MARAWAS: MANAGEMENT OF RADIOACTIVE WASTE'

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ABSTRACT

The Erasmus project 'Blended learning in radioecology and radiation protection' started in Sept 2015 with 8 academic partners from the CHERNE (Cooperation for Higher Education on Radiological and Nuclear Engineering) network in collaboration with a regulatory body and research institute. The total project consists of the development of 12 ECTS 'distance' learning activities offered in 6 modules on the project platform and the organisation of 12 ECTS 'mobility' training activities offered in 6 themes. In the framework of this Erasmus+ project, UHasselt (Diepenbeek, Belgium) organised a training school in Management of Radioactive Waste 'MaRaWas' in November 2016.
Twenty students, 3th bachelor and master in nuclear engineering of six project partners, registered for this course. The module comprised a five days training module with lectures, experimental sessions, technical visits and a round table discussion dealing with radioactive waste in different aspects and contexts. Pre-training and tasks were offered using a separate module on the blended learning platform of the project in order to distribute a study guide and background course material, subjects for group tasks and practical information. The enrolled students were divided in groups of 4 students of at least 3 different nationalities. Next to the specialised radioactive waste management skills, communication, collaboration, networking and team building between students with different backgrounds in knowledge, skills and competences were hereby achieved.

1. Introduction

The Council of the European Union adopted on 5 December 2013 the Council Directive 2013/59/Euratom, laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation [1]. Member States have to transpose this new revised Basic Safety Standards Directive (BSS Directive) into their national legal systems by 6 February 2018. The future effectiveness of the regulated practices of this directive depends upon the well skilled and trained workers in the different fields as radiation protection experts (RPO) and radiation protection officers (RPO).
Article 4 of the directive defines RPE(73) and RPO(74) and under the chapter IX 'General responsibilities of member states and competent authorities and other requirements for regulatory control', RPE and RPO tasks are summed in articles 82 and 84 respectively. But no guidance in terms of education, training and experience levels are specified which can allow still a great flexibility by the member states upon implementation.
However, large efforts are made on both European and national levels in several networks and projects to elaborate the directive formulations into clear but comprehensive guidelines which should allow harmonisation and mutual recognition among the member states. HERCA (Heads of the European Radiological protection Competent Authorities) set up a special Task Force 'Education and training in RP' in November 2012 [2]. For RPE, they analysed the applicability between HERCA members of the procedure developed by ENETRAP for the benchmarking of national E&T on RP. For RPO, they made a new survey

on the current RPO requirements in the different HERCA member states. In their RPE/RPO workshop in Paris 2015, high expectations were formulated towards the ENETRAP III guidance as reference and tool for harmonization for RPO and RPE education and training requirements [3]. It was concluded that a common approach based on this guidance should be encouraged both for the implementation or updating of educational syllabi in universities and for the implementation and development of ongoing training for RPE and RPO. March 2016, ENETRAP III provided an extensive report as guidance for regulatory authorities and professional bodies on the roles of RPE and RPO, which specifies the knowledge, competences and practical skills of both [4]. The member states can use it as guidance in the development of their own specific training and recognition processes depending on their own legislative and educational frameworks. Waste management is listed as competence 21 in the basic training module 3 of the European reference training scheme proposed by ENETRAP III with two activities: 1) manage waste for an operation and 2) manage waste generated during decommissioning; and in the specialised module 5 'Waste and decommissioning'.

Waste management is an important economical factor in all processing industries especially for radioactive or radiological contaminated waste streams. RPEs are therefore confronted with nuclear waste management in very different contexts. The first step in nuclear management is the minimization, classification and quantification of hazardous levels and waste volumes during operation. Next step is the local short term storage and preparation for transport to a waste treatment facility and finally the conditioning and final disposal at the waste facility plant. Furthermore, the waste itself is very divers leading to different treatments, different exposure routes, different national legislations, … Organising a specialised training school in waste management for master students from different European partners of the CHERNE (Co-operation in Higher Education on Radiological and Nuclear Engineering) network was therefore a challenge. In this paper the first attempt in the framework of an Erasmus+ strategic partnership is proposed and discussed in detail.

2. Organisation

CHERNE is an open European academic network for co-operation in higher education on radiological and nuclear engineering. The goals of CHERNE are:

- to share competencies and facilities in organising teaching activities for their students, mainly at the Master level,
- to enhance the mutual support by learning from each other, by exchanging experiences and by regular mutual reflections.

CHERNE was founded in 2004 and since then 16 international projects were organised, mostly with European grants and more than 300 students could follow teaching activities in specific nuclear topics and at specific nuclear facilities enabled by the partnership. New activities are announced on their website http://www.cherne.ntua.gr/ .

The current Erasmus project 'Blended learning in radioecology and radiation protection' started in September 2015 for 2 years with 8 academic partners

- HAUTE ECOLE BRUXELLES BRABANT - BELGIUM
- UNIVERSITEIT HASSELT (UHasselt)- BELGIUM
- FACHHOCHSCHULE AACHEN (FH Aachen) - GERMANY
- UNIVERSITA DI BOLOGNA(UNIBO) - ITALY
- UNIVERSIDADE DE COIMBRA - PORTUGAL
- CZECH TECHNICAL UNIVERSITY IN PRAGUE(CUT) – CZECH REPUBLIC
- NATIONAL TECHNICAL UNIVERSITY OF ATHENS(NTUA) - GREECE
- UNIVERSITAT POLITECNICA DE VALENCIA (UPV)- SPAIN

in collaboration with the GREEK ATOMIC ENERGY COMMISSION – GREECE, a regulatory body, and THE NATIONAL RADIATION PROTECTION INSTITUTE (SURO) – CZECH REPUBLIC, a research institute. In this blended learning project, 'distance' education activities are developed and offered in 6 modules (2ECTS/module) on the E-learning platform (**http://edu.eeae.gr/**) in combination with one week 'mobility' training activities offered in 6 different themes (2ECTS/week). The modules developed on the E-learning platform support the face to face learning activities in the training schools making it possible to reduce the actual mobility to 1 week. Nevertheless, extra modules can be added to the platform with dedicated content for the activities or practical information of the training school. In November 2016, the 'MaRaWas' (management of radioactive waste) training school was organised at Hasselt University (Diepenbeek, Belgium).

3. Marawas Trainingschool

3.1 One week training school: program of Marawas

Management of radioactive or radiological contaminated waste involves many different aspects. Organising a one week training school implies therefore the selection of specific activities which are specialised in one particular subject or which reflect this diversity. The latter was opted for the first edition of MaRaWas. Furthermore, students participating in an international training school have very different backgrounds in knowledge, skills and competences and the training school needs to set the framework for an optimal exchange of knowledge and collaboration between the different actors.

A key challenge that needed to be tackled specifically for a one week training school was to organise an efficient training without much time for introduction lectures and labs. On the other hand, the 2 ECTS of provided training needed to reflect a study load of about 60 hours which goes beyond a one week face to face learning activities. To achieve this goal, the practical sessions were linked to the developed e-learning environment in different ways. Firstly, an answers to questions session provided additional guidance on questions regarding the electronic study guide and the provided background material which had to be studied in advance. Secondly, divided in groups, the students needed to collaborate before the intensive training week in preparing a dedicated assignment on risk management. This assignment was to prepare a small paper that after feedback should be presented during an interactive round table session. The advantage of this approach was also that the members of the different groups already interacted before the training session which facilitated the collaboration during the training school.

The final program (figure 1) comprised a five days training with lectures, practical sessions, technical visits and, as mentioned, a round table discussion dealing with radioactive waste in different aspects and contexts. Due to the higher security level nowadays the practical organisation and registration for the training school had to be started more than 4 months in advance, even before the start of the academic year. Especially for the technical visits a lot of administration had to be fulfilled to get access to the facilities for students and teachers.

3.2 Practical organisation

Twenty students, 3^{th} bachelor and master in nuclear engineering of six project partners, registered for MaRaWas. They were divided to obtain mixed teams of 4 students with at least 3 different nationalities. Figure 2 presents a selection of pictures taken during the different activities.

As discussed before, the first day started with an answers to questions session in which students got feedback on questions they formulated in advance during the pre-training phase. Followed by a session of short presentations of PhD research linked to waste management. 5 supervisors helped the teams of students with three practical half day exercises in the labs:

- decontamination and waste management in a radiochemistry lab
- portal monitoring and intervention training
- reuse of NORM in the production of geopolymers

Monday	Tuesday	Wednesday	Thursday	Friday
Arrival in [illegible] [illegible] [illegible]	practical [illegible]	Technical visit : [illegible]	Technical visit: [illegible]	[illegible]
21-25 NOVEMBER 2016				
practical exercises a. Decontamination [illegible] b. [illegible] c. [illegible]	practical [illegible]	Technical visit : Euridice - [illegible]	Lecture of Niras Presentations and [illegible] Social event	oral presentations and [illegible]

Figure 1: Program of 1 week training school MaRaWas-2016

Next, the students visited different waste treatment facilities near Mol. At Belgoprocess, they could see how different types of radioactive waste are treated and conditioned and how temporary storage for Belgian radioactive waste is organised. Tecnubel demonstrated their services in the total maintenance and cleaning up of nuclear and non-nuclear facilities, the rehabilitation of the surrounding sites, but also in the decontamination, dismantling of certain components. And at the site of Euridice, they visited the exhibition and the underground research lab Hades and learned about the feasibility of long term storage of high level waste in Boom clay formations at a depth of 225 m. The last technical visits on Thursday morning were focussed on the on-site monitoring of waste in order to prevent radiological contamination at a hospital and at a steel production plant. Thursday afternoon started with an invited lecture of an expert of NIRAS (National institute for radioactive waste and enriched fissile materials) which covered in detail the Belgian radioactive waste management. Afterwards the students presented their topic of the round table. 2 weeks in advance, the teams were asked to submit a small paper on an assigned topic:

- Stakeholders in the medium and long term storage of radioactive waste
- On site waste management and monitoring in hospitals
- Waste management in university labs (on site) across Europe
- Transport procedures of radioactive waste to a treatment facility
- Approaches for the management of NORM waste in EU

The papers were evaluated by 2 separate reviewers selected among the home institute professors. Feedback was formulated to improve their presentation and the round table discussion. The round table was attended by 2 experts, professors of the partner institutes, all students which resulted in a critical reflection on the topic from many different aspects beyond the technical ones, like ethical, public perception, differences in regulation…

Finally, on Friday, the students presented the results of one of their practical sessions. The final mark for each team of the training school was based on the evaluations of the paper, the round table, the presentation and performance in the practical sessions.

Figure 2 : Actvities in MaRaWas

4. Critical reflection

The evaluation of this training school can be done from different perspectives. The students highly appreciated the practical exercises and technical visits, the expert lecture at the round table and the social event. The use of the e-learning module to prepare certain activities using the study guide and background documents was evaluated as helpful and made it possible to reduce the real mobility to one week of intensive activities. Only the preparations of the topic for the round table could have been more efficient if the instructions were more elaborated, especially because the students didn't know each other yet. The practical organisation asked a lot of work in advance but was an overall success. The guidance of the training activities was accomplished thanks to the efforts of many colleagues, external experts at the technical visits and round table. Due to this close guidance a much lower students/tutors ratio was accomplished than possible in normal courses. Nevertheless, this intensive program with different training activities in such multinational and multidisciplinary group of students would not be possible otherwise and a financial support is certainly needed. Moreover, the financial support of this training school by Erasmus+ and University Hasselt not only facilitated the mobility and hosting of the students. Also the cost for the organisation of the activities (labs, technical site visits, social event,…) were covered. For future organisation without the financial support, a fee needs to be asked from the participants next to their mobility cost.
During this week, the individual student teams and the entire group became more close and some of them decided to attend also future training modules in the scope of this Erasmus project. The aims of this training school was not only to enlarge their knowledge and skills in

nuclear waste management but also to obtain competences in collaboration before and during the course, in English communication, team work and networking. For sure these students experienced the differences in nuclear training among different partner institutes and appreciated each other qualities.

5. Acknowledgements

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6. References

[1] Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. Official Journal L-13 of 17 January 2014.

[2] http://www.herca.org

[3] http://www.herca.org/herca_news.asp?newsID=46

[4] Richard Paynter, Joanne Stewart, Annemarie Schmitt-Hannig, Michèle Coeck, Antonio Falcao, 'European Guidance on the Implementation of the Requirements of the Euratom BSS with respect to the Radiation Protection Expert and the Radiation Protection Officer', March 2016 available on http://enetrap3.sckcen.be/en/Workpackages/WP7

Radiation Protection Training

Teaching a combined audience – the gains and the losses

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ABSTRACT

With an eye to providing training that meets the exact needs of his or her staff and in getting best value for money, employers will often bring in trainers to deliver bespoke courses that take into account the employer's specific working environment, sometimes sending managers, supervisors and operators on a single training event. In contrast, commercial radiation protection training providers such as Public Health England offer generic radiation protection courses which appeal to audiences from a broad range of workplaces.

This paper examines how much the training needs vary from one industry to another and according to the role of the participants, and answers the question "What is gained and what is lost when we combine our audiences?"

What do we gain and what do we lose when our audience is heterogeneous? Is it better for participants to undertake focussed training with those from the same workplace, who are expecting to undertake the same work with the same radiation hazards, or does such an approach constrain the learning and encourage an inward-looking culture? Are the networking and cross-learning opportunities given by open courses worth the costs of sending an employee away to a remote training venue? Is it better to use a trainer who knows and works with the participants or does the experience brought in by an external trainer justify the additional cost?

The answers to these questions will depend on a range of factors including the subject matter, the nature of the training and the characteristics of audience. This paper discusses the issues, and finally considers, in the context of "value for money" what an employer should consider when choosing a training format.

The training formats

1 Internal course, internal trainer

Training personnel within the working environment, alongside colleagues, is often seen as a cost-effective solution. Using this format, an employer can bring together managers, supervisors and operators to learn about new procedures or to develop new skills. Practical work can be realistic and appropriate and discussions can focus on local, practical issues. This format can also encourage team-working, which may be especially important where regulatory compliance may require a collective effort and willingness on all parts.

An employer who is looking to minimise costs might prefer to have the training delivered by an internal trainer, however the success of this model depends significantly on the radiation safety and the training expertise available within an organisation. Where such expertise exists, this can be a cost-effective option, however where this is missing, the training may just reflect (and perpetuate) local culture.

There is a real and significant risk if this approach is used too widely. Habits (good or bad) become embedded in a workforce as they are passed from manager to worker, and an personnel may only learn to follow procedures without feeling compelled to take wider responsibility.

Internal training events need to be carefully managed so that staff are not distracted and pulled away to other work business during the course. Employers should also be aware that by putting everyone through the same training programme, there may be a perceived loss of value because 'everyone has to do it'.

2 Internal course, external trainer

If radiation protection, or radiation protection in the context of a new application, is new to the site, if a workforce is cynical and dis-trusting of the employer, or if bad habits have been passed down from managers to staff over the years, it may be appropriate or necessary to bring in an external trainer with appropriate expertise. While this may be more expensive, the training will normally be perceived as more valuable since the trainer will have a non-partisan perspective on the radiation protection arrangements and is more likely to be perceived as a specialist. Discussions may be more open, particularly if managers aren't present, and the trainer might introduce new skills, ideas and information. An external trainer is also more likely to be allowed to stick to his or her programme, and not be pressured into curtailing the training to fit with operational pressures. An external trainer must, however, have a good understanding of the employer's particular radiation application and the associated issues.

3 External, open course

External, open courses are those where an employer sends his employee(s) away to learn alongside others from other businesses, and sometimes from other industries. Typically, the participants will learn the principles of radiation protection and how to apply them in a generic sense. While critics might argue that this is not targeted training, that there is a risk that the subject is too broad to be taught to a mixed audience, in practice the radiation protection principles do not change, these principles simply need to be applied according to the workplace. Whether the employer operates a nuclear power plant, an NDT firm or a hospital, the concepts, dose limits (and the basis for them), monitoring techniques, routes of exposure, time, distance and shielding and contamination control techniques are the same. In fact, the variety of radiation applications amongst participants, offer opportunities for discussions that may not be available on internal courses.

This format is very often appropriate for RPOs and others who are expected to take on radiation safety responsibilities, and offers added value in a variety of ways including:

Perceived value: If an employer invests in sending his employee off-site for training, the training is likely to be perceived as more valuable, by the employer, the employee and perhaps also the regulator, especially if the training is delivered by a recognised radiation protection training provider. The employer is more likely to expect a tangible difference at the end of his training (a return on his investment), and will expect participants to 'step up' and take on a role when the training is complete. This expectation is likely to encourage the trainee to engage fully with the training.

Networking: When a participant is the only person fulfilling a role within an organisation, they may welcome the opportunity to discuss issues with others. This will be particularly relevant for refresher or update training, where participants already have experience of radiation protection, and for professional level training where radiation protection is to be that person's main job. The participants have an opportunity to learn from others, and each participant will be a good resource, bringing their own perspective and experience to the classroom.

Perspective: It is especially helpful for regulators and other radiation protection professionals to appreciate the role and point of view of other professionals. In terms of workplace training too, RPOs should recognise how their own workplace compares with others. A sense of perspective can strengthen knowledge and engender confidence so that participants are better placed to supervise others and talk to them about the requirements and the risks in their own workplace.

Learning by analogy: This is a learning technique whereby the trainer makes a point using an example that is not directly relevant to any member of the audience; by seeing how the principles are applied in another workplace, participants may be more able to see 'by analogy' how to resolve their own issues and apply their solution in their own workplace. This technique has the added benefit that the participant feels that he or she has created, and therefore 'owns' the solution. This method of learning engenders a deeper level of understanding than learning by rote.

Speaking up: If the atmosphere in the classroom is right, participants may be more willing to air concerns or mis-understandings than if managers or colleagues are in the room. More than any of the above points, this depends on creating the right learning atmosphere, however there are various well-established classroom management techniques that can achieve this.

The success of off-site, 'open' courses depends on the technical and practical experience of the trainer who should be acquainted with a range of radiation applications and radiation protection issues.

Considerations

1 Cost vs benefit

The employer will always consider the cost of his training carefully: the training fee, his own staff travel costs and their time off-site. The employer will want to spend the company money wisely and will be looking for a training package that meets the exact needs of the workforce. An employer may be attracted to an efficient training programme that ensures 'Person A' can complete 'Task B' or can fulfil 'Role C', no more and no less. In fact, an employer may be reluctant to 'gold-plate' the training in case the employee takes the new skills (especially transferrable skills) and applies for work elsewhere.

A more circumspect employer should also see the long terms gains of investing in training that offers all the elements of added value outlined above: a confident and responsible workforce, a workforce where radiation protection culture is strong, where employees can apply the principles to atypical situations, use monitors, dosemeters and contamination control techniques skilfully and a working environment where incidents are minimised or handled safely.

It is worth noting here that the website "OTHEA" contains the descriptions for over 100 radiation incidents where there are lessons to learn: In several cases, poor training is cited as a cause. There are many relevant examples, two of which are:

"Loss of control of a well-logging source being transferred from a transport container"
"Unsafe Transport of a Waste Radiotherapy Source"

The descriptions in OTHEA indicate that the employees in question did not take responsibility for radiation safety, that they were simply required to follow a procedure. The incidents resulted in significant financial penalty in both cases; the employers may have saved money by arranging cheap training at the time but in the long term, both employers were financially (and reputationally) poorer.

2 Nature of the training

Where training is task-orientated or in support of a system of work, it can be appropriate for the training to be provided in-house, perhaps by experienced personnel within the company. This provides a good opportunity to practice skills in a realistic workplace and discuss practical issues with colleagues.

However, when participants are simply taught (told) to perform certain tasks in a certain way, or tackle incidents by following specified procedures, their capability will always be limited to the issues for which an employer has systems of work in place, in addition, there may not be any personal incentive to take responsibility for radiation protection. Those who know the principles and then discuss issues with others in the classroom, and who see an issue from other's point of view, will be able to make better and more informed decisions in their own workplace and be able to tackle novel problems.

The need for perspective and independent thinking is particularly relevant for professional level training. Not only will the trainees need to see radiation protection and risks in perspective; respect the expertise of others; and understand operational issues, but applying some complex principles in any novel situation is an essential part of their professional capability.

3 Nature of the audience

Audiences will respond to the training environment according to a range of factors, including the culture of their workplace and their own personality. It is often the case that those working in very large organisations may be more passive because they may feel that they are expected to simply comply with local procedures. However an employee who is part of a small team (or is from a smaller workforce) or is being required to take on a role on their own, may be more inclined to take responsibility for implementing anything they learn on a training course.

More cynical audiences may respond better to external trainers and previously trained audiences may welcome an opportunity to discuss their experiences with (and learn from) others. Individuals who have a more reserved nature may not respond well in a classroom of strangers, those who are more outgoing are likely to make the most of the networking opportunities.

Example 1 *An employer is looking to implement or improve his radiological monitoring programme. The employer wants his health and safety managers, RPOs and operators to understand the monitoring programme, what and when to monitor, how to record the results and what to do if trigger values are exceeded. The various parties (managers, employers, supervisors) all have a different role to play, but collectively, their work will ensure legal compliance.*

Here, the training is given in support of local systems of work and the participants will certainly want to discuss local issues. There is a benefit in managers, RPOs and operators being part of the same training event because:

- *Each participant should know that their colleagues / staff / managers have heard the same message.*
- *Regulatory compliance and good radiological protection is achieved as a team and participants will need to understand the part they play – discussion is a good means to achieve this understanding, and trust in each other.*
- *The requirements are specific to the workplace. Running the course internally will enable specific monitors / monitoring techniques and areas to be used to practice techniques.*

In this instance, it may be cost-effective to train employees together, even if their role is different, because of the number of employees who require training. The employer may also want the training to run on a mutually convenient date and time; such flexibility is not usually available for open courses.

Example 2 *Five RPOs from the same workplace require refresher training. They have all worked together since their initial training five years ago and this training is to update and possibly extend their knowledge. They have worked together for a while and have developed their own good and bad local habits and they have experiences to discuss and share with others. In this situation, (and dis-regarding the financial considerations for now), a public course would be ideal since participants would benefit from hearing the views of others (and vice versa – the rest of the course will benefit from hearing their views and experiences), they will be keen to network with others and are likely to be fully engaged in the training as they have some previous experience. To get the best possible benefit from this approach, the five should consider attending the training in smaller numbers.*

However, cost is likely to be significant in this example and an employer will probably consider bringing in an external trainer to train the five on-site. For all the reasons given above, however, a more outward-looking employer might consider open courses, perhaps phasing the training over five years, to stagger the cost.

Example 3 A regulator recruits three graduates to train as radiation inspectors over a period of five years. Their training programme will include formal qualifications (examined) and on-the-job training / mentoring. In practice, the candidates need to pass examinations. They have an option to study privately, and sit the exams when they feel they are ready, or go off-site to a public course, attended by trainee radiation protection professionals from their own country and from abroad.

Academically, the qualification may be the same regardless of where an employee sits the examination, however the added value of attending an open course are considerable. The trainees will learn how as a regulator, they can work with other experts to undertake fulfil their role, develop working relationships and mutual trust in each other’s expertise. As trainee radiation protection professionals, it is expected that these participants will be outward-looking on a training course and ready to engage with others, especially if the training is likely to deliver career development for them.

Summary

Taking all of the above into account, the gains and the losses of teaching a heterogeneous audience can be summarised as:

Teaching a heterogeneous (mixed) audience in an open source	
Gains	*Losses*
• Participant's access to expertise beyond that in their own work environment • Encourage a sense of responsibility • Training is perceived as more valuable • Deeper understanding can be achieved • Networking and understanding of wider issues / other roles • Participant's own experiences are a learning resource, (especially during refresher training) • Participants are away from the workplace – fewer distractions	• Individuals learn in isolation from colleagues • Practical and group work may not be specific • Expensive for a large workforce • Shy participants may not engage fully • Dates / times not flexible

Acting on this information, and considering the cost of training, an outward-looking employer might consider:

- Is this training in support of in-house processes and procedures only, consequently should it be delivered locally so that local equipment and facilities can be used?
- Is my radiation hazard significant – could the consequences of an incident be serious?
- Do I expect my employees to think independently and take some responsibility for radiation protection? If so, I should consider investing in training that will engender confidence, and provide a deeper level of understanding.
- Do I think that habits (good or bad) have become embedded? If so, I should look for appropriate, new perspective.
- Will my employees respond well to an external trainer?
- Is it important that my employees have an understanding of the wider risks?
- Are my employees the sort of people who will make the most of the opportunities to engage with others and learn from others' experiences and is this important in their role?
- Is it important for the company or for the employees that the training is given by a recognised radiation protection training provider?

Conclusion

The employer's ultimate choice in relation to radiation safety training must be made by balancing a range of issues: the radiation hazard, the resources (financial and time) available, and the nature of the employees.

In-house training delivered by colleagues will often offer savings in the short term and may be an appropriate choice in some situations, however the long term cost of poorly managed incidents, staff doing no more than following procedure, and ultimately fines arising from regulatory action, are also 'costs' to the business and should be factored in. Difficult decisions may need to be made

EDUCATION IN RADIATION PROTECTION FOR MEDICAL STAFF IN TRAINING

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ABSTRACT

The new Directive 2013/59/EURATOM establishes that professionals involved in medical radiological procedures shall receive adequate education and training in Radiation Protection. In particular, article 18 states that both practitioners and referrers involved in ionizing radiation procedures need to acquire an appropriate level of theoretical and practical education in medical schools. In Madrid, this education is completed during the training programme of interns at Hospitals, as several Radiation Protection courses imparted every year.

This training is organized into two different levels, basic and advanced, according to the degree of involvement in radiological procedures. Basic level of education is also organized into three different sublevels, the first one involves interns who will become mainly referrers in the first year of residency, the second one is intended for the same trainees during third to fifth year of the programme and the third one is aimed to nurses in training. The advanced level applies to practitioners in training: radiology, nuclear medicine, radiotherapy and radiopharmacy residents, specialties directly involved in radiological procedures. This level is organized as a formal education so that the trainees obtain the accreditation needed to perform their activities as practitioners.

All trainees must answer a satisfaction questionnaire at the end of each course, so as to evaluate their level of fulfilment regarding teacher's explanations, contents and applications, documentation supplied and organization of the course. Besides, a section of suggestions is included where any improvement or modification can be remarked.

The aim of this study is to evaluate the success of the Radiation Protection education programme at our country. The analysis is mainly based on the satisfaction questionnaire results corresponding to several courses celebrated between 2013 and 2015.

Radiation Protection basic courses intended for third to fifth trainees have obtained a better score in comparison to those courses aimed to 1st year physicians and nurses in training. The best results correspond to those courses from the advanced level. This result may be due to the following reasons; basic courses intended for referrers and nurses during their first year are primarily focused in basic concepts about ionizing radiations, so they refer that contents are not related to their daily activity. Second level of basic education is more practical and focused mainly on justification of radiological practices, so they find it more useful for their activity. On the other hand, advanced courses, intended for practitioners have a great acceptance among trainees. This is due to their familiarization with ionizing radiation at daily practice and also to more practical and specific contents for each specialty, notwithstanding they obtain further accreditation so the trainees are more motivated.

It is mandatory that health professionals receive further radiation protection education, adapted to the level of involvement in radiological procedures.

1. Introduction

The Council Directive 2013/59/EURATOM of 5 December 2013 [1], laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation, emphasizes in its forth chapter that Member States shall establish an adequate legislative and administrative framework ensuring the provision of appropriate radiation protection education, training and information to all individuals whose tasks require specific competences in radiation protection. The provision of training and information shall be repeated and documented at appropriate intervals.

The contents of the former Directive have been incorporated into the Spanish legislation[2,3], establishing basic Radiation Protection education as part of both the programmes of medical schools and the training programmes of medical specialties. The last Directive is expected to be incorporated into de Spanish legislation before 2018.

According to legislation, this basic education for physicians in training is responsibility of the Medical Physics and Radiation Protection Departments of university hospitals.

The European Commission Guidelines on Radiation Protection Education and Training for health practitioners, 116 and 175 [4,5], establish that such training should include basic Radiation Protection tuition, needed both by the referrers and the practitioners themselves. Knowledge on patient radiation protection such as biological effects of ionizing radiation, justification of exposures, risk-benefit analysis and typical doses for each type of examination are important basis to be learnt by physician and trainees during Radiation Protection courses. In particular, Guideline 175 takes into account new and more complex techniques and equipment related to ionizing radiation, together with the appropriate training necessary for their adequate performance.

Subsequently, some basic training in Radiation Protection is already being provided to medical students during the preclinical training period in Medical University Schools. They receive, through the first academic year, basic knowledge on General Physics, Radiation Physics and Radiation Protection.

Since 2007, additional Radiation Protection education has been established during the residency period of the education, as part of the medical specialist training programme [6,7]. Initially, this tuition was provided during the first year of the residency. In 2009, such experience was analysed and evaluated as a tool for optimization and improvement of the training programme [8].

The objective of this study is to continue with the analysis and evaluation of such education and training programmes, widening the scope of consideration on the Radiation Protection education developed from 2013 to 2015 at our hospital as well as at our region.

2. Material and Methods

The basic Radiation Protection education has been managed together by the regional Council and the Medical Physics and Radiation Protection departments of the university hospitals at our region. The analysis is mainly based on the satisfaction questionnaire results corresponding to several courses held between 2013 and 2015.

This training has been organized into two different levels, basic and advanced, according to the degree of involvement in radiological procedures. Basic level of education is also organized into three different sublevels, the first one involves residents who will become mainly referrers in the first year of residency, the second one is intended for the same trainees during third to fifth year of the programme and the third one is aimed to nurses in training.

The advanced level applies to practitioners in training: radiology, nuclear medicine, immunology, clinical biochemistry, radiotherapy and radiopharmacy residents, specialties directly involved in radiological procedures. This level is organized as a formal education so that the trainees obtain the accreditation needed to perform their activities as practitioners.

The basic level of education aimed to residents in their first year of residency is developed in a one day course with a length of six hours in just one session. After the lessons, the participants have to accomplish an evaluation test and to fill in a satisfaction questionnaire.

The same scheme is followed for the third sublevel, which involves nurses in training. The basic level course aimed to residents in their third to fifth year of the programme takes place in specific sessions enhancing the training practical aspects.
The basic level courses encompass ionizing radiation fundamentals such as structure of matter, radiation quantities and units, X-ray generation, radiation detection, the x-ray tube, x-ray equipment and image formation. These fundamentals were followed by one lesson of biological effects of ionizing radiation and another one of Radiation Protection principles and legislation. Maybe the most important lesson for referrers is the one which focuses on the description of the different procedures and equipment available at the hospital, with a brief notion about the dose received by the patient.
Further editions have meant changes in some of the contents and their complexity, to adequate them to the previous knowledge and interests of students, and to improve those aspects which are more requested in the satisfaction questionnaires of former editions.
The advanced level of education, besides the theoretical contents, includes practical lessons with x –ray equipment at dedicated rooms to optimize radiation protection during radiological procedures. The number of students at this level is reduced, for it applies just to some specialties. This also implies that course editions cannot be annual.
At the end of both curses, basic and advanced, a satisfaction questionnaire, developed by the regional Council, is provided to the trainees following the final evaluation, so as to evaluate their level of fulfilment regarding explanations of the teacher, contents and applications, documentation supplied and organization of the course. In addition, a section of suggestions and observations was included where any improvement or modification could be remarked. Each item of the satisfaction questionnaire was marked between 0 and 10. Special interest had items such as “Utility for your job”, “Degree of knowledge acquired”, or “Global assessment of the course”.

3. Discussion and Results

The satisfaction questionnaires from 2013 to 2015 showed that the trainees were much more interested in medical aspects, of direct application to the clinical practice, than in basic Radiation Physics. They found the theoretical contents extremely difficult, although they admitted they are necessary in order to develop their professional activity.
Other subjects were not just lightened but suppressed; instead of them, it was decided to emphasize on the principles of Radiation Protection and the specific aspects of radiological protection in Medicine. For this purpose, some practical contents have been included since 2009, to complete the theoretical concepts and these changes have been maintained in subsequent courses. These practical contents are focused on radiological risk information for patients and also exposed workers. Of special interest are those situations involving pregnant women (both workers and patients) and paediatric patients, for whom the application of justification principle is even more critical. Actually, the inclusion of practical cases regarding those specific exposures had already been suggested by the trainees in the questionnaires.
On the other hand, “Radiobiological effects” has appeared to be one of the subjects that hold more interest of the students, so it has remained in the contents since the beginning, though it has also got lighter.
From the three basic level courses, the one which is aimed to resident in their first year of residency has a great acceptation. More than 1200 students have attended to this course at different hospitals over the three years in evaluation. This number of trainees is 120% higher than the number of participants during the first editions [8].
In 2012, nurses in training in the first year of their residency programme at our region, were invited to attend at the basic level course for medical trainees. Due to the high participation registered and the specific training needs of nurses, it was decided to adapt the basic course programme and create a new modality for this group. This basic course sublevel has started in 2013. Table 1 shows some of the questions from the satisfaction questionnaire.

Basic Level Course for nurses in their first year of residency			
Year	2013	2014	2015
Number of participants	235	120	120
Theoretical contents	6.91	6.22	6.04
Practical contents	5.74	5.56	5.46
Methodology suitability	6.49	5.54	5.31
Utility for their job	5.82	5.18	4.52
Degree of knowledge acquired	6.26	5.43	5.62
Aroused interest	5.91	5.31	4.96
Response to previous expectations	6.21	5.25	5.32
Delivery documentation quality and suitability	7.35	5.78	7.04
Employed resources quality and suitability	7.03	6.11	6.64
Employed installations suitability	8.00	7.55	7.13

Tab 1: Averaged outcome (from 0 to 10) of some evaluated questions from the satisfaction questionnaire.

The basic level course aimed to trainees during third to fifth year of residency had a great acceptation.. The evaluation of the course by the students is the highest among the three sublevel courses (table 2). Their higher degree of knowledge of the course topics causes a greater motivation among the participants.

Basic Level Course for trainees during third to fifth year of residency at Madrid County		
Year	Number of participants	Global assessment of the course
2013	752	6.83
2014	755	7.05
2015	2731	6.79

Tab 2: Number or participants and average outcome of the global assessment of the course aimed to trainees during third to fifth year of residency.

The advanced level course is held every two years and aimed to trainees belonging to specialties which directly make use of ionizing radiations. It is the best evaluated course because their contents are more related to the daily practice of the participants. The students also obtain the accreditation needed to perform their activities as practitioners [9].

4. Conclusions

The imparted courses during these years have been a great support in arising a better understanding of ionizing radiation and the radiation protection principles. As a consequence, justification of radiologic procedures has been improved.

Optimization of radiation protection for both operational and medical exposures has been achieved due to a wider knowledge of ionizing radiation risks.

A higher degree of implication and motivation of the residents has been assured by creating and putting into practice specific courses with contents adapted to clinical practice.

New technologies and more sophisticated procedures require continuous education in Radiation Protection to be imparted for all health professionals.

Since the attendance to these courses rises every year, an increasing number of people (both workers and patients) benefits from such education.

A better communication of radiation risk, especially in paediatric patients and pregnant women, leads to a higher patient safety in medical radiological procedures.

5. References

[1] European Commission. Council Directive 2013/59/EURATOM of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom; 13:14-15

[2] Ministerio de Sanidad y consumo, Gobierno de España. REAL DECRETO 815/2001, de 13 de julio, sobre justificación del uso de las radiaciones ionizantes para la protección radiológica de las personas con ocasión de exposiciones médicas. 2001 14/07/2001;13626(168):25591-25594.

[3] Ministerio de Sanidad y consumo, Gobierno de España. Resolución mediante la que se acuerda incorporar en determinados programas formativos de especialidades en ciencias de la salud, formación en Protección Radiológica. 2006. 21/04/2006

[4] European Commission. Radiation Protection 116: Guidelines on education and training in radiation protection for medical exposures. 2000.

[5] European Commission. Radiation Protection 175: Guidelines on radiation protection education and training of medical professionals in the European Union. 2014

[6] ICRP. Radiation protection in medicine. ICRP Publication 105. Ann.ICRP 2007;37(6):1-63.

[7] ICRP. Education and Training in Radiological Protection for Diagnostic and Interventional Procedures. ICRP Publication 113. Ann.ICRP 2009; 39(5): 1-56.

[8] Education in radiation protection for physicians in training. A three year experience. Garcia Castañon P. ETRAP 2009.

[9] Instrucción IS-17, de 30 de enero de 2008, del Consejo de Seguridad Nuclear, sobre la homologación de cursos o programas de formación para el personal que dirija el funcionamiento u opere los equipos en las instalaciones de rayos X con fines de diagnóstico médico y acreditación del personal de dichas instalaciones. CSN. 30/01/2008; 43: 9023-9033.

TRAINING FOR THE USE OF E-LEARNING TOOLS FOR SPECIALISTS IN THE NUCLEAR SECTOR OF LATIN AMERICA AND THE CARIBBEAN

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ABSTRACT

The Latin American Network for Education and Training in Nuclear Technology (LANENT) and the International Atomic Energy Agency (IAEA) developed a course to introduce the use of e-learning tools and to present the processes and stages involved in the planning, development and implementation of an online course. The training involved experts of the nuclear sector, from the LANENT community of Latin American and Caribbean countries, that are directly responsible for the education and/or training of their institutions. The collaborative work performed by a team of consultants to prepare the course shared a virtual office in the Moodle platform of the LANENT portal as well as periodic meetings through videoconferences, via Webex, to review advances and coordination. The modules of the course were implemented in a scorm format as reusable digital learning objects and were arranged in the virtual classroom for the participants. Moreover, its instructional design included a one-month online pre-training phase and 40 hours of self-learning in a virtual learning environment available at the LANENT portal which was followed by a 5-day face-to-face training sessions of 35 hours at the Metropolitan University of Education- UMCE, in Santiago – Chile. The first course started in 2015 in Santiago, Chile, with 11 professionals from 6 countries and the second one in 2016 in Lima, Peru with 18 professionals from 7 countries. Participating professionals had the opportunity to analyse the dimensions of pedagogical and technological management in the implementation of e-learning methodologies and to learn tools of authoring interactive digital content and to build a community of practice.The participants of the two editions are connected in a community of practice to continue working collaboratively, expanding their new knowledge and skills on e-learning for their education/training/dissemination engagements on the themes of their professional activities in the nuclear field. To reinforce the concepts learned, they are currently organized into four groups to plaining an instructional design to offer online courses in the following subjects: Radiological protection, Introduction to Nuclear Energy, Effect of non-ionizing radiation, especially cellular and Responses to Emergencies, respectively. The results achieved exceeded expectations, translating into an effective educational strategy for the training of nuclear professionals in e-learning methodologies.

1. Introduction

The Regional Introductory Training Course on the Use of e-Learning Tools as a Support to Nuclear Education and Training, emerged from the Consultants Meeting held at the Metropolitan University of Education Sciences (UMCE) and at the Center for Studies Nuclear La Reina of the Chilean Nuclear Energy Commission (CCHEN), in Santiago de Chile, under the auspices of the IAEA and as part of the activities of the RLA-0048 Project of the LANENT Network. The members of LANENT working groups have considered that it would be important for the region to provide an opportunity for training in e-learning through a hybrid course, implemented in two successive stages - online and face-to-face - demonstrating the potential of self-managed learning mediated by ICTs and the advantages of a set of tools for the design, implementation and evaluation for education and / or training in the nuclear field. For this, it has been determined to offer training alternatives at different levels, which facilitate the work of teachers and trainers. As a first step in this regard, it was decided to design and implement an introductory course on the possibilities offered by the e-learning teaching modality in its different forms, aimed at teachers and trainers. The Meeting of Consultants on Training of Teachers and Trainers for Creation and Implementation of Courses of Nuclear Matters in e-Learning Mode had the following objectives:

1. Create a course on e-learning (structure, content selection and technological tools) to provide guidance and support to university professors for the development of online courses in the field of nuclear applications.
2. Develop at least the following tasks for the course: selection of content specialists, methodologies and technological tools, and determination of responsibilities; instructional design; development of teaching material for online learning; implementation and distribution of the course and methods of management and evaluation.

1.1 Course structure and modeling

The course was developed in "blended-learning" mode, starting with a pre-training stage carried out through the Educational Portal of the LANENT Network and a face-to-face stage. The course focuses on the promotion of e-learning as a teaching method that can be used for various educational and training scenarios on the peaceful uses of nuclear technology. It provides pedagogical knowledge on instructional design and evaluation for this teaching methodology, and practice opportunities with multimedia tools for the production of teaching material, as well as management of the Moodle computer platform that the IAEA has made available to regional networks for Education and training mediated by information and communication technologies.

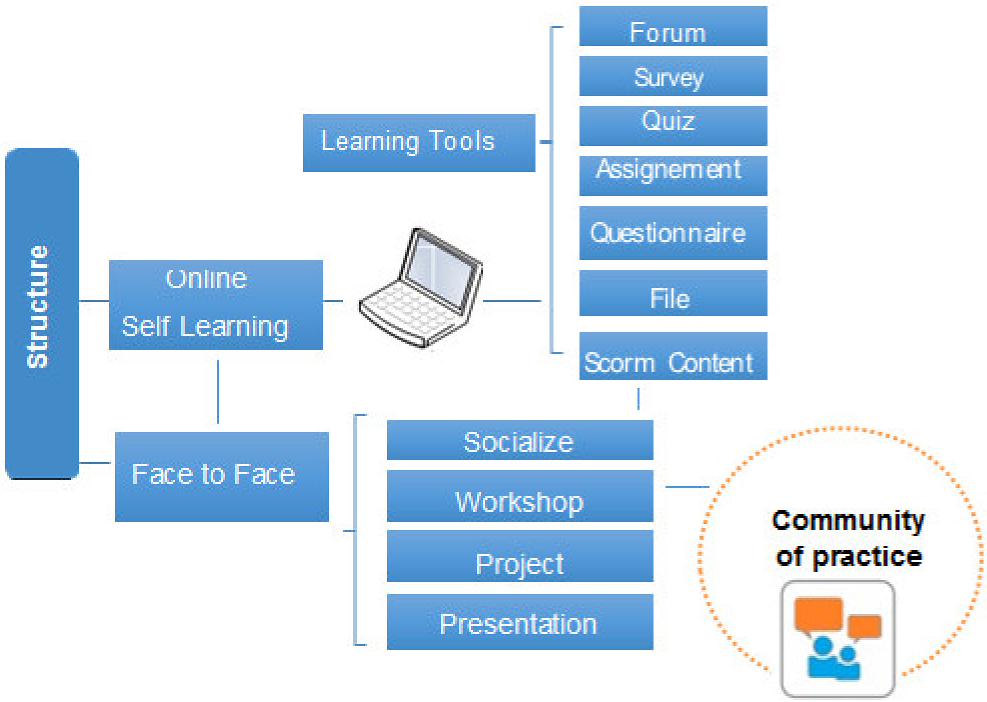

Fig 1: Course structure

1.2 Pedagogical Planning and Production

The pedagogical planning of the course was a fruit of the Meeting of Consultants in Santiago in December 2014, giving rise to an intense collaborative work in network for the production of contents, learning activities, didactic and evaluation resources throughout 2015, between the months of January and September. In this period, the support of the IAEA through the Webex system for video conferencing and the access to the Moodle computer platform through LANENT Educational Portal, installed on a server of the CNEA in Argentina, was of vital importance.The instructional design of the course included a one-month online pre-training phase and 40 hours of self-managed independent study in a virtual classroom implemented in the LANENT portal, followed by a 5-day face-to-face training phase (35 hours). [1] The contents were defined to be developed in two stages. The first, online (self learning) and the second, face-to-face, with the following purposes:

A) Online

- Present the basic concepts related to the e-learning modality, understood as a way of teaching aimed at promoting autonomous learning mediated with computer and communications technologies;
- Review, at an introductory level, a set of technological tools to design and implement e-learning courses.

B) Face-to-face

- Reinforce and socialize learning outcomes on the basics of the online stage;
- Practice the use of technological tools for e-learning reviewed in the online stage;
- Apply e-learning tools to the design of an online pilot course on topics of interest and specialty of each participant.

The contents of the course were structured in 6 modules:

Module 1 - Presentation
Module 2 - Introduction to E-learning
Module 3 - E-learning: Content Dimension
Module 4 - E-learning: Pedagogical Dimension
Module 5 - E-learning: Technological Dimension
Module 6 – E-learning: Management Dimension

Learning outcomes:

- Understand the basic processes and steps involved in planning, developing and implementing an online course in its different variants and dimensions: self-learning or guided by a synchronous or asynchronous tutor etc;
- Analyze the pedagogical and management aspects of each dimension involved in the creation of an online course;
- Know the role of a working group to implement e-learning methodology;
- know some of the tools integrated in the various stages of the process and their use, with examples related to the most used;
- Understand basic technology requirements in online courses.

1.2.1Structure to create the contents of each module

Each module was developed with a common structure, according to the instructional design expected for the course, as this example:

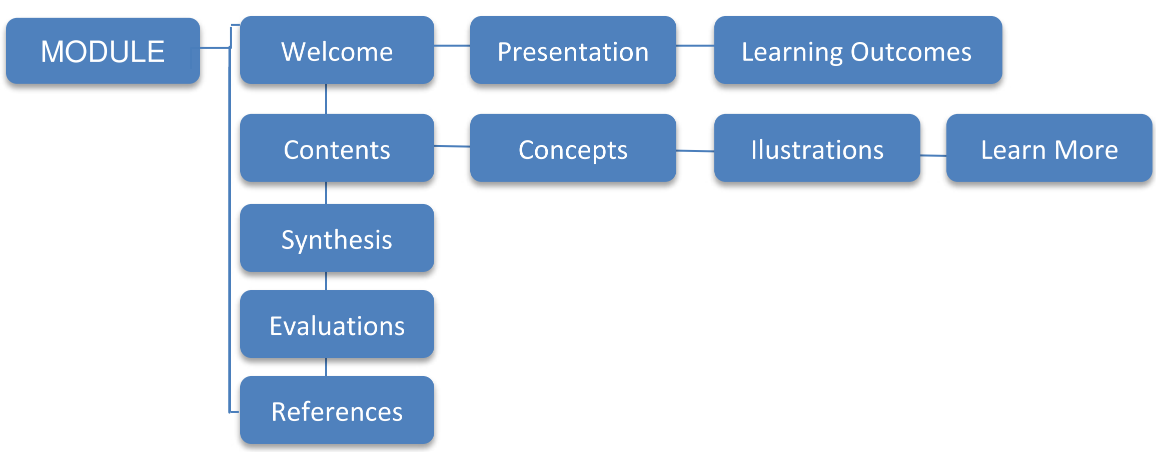

Fig. 2: Structure to create the contents of each module

1.3 Implementation of the Pre-Training - Online

The virtual pre-training stage of the course was implemented in the LMS Moodle environment of the LANENT Network. The main functionalities available in Moodle allow communication and interaction to be established, publication of contents, accomplishment of tasks (lessons) and evaluations of the learning.

1.3.1 Contents, Activities and Evaluation

The virtual learning environment Moodle was organized to provide participants with autonomy of study, considering the premise of being a stage of self learning. As it is a project for the countries of Latin America and the Caribbean, the language adopted in the course is Spanish. The learning virtual environment selected for the course was the Moodle plataform Moodle (https://plms.lanentweb.org/). It is an environment for the creation, participation and administration of courses on the Web, free and open source, presented during the course and in face-to-face meetings, when a workshop is developed for its initial exploration.

A presentation video was produced, which was included in the Moodle virtual classroom of the course, and socialization and learning forums were set up. In addition, 3 tasks were scheduled for intermediate evaluations, and a tutorial feedback service was provided by UMCE professionals for those who would like to request it.

Fig 3: Welcome Presentation Video (Scorm Package)

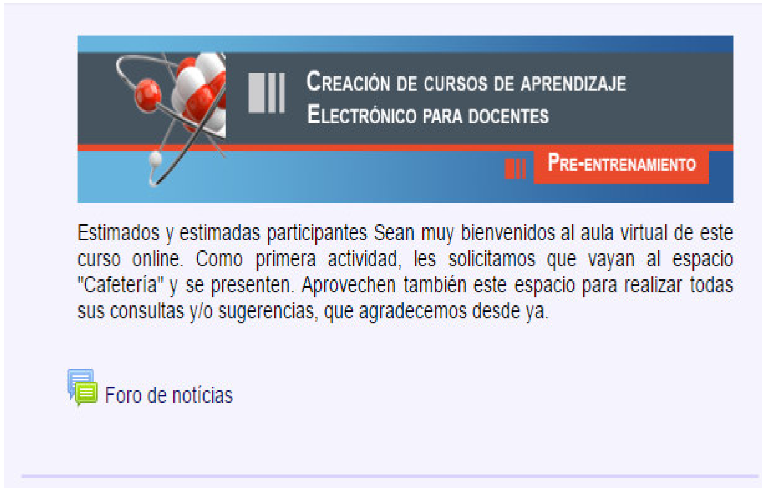

Fig 4: Welcome to the Course (Moodle Content)

There is a space in which the participants find the main information about the course, as well as an invitation to introduce themselves to the other participants. (*Cafeteria*) In addition, they can access the Course Guide to obtain all the information about how the course is organized.

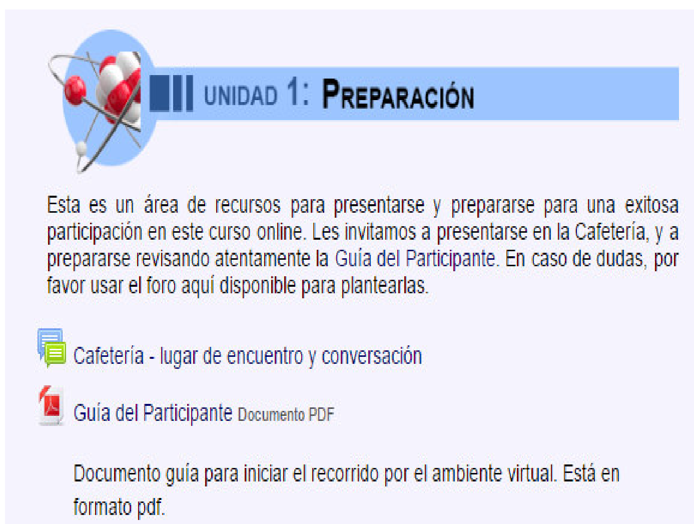

Fig. 5: Course Information

The specific content of the online course is presented in order to allow an autonomous and self-managing navigation for each participant to their own style and pace of learning. The content is distributed in 6 modules, available in two parts. Also, the forum is accessed on the contents and space of tasks prescribed in some of the modules, for sending them to the tutors and receiving feedback. The virtual environment provides digital content, additional bibliography to enrich and deepen learning, useful links to complement the training and a glossary.Partial exams are used at the end of each module, which can be repeated until the required minimum knowledge is reached. A final evaluation of the course, of multiple choice type, is made and can be repeated. It can only be done after successful completion of the partial evaluations.

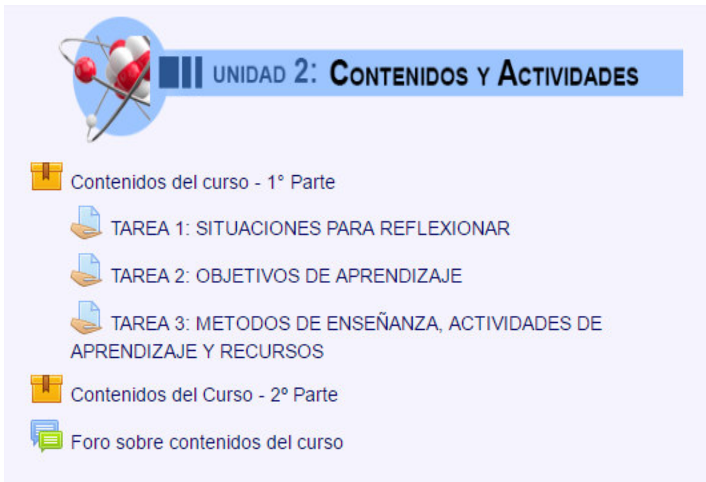

Fig 6: Contents and Activities

1.3.2 Content in scorm format

The digital content of the course was developed through the Articulate authoring software (https://articulate.com/). After creating the e-learning project with this authoring tool a scorm content package is generated to publish in the virtual learning environment (LMS platform). Some examples of scorm format content created in accordance with the instructional design of the course [3]:

Sample Text:

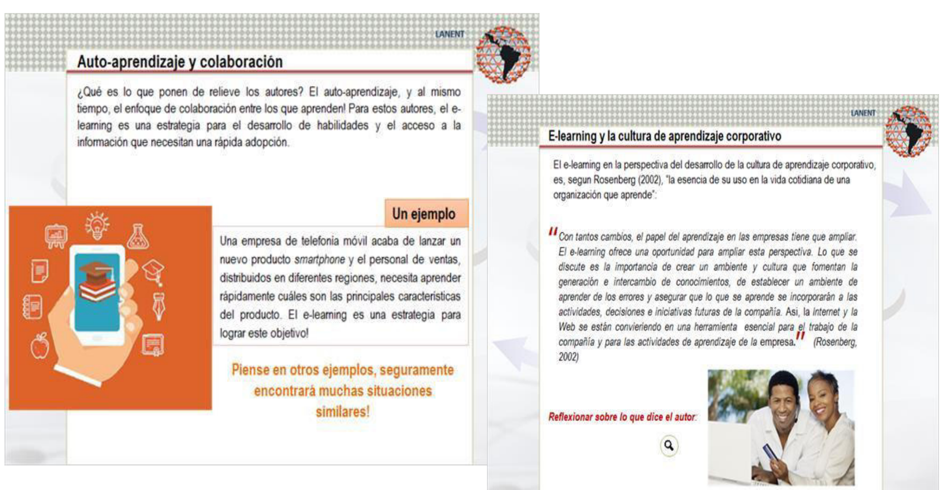

Fig 7: Example Scorm Content – Sample Text

Interactive content in scorm format

Fig 8: Interactive content in scorm format (Example)

1.4 Face to Face

The course as a whole is anchored in the development of a project. The participant should, from the definition of the theme, organize the planning and detailed educational design and then implement in the Moodle environment. The implementation of the courses in the Moodle environment counts on the elaboration of the graphic design as insertion of images, animations, videos and suggestions of addresses in the internet and the organization and structure of the virtual environment. At the beginning of the course students take up a student role in the Moodle environment and.

In the face to face phase the participants should create a course project, applying the knowledge learned in the online step. Moodle environments are created for each participant can act as an educational planner and designer. Therefore, throughout the course they have two courses in the environment: the Pre-Training course and the course they develop. It is an opportunity to articulate and practice, according to the methodological proposal of training in action.

After the implementation, each participant presents his / her project and analyzes the projects of the participants, seeking together to identify points to be adjusted and improved, thus exercising the collective construction of knowledge.

The face-to-face stage, considered a fundamental part of the practice of e-learning, provided the participants with practical training in computer lab 8 h / day * 5 days; use of software tools deployed in a special section of the virtual classroom; group discussions on e-learning for nuclear education and training; individual / couple working on small sample projects and course evaluation.

The expected results were successful, giving participants the opportunity to:

- Discussion of the main barriers commonly argued against e-learning, in comparison with traditional teaching methods and resources;
- Demonstration of the possibilities and opportunities of e-learning/b-learning for nuclear education and training in the region, through individual immersion on a pre-training stage about those topics using a LMS;
- Practical learning of ICT tools, through individual and group hands-on work about resources for production, delivery, managing and assessment of e-learning/b-learning courses;
- Exploration of needs and expectations for future courses on nuclear education and training in the region, to be built in collaboration, thanks to the develop of a community of practice.

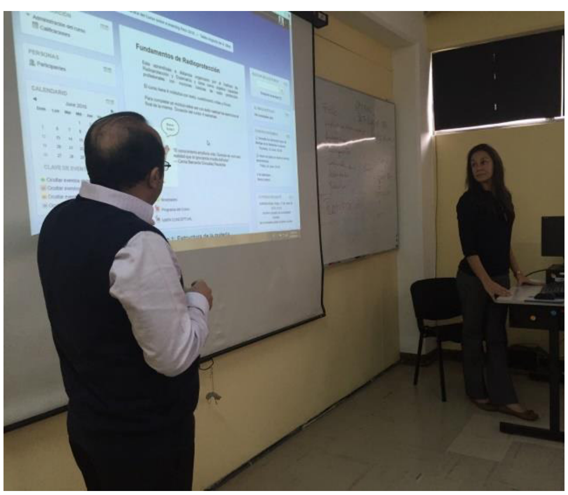
Fig 9: Participants presenting their project


Fig 10: Workshop

1.5 Community of Practice

After the face-to-face stage, the participants decided to stay connected to continue working collaboratively and expanding their new knowledge and skills on this teaching modality for their education / training / dissemination engagements in their professional activities in the nuclear field.It is taking advantage of the virtual classroom of the course in the LANENT Portal, to shape that community of practice on e-learning for education and training in nuclear technology. This community of practice works collaboratively in the following purposes:

- Review the evaluation of the course and suggest improvements for a new version, which can be implemented in the same modality of two stages, online and in person, for new stakeholders of the nuclear field of the region;
- Apply the knowledge and skills acquired in the course on e-learning to the collaborative network design and production of a nuclear content course, to be implemented in the region from 2017.

Also, IAEA Webex videoconference meetings have been held to plan and start the committed tasks, since it is programmed to offer the version of this course on e-learning to a new group of participants.

Conclusions

The course has grown the community of practice, created in its first version in Santiago de Chile, from 11 to 36 members plus the teaching staff. The theoretical and practical lessons exceeded the expectations of teachers and participants. Hence, it is expected that future projects continue providing specific training to more Latin American and Caribbean professionals. The aim is to apply the knowledge acquired in the creation of e-learning courses in topics defined according to the interest of the participants and the priorities defined in the strategic profile of the region. The results achieved accomplished the goal of translating into a complete design, production and implementation plan for an introductory course on e-learning, to be taught in two successive stages, online pre-training and face-to-face training.[2]

References

[1]Term of reference: Introductory course to the use of e-learning tools as a support for education and training in the nuclear sector pre-training in e-learning modality. Group of IAEA/LANENT/UMCE, Santiago, Chile, 2015.

[2]Matzen, C.P. Mission Term Report - Project RLA 0048. Santiago, Chile, 2016.

[3] José, M.A. Mission Term Report - Project RLA 0057. São Paulo, Brazil, 2016.

RECENT DEVELOPMENTS IN VIRTUAL DOSE MINIMISATION GAME FOR EDUCATION, TRAINING AND OUTREACH

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ABSTRACT

Using our extensive experience with the use of 3D, virtual and interactive computer-game like models for education and training, we have developed a computer-game to communicate to the player the salient physics of radiation and the principles of radiation protection. It is a scavenger hunt game that takes place in a 3D, virtual model of the TRIGA research reactor that existed at the University of Illinois at Urbana-Champaign and has recently been decommissioned. Virtual objects are placed in this model of the multi-level facility. Also stored in the reactor building are several radiation sources that lead to a realistic radiation field. The goal of the game is to minimise the dose received while collecting the objects. Many of the radiation sources are placed in direct path to the objects. Thus, to minimise the dose one must go around the radiation field. The player is meant to learn about important concepts in radiation protection such as time and distance. The radiation field can be visualised during the game as a colour-coded floor. The program also includes a realistic virtual dosimeter, and a scoring system. The scorekeeping feature introduces a competitive aspect. Younger players tend to play the game multiple times to improve their score relative to their peers. After repeatedly playing the game, the player becomes familiar with the facility and the location of the radiation sources and their varying strengths. The player becomes aware of the optimal path to receive minimal dosage and is able to manoeuvre through the reactor building with ease. Though the players on their own may not “discover” the importance of time and distance simply by playing the game multiple times, they can certainly experience the role these factors play in minimising dose if they have been told about their importance in advance. Thus, virtual, 3D, interactive models can be used for training in radiation protection as they allow users to become familiarised with the environment through repetitive encounters that may otherwise be risky or harmful in a physical, radioactive environment. Additionally, the game format proves to be an effective way to educate a younger audience. The gaming approach engages and entertains the player and educates them of key concepts in radiation protection. Therefore, these models can be used as a means of education and training across a wide range of ages.

1. Introduction

At the Virtual Education and Research Laboratory (VERL) in the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois at Urbana-Champaign, we are developing a range of 3D, virtual, interactive models to be used for education, training and outreach purposes. One such model that has been developed is a scavenger hunt game, played in a radioactive environment. The goal of this game is to minimise the dose received while collecting objects placed around the facility, and in the process learn about three important concepts in radiation protection: *time, distance, and shielding* [1].

2. Dose Minimization Game

This scavenger hunt game is played in the virtual, 3D model of the University’s TRIGA research reactor [2-5]. The TRIGA model was developed using the Unity-3D game engine (Fig 1). The interactive model allows users to explore the multi-level facility and operate the reactor using the virtual control room [3]. For the purpose of the dose minimisation game, virtual objects are placed in this model (Fig 2). Also stored in the virtual reactor building are several radiation sources that lead to a realistic radiation field. The goal of the game is to navigate through the reactor building and collect the objects while receiving the smallest radiation dosage possible.

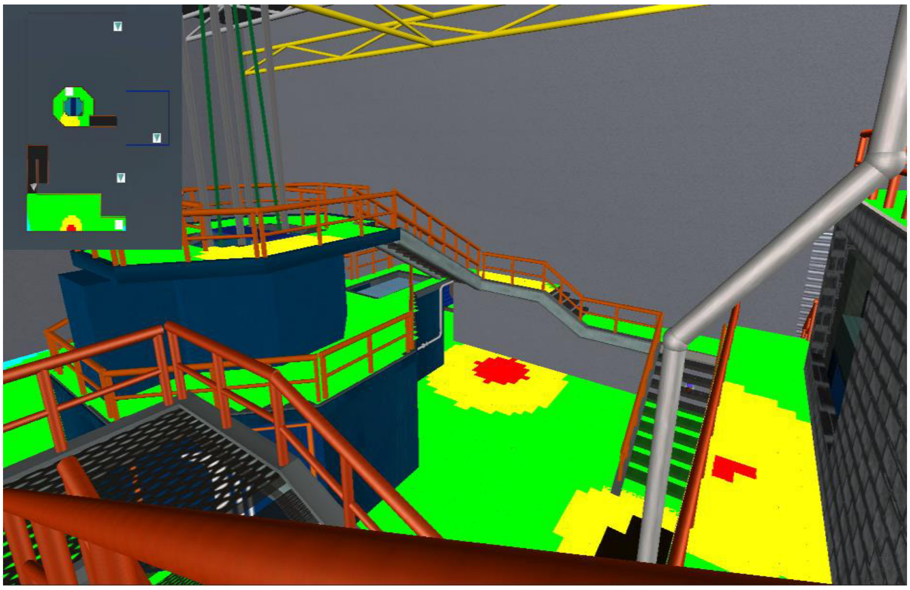

Fig 1. A view of the inside of the TRIGA reactor building.

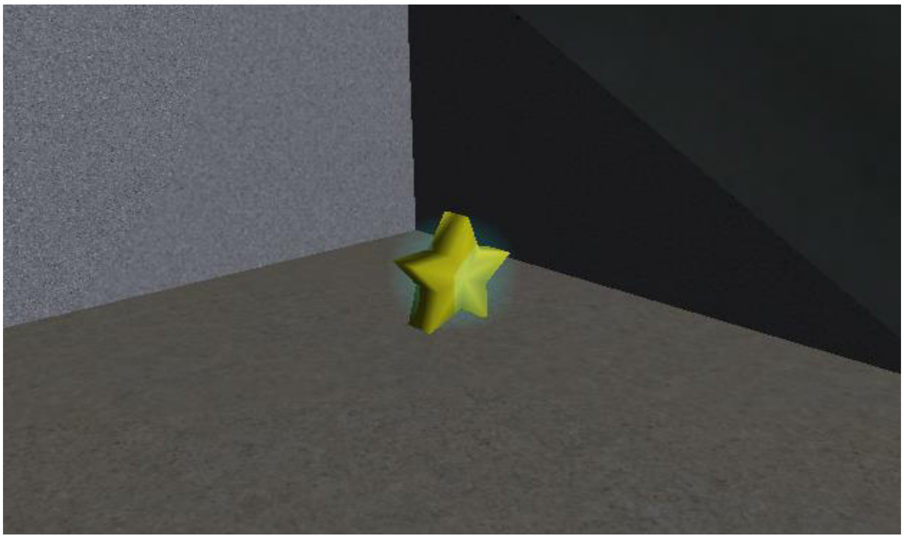

Fig 2. A view of one of the objects placed in the reactor building. A faint blue glow appears around the objects that are to be collected.

The locations of the objects and strengths of the sources are randomised each time the game begins. Hence, the optimal path to minimise dose varies each time the game is played. At the start of the game, the player is briefly shown a map of the radiation field and the locations of the various objects to be collected (Fig 3). The radiation field map can be viewed during the game and is toggled by pressing a button. With the given information, the player has to strategically determine the best path to take to achieve the goal of the game.

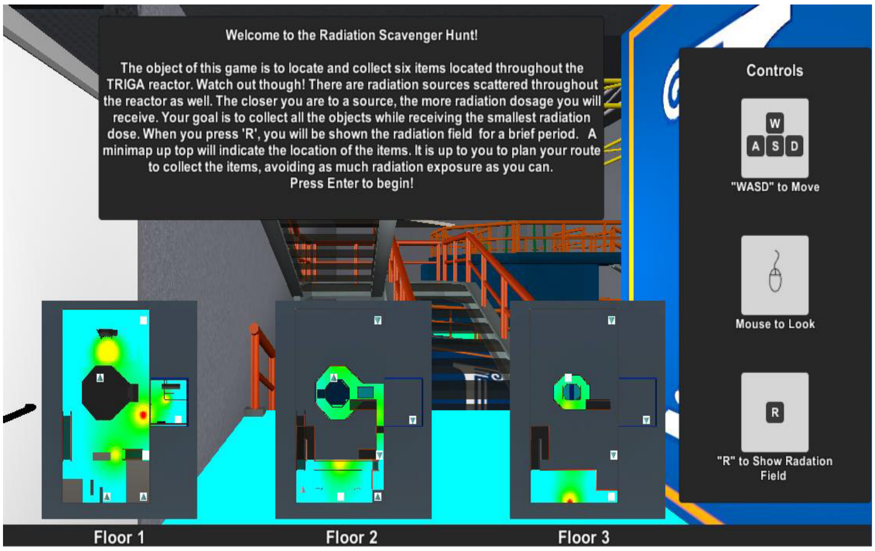

Fig 3. A view of the start screen

While the game is being played, three different counters are displayed at the bottom of the screen (Fig 4). The first counter displays the dose the player has received (in mSv), the second keeps track of the number of objects that have been collected, and the third shows the length of time the colour-coded radiation field map has been used. A minimap, in the top left corner of the screen, is also displayed. This shows the location of the objects to be collected. The game also includes the dosimeter feature [4] which keeps track of the dose received and has a beeping sound similar to that of a Geiger counter. The frequency of the beeps is directly proportional to the strength of the radiation level at the player's current location.

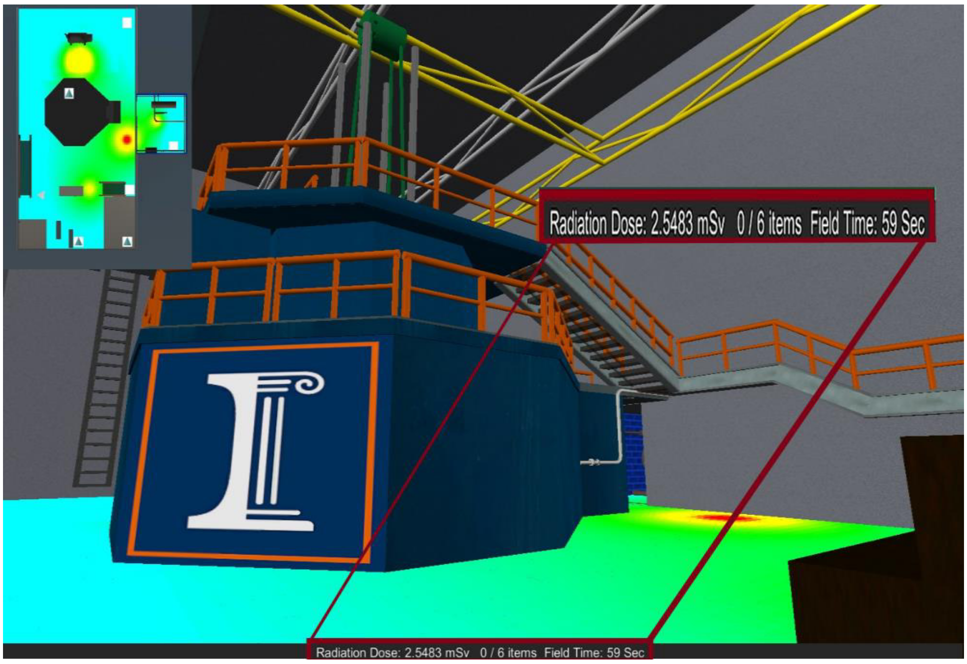

Fig 4. A view of the TRIGA reactor and the colour-coded radiation field with a zoomed-in view of the three counters

When all six objects have been collected, the user is shown an end-screen. The end-screen of the game presents the dosage received, the length of time the radiation field was viewed, a score, and a list of comparative doses (Fig 5).

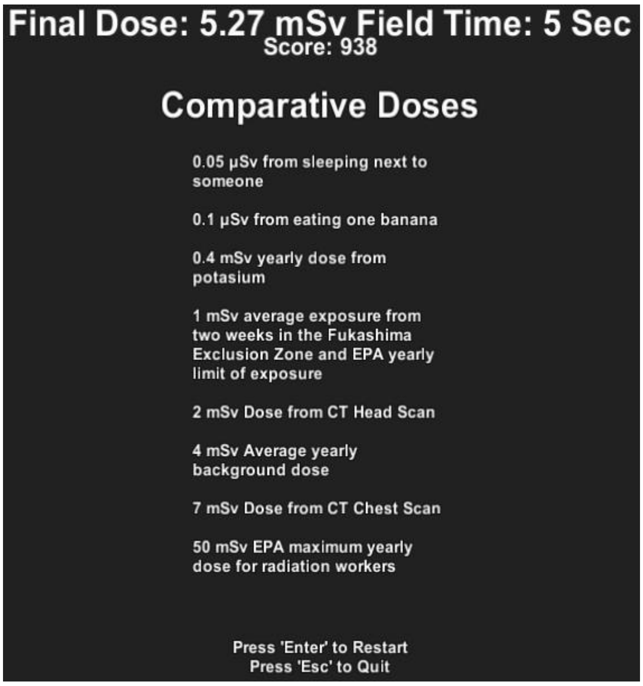

Fig 5. A view of the end-screen

3. Dose Game Development

The process of developing the dose minimization game includes three main components: modelling the 3D environment; event scripting; and user interaction. The 3D model of the TRIGA reactor was built using game engines such as Unity3D and has been reported earlier [2-6]. This site was chosen as the location for the dose game as it has multiple levels and rooms, making the game more challenging. The features of the scavenger hunt game were implemented using various scripts written in C#. For example, the dose rate is calculated using a physics model that uses the strength and location of the source as well as the location of the player [4]. When activated by the player, the radiation-display feature turns the floor into a colour-coded radiation field (Fig 4). Scripts are also used to randomise objects that need to be collected by the player. When the game begins, a script uses a random number generator to choose and display six objects in the reactor building. There are currently twenty four objects programmed in the model, but only the six chosen are visible and should be collected during the game. The game begins once the six objects are *spawned*. The locations of the radiation sources are predetermined and are chosen in such a way that in many cases the most straightforward path towards the object will lead to the highest dosage.

A competitive aspect is implemented by providing an incentive to the player who is able to achieve minimal dosage exposure in the smallest amount of time amongst a group of similarly-aged players. The final score depends on three factors: total dose received; time-to-completion; and duration of time radiation field was visualised during the game.

4. User Interactions

The player in the current model moves using the keyboard controls while the mouse is used to control the *camera* (direction in which the player is looking). The user is currently able to enter various rooms and walk up and down staircases. The desired objects are collected, or picked up, by simply walking into them. The radiation level in the currently implemented physics model simply drops as the square of the distance from the source. The colour-coded radiation field map is toggled by pressing “R” on the keyboard. A script is used to keep track of the length of time the radiation field map is viewed.

The game can test the ability of players well versed in the concepts of radiation protection. It can also subconsciously teach these concepts to middle and high school students after consecutive attempts. When competition is introduced, players are more prone to repeatedly playing the game.

5. Discussion and Conclusions

Several improvements have been planned. In addition to randomising the objects to be found, we also plan to use multiple sources and vary the location and strength of sources in each rendering of the game. Shielding and attenuation are important concepts for radiation protection. Realistic radiation fields calculated using codes like MCNP will also be implemented to include these concepts. To increase competitive appeal, another feature to be implemented is to (via a script) keep historical records of the best score, lowest dosage achieved and minimal time elapsed.

This educational game will be a useful teaching tool for children as well as adults who may be new to the nuclear field, such as new or temporary employees who work in radioactive environments. By playing the game, players understand that time and distance are important concepts in radiation protection. The list of comparative doses allows for players to understand the different orders of magnitude of dose. Those new to or unfamiliar with radiation concepts are able to understand their relative level of dosage received in the game. This game also proves to be an efficient tool for engagement and outreach. When players opt to play the game repeatedly, they become familiarised with the layout of the facility as well as the location of various radiation sources. They are thus able to take advantage of virtual, immersive, technology for training purposes. Additionally, the game can show that accomplishing simple tasks within radioactive environments, such as collecting objects, is not necessarily harmful, especially with the appropriate preparation. The comparison of dose received by performing menial tasks inside a reactor facility paired with the dose received in other daily instances, as shown in the end-screen (Fig 5), may help destigmatize misconceptions some may have about low-level radiation environments.

Given that Unity3D supports use of its models on handhelds devices such as smartphones and tablets, this game would be very easy to distribute. Unity3D also provides support to various virtual reality headsets such as the Oculus-Rift and the HTC Vive. These headsets allow players to control the *camera* by moving their head [6]. These options would allow easy and immersive access to the virtual reality space and therefore would give workers a chance to train safely without the risk of receiving an actual dose.

6. References

1. G. MATTINGLY, E. RIEWSKI, Q. TAN, D. CHUN, RIZWAN-UDDIN, "A 3D, Interactive and Virtual Dose Minimization Game for Education and Training," *Transaction of the American Nuclear Society*, **114**, (2015).
2. Y. LI, I. HADDISH, X. ZHU, Y. SATOH, RIZWAN-UDDIN, "A 3D, Interactive Virtual Instruction Laboratory and a Virtual Model of a Reactor Control Room," Proc. ANS ICONE (2014).
3. Y. SATOH, Y. LI, X. ZHU, RIZWAN-UDDIN, "A 3D, Virtual Research Reactor with Interactive Control Room," *Transaction of the American Nuclear Society*, **111**, 169, (2014).
4. Y. SATOH, Y. LI, X. ZHU, C. KUPRIANCZYK, RIZWAN-UDDIN, "Virtual Research Reactor with Interactive Control Room for Reactor Operator Training," Proc. ANS NPIC/HMIT (2015).
5. Y. SATOH, Y. LI, X. ZHU, RIZWAN-UDDIN, "3D Virtual Laboratory with Interactive Instructions for Nuclear Education and Training," Proc. ANS ICONE-23 (2015).
6. Y. SATOH, RIZWAN-UDDIN, "3D Virtual Research Reactor in Oculus Rift with LEAP Interactivity," *Transaction of the American Nuclear Society*, **112**, (2015).

SUPPORT AND INTEGRATION OF EDUCATION AND TRAINING FOR RADIATION PROTECTION RESEARCH IN THE EUROPEAN JOINT PROGRAMME CONCERT

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ABSTRACT

CONCERT is a Euratom-funded European Joint Programme, set up as an umbrella structure to prioritise and support radiation safety research in the areas of low-dose risk, radioecology, nuclear emergency preparedness, radiation dosimetry, medical radiation protection, and the social sciences and humanities. It began in June 2015 and will run for 5 years. Members of the CONCERT consortium are national research funding agencies and the radiation protection platforms: Alliance (radioecology), NERIS (emergency response), MELODI (low-dose research), EURADOS (radiation dosimetry), and EURAMED (medical radiation protection). As well as organising open research calls, CONCERT undertakes integrative activities such as promotion of the wider use of the European radiation infrastructures, and the support of education and training.

At the level of radiation exposure associated with most scenarios of concern for radiation safety, the incidence of harmful effects can be obscured by the noise of natural occurrence rates. Studies over many years are required to obtain reliable risk estimates, employing a wide range of scientific disciplines. This long-term broad-scope process requires a programme of education and training specifically designed to ensure a continuing influx of new top-level students into the needed scientific areas. CONCERT includes a workpackage dedicated to the support of such a programme. (See http://www.concert-h2020.eu/en/Concert_info/Education_Training.) It consists of 5 subtasks:

1. Attracting and retaining students and junior scientists into the Radiation Protection research fields: A programme of travel grants will run for the duration of the EJP in order to provide greater opportunities for students to gain experience and networking through attending conferences, courses, and visiting other institutions.

2. Education and training as an essential part of dissemination and knowledge management within CONCERT: E&T should be an intrinsic part of all research programmes so that students can gain in-depth experience of the topic. The CONCERT open research calls require applicants to provide a plan as to how they will involve universities, and provide thesis and project opportunities for students.

3. Targeted E&T initiatives: There is an annual call for institutions to host short (1 to 3 week) courses in topics of their expertise. Sponsorship from CONCERT allows the courses to be offered at no cost and, in some cases, with accommodation provided.

The topics specified in the calls are aligned with the E&T priorities of the partner research platforms.

4. Coordination and collaboration on E&T policy and strategy: An annual forum is held to discuss the E&T priorities of the platforms and other interested parties to provide guidance for the overall programme.

5. European integration of junior scientist career development: A European network of students and professors is being set up as a way of information sharing and career development.

1. Introduction

Since the year 2000, Europe-wide studies have identified a problem with the maintenance of the range of expertise essential to keep up competence and run an effective programme of research into the risks to humans and the environment from low-dose radiation. The findings indicate that specific programmes aiming at knowledge management across generations need to be designed in order to achieve sustainable continuity and development. Furthermore, the science underpinning radiation protection is becoming more multidisciplinary, and embracing new and wider fields of study such, as it seeks to understand and control the risks to biological and social systems. The new science is powerful and has the potential to answer important questions, but it tends to be confined within specialist university departments and research institution. To respond to the challenge of developing and maintaining new competence within the radiation protection research community, there is a need for support of education and training in all the sciences providing the basis for radiation protection, and in particular specific research areas such as the hazards from low-dose radiation, medical applications of ionising radiation, radioecology, emergency and recovery management and dosimetry.

DoReMi was a Euratom-funded Network of Excellence which ran from 2010 to 2015 to promote and integrate European research into the risks of exposure to low doses of ionising radiation and to help set up the low-dose research platform MELODI. In addition, DoReMi began promoting training and education in support of the research programme within the NOE, and also making more widely available training opportunities in order to help attract top-level students into the field. The experience gained from DoReMi was carried over into European Joint Programme CONCERT, which will run from 2015 to 2020. The scope of CONCERT has expanded from DoReMi in that it incorporates not only MELODI, but 4 other radiation protection platforms. The contribution of CONCERT to the support of education and training in radiation protection is described in this paper.

2. The CONCERT European Joint Programme (www.concert-h2020.eu)

The 'CONCERT-European Joint Programme for the Integration of Radiation Protection Research' under Horizon 2020 operates as an umbrella structure for the research initiatives jointly launched by the radiation protection research platforms MELODI, ALLIANCE, NERIS, EURADOS, and EURAMED. Based on the Strategic Research Agendas developed by each of the platforms, CONCERT is developing a joint programme of research priorities in consultation with participating Member States. The research topics have formed the subject of two open Research and Technology Development (RTD) calls, in 2016 and 2017, administered by CONCERT and funded by the Euratom research and training programme 2014-2018. The ensuing research contracts are co-funding actions and are designed to stimulate and coordinate the EU national programmes of research into radiation protection.

CONCERT is made up of 7 Workpackages: one for administration, 3 for formulating and managing the RTD calls, one for stakeholder engagement, and two for integrative activities designed to facilitate and develop EU research capability and resources. These activities include promoting the use of and facilitating access to major European research infrastructures, such as exposure facilities including those for animal and plant experiments (both laboratory and field facilities), epidemiological cohorts, sample banks, databases and analytical platforms, models and tools (including e-infrastructures). There is also a workpackage dedicated to supporting and coordinating education and training for the development and maintenance of expertise in all of the areas having application to radiation research. A strict distinction is made between this action and more general training for radiation protection. There is of course a strong need for training in the understanding and practice of operational radiation protection, particularly in the workplace and in medical use of radiation. But there are other bodies, both commercial and nationally funded, that are very competently providing this service, and there is no call for CONCERT to compete with them.

3. Education and Training as an integrative activity in CONCERT

Workpackage 7 of CONCERT is dedicated to education and training for the support of radiation protection research. It is formed of 5 separate tasks:

Task 7.1 – Attracting and retaining students and junior scientists into the radiation protection research fields.
This is led by Stockholm University and is made up of 2 subtasks. The first offers grants on a competitive basis to junior scientists to attend conferences and training courses. The criteria for giving support are based on references provided by the applicant, and the appropriateness of the proposed grant for furthering the aims of CONCERT. Four grants are awarded every 3 months, each for a maximum of €625. The awards began in 2016, and have proved very popular. Typically there are more applications than there are awards that can be given.

The second subtask is investigating the possibility of increasing transferability of educational credits within the EU states, in order to facilitate cross-crediting university course modules (such as the MScs in Radiobiology and Radioecology), and to work towards full mutual recognition of pre-requisites and degrees. A dialogue with institutions involved will be maintained through a regular forum coordinated by this task.

Task 7.2: Education and training as an essential part of dissemination and knowledge management within CONCERT
This task is led by the National Research Institute for Radiobiology and Radiohygiene, Budapest. E&T is promoted as an integral part of all CONCERT-funded RTD research projects. Proposals in the 2 open calls were encouraged to include provision for:

- PhD thesis work; where possible students from new member states shall be encouraged to qualify for PhD Programmes.
- MSc project work; project partners will be encouraged to liaise with universities offering MSC Programmes in scientific disciplines required for radiation protection research to provide supervised projects.
- Offering short courses (1-3 weeks) or teaching seminars on the new science/technology being used or developed. Courses, seminars, and student opportunities within the RTD projects will be coordinated by this task and promoted through the EJP website.

The following text was included in the two CONCERT calls:

"Education and training is a part of all activities within CONCERT. Proposals should include a plan for integration of education and training into the research programme, with a description of the proposed activities. The proposal should also give details of collaboration or involvement with academic departments, and of intended PhD thesis work, MSc project work, teaching seminars, ad hoc courses on the topics of the proposal, etc., where possible."

Task 7.3: Targeted E&T initiatives
This task is led by the University of Pavia, Italy. An annual open call is made for institutions to organise short courses (up to 3 weeks length), summer schools, or teaching seminars on topics of relevance to research into radiation protection. Initiatives under this task include professional training at the MSc /PhD level covering all aspects of the scientific research areas underpinning radiation protection and emergency and recovery management. Grants in support of courses are made on the basis of direct costs (travel, subsistence, consumables). The courses are generally free to students (including accommodation).
The Programme is reviewed annually on the basis of student feedback and consultation with stakeholders, and modified if necessary. To date each of the participating platforms except EURAMED has hosted courses supported by this Task. This initiative of sponsoring short courses was a feature that proved very successful when developed in DoReMi, and this success is continuing in CONCERT. The courses currently running are advertised on the CONCERT website (www.concert-h2020.eu/en/Events).

Task 7.4: Coordination and collaboration on E&T policy and strategy
This task is led by SCK•CEN, the Belgian Nuclear Research Centre. It consists of 2 subtasks. The first seeks to develop coordination and collaboration in E&T by inclusion of the interests and requirements of the E&T Working Groups of all the radiation protection research platforms involved in the EJP (MELODI, ALLIANCE, NERIS, EURADOS, and EURAMED), and with networks such as EUTERP and the ENEN Association. Dialogue is entered into with other interest groups and stakeholders in order to take account of common policies, resources, and funding streams. The main activity of this subtask is to organise an E&T session at the Radiation Protection Research Workshops organised by MELODI (Munich 2015, Oxford 2016, and Paris 2017 – see www.icrp-erpw2017.com).
The second subtask, under responsibility of INSTTI, is to provide for vocational training for experts as foreseen in the new Euratom BSS directive and to ensure new findings from current research are taken up in training radiation protection experts.

Task 7.5: European integration of junior scientist career development (Lead: HMGU
This task is led by the Helmholtz German Research Centre for Environmental Health, Munich. There are 5 subtasks. They are:

- Initiate and encourage interaction between CONCERT, the platforms and the EURAYS association of junior radiation research scientists.
- Establish a cross-border network of mentoring for junior scientists based on a selection and mentor-mentee matching Programme.
- Conduct career days for junior scientists during CONCERT meetings, to include meetings with senior scientists, job fair, career advice and networking.
- Hold "Meet the Professor" lunches during international conferences held in Europe (including the IRPA, ERR, ICRR, MELODI and DoReMi meetings), to allow junior scientists contact with leaders in the community from academia and stakeholders, regulators and policy makers.
- Establish the NEWS (north, east, west, south) network to facilitate dialogue between junior faculty members in new and established member states.

4. The E&T priorities of the participating Radiation Protection Platforms

4.1. MELODI (www.melodi-online.eu)

The focus of the MELODI platform is research into the risks from levels of ionising radiation in the region where it is still unclear whether the linear no-threshold model applies, or whether the risks are significantly greater or less than predicted by this model. Significant deviations in either direction would be significant both socially and economically. Less risk if proven scientifically would be of considerable reassurance to the public. More risk would have implications for the justification and optimisation of practices that involve the controlled use of radiation, particularly in the medical area.

MELODI acknowledges that at the relevant level of radiation exposure the incidence of harmful effects can be obscured by the noise in natural occurrence rates, and that to obtain reliable risk estimates requires studies over many years, even decades, employing a wide range of scientific disciplines. This long-term broad-scope process requires management to ensure continuity and cross-fertilisation of all the necessary disciplines. It is precisely this stewardship of the necessary resources of knowledge, skills, and expertise that calls for a strategic programme of education and training specifically designed to ensure a continuing influx of new top-level students into the needed scientific areas.

There are many ways in which E&T can provide support to the low-dose research community:

- Providing entry points for attracting new students into one of the relevant disciplines.
- Supporting students with career development to help them continue in the area
- Integration of university teaching departments with institutions engaged in cutting edge research programmes for the benefit of both
- Providing continuing education for working researchers in order to provide access to new and emerging developments and infrastructures, and to help penetrate the walls of the silos of specialisation
- To provide a conduit for new research results to a wider scientific and operational radiation protection audience in order to raise the profile of the topic of fundamental radiation risk research.

4.2. ALLIANCE (www.er-alliance.org)

The 2014 Strategic Research Agenda for Radioecology identified that the key challenge in E&T was “To maintain and develop a skilled workforce in Europe and world-wide, through university candidates and professionals trained within radioecology” since “Scientific research in radioecology and application of that knowledge in the radiation protection of man and the environment requires scientists and workers with adequate competence and appropriate skills.” The people in need of E&T in radioecology are both students and professionals within research, industry and radiation protection. Radioecology is a multidisciplinary science, requiring teachers from many fields, who need to reach out to students with a range of backgrounds. Being a relatively small science, teachers and students are widely scattered geographically, which leads to the need for intensive courses to minimize costs, and/or online E&T. The COMET (COordination and iMplementation of a pan-Europe instrumenT for radioecology) project is funded by the EU as part of the 7th Framework programme until May 2017. In order to address these needs, COMET has developed an E&T web platform and arranged a number of courses and workshops for students and professionals. COMET has given refresher courses in conjunction with conferences, field-courses, hands-on training courses and full PhD and MSc courses for international audiences. The most important contribution from COMET is that the courses can draw on expertise from the COMET partner organisations to assemble relevant experts to teach courses as COMET holds the best expertise within radioecology topics. In addition, COMET has been engaged in discussions with stakeholders for more long-term solutions to maintain the sustainability of radioecology E&T after the end of the project. A list of all the courses given by STAR, COMET and the MSc in radioecology is to be found at the Radioecology Exchange website. Despite progress in some areas, many of the challenges outlined in the 2014 SRA unfortunately remain, mainly due to the lack of sustainable dedicated funding. For example, increasing student and teacher mobility, development of web-based learning tools and distance courses all require sustainable funding mechanisms. Development and implementation of e-learning tools also requires the engagement of experts in digital learning, which has not been possible in COMET due to lack of dedicated resources. Future plans within the ALLIANCE and OPERRA must urgently address this lack of sustainability if radioecological competence is to be maintained in Europe.

4.3 **NERIS** (www.eu-neris.net)

NERIS is the European Platform on preparedness for nuclear and radiological emergency response and recovery. The mission of the NERIS Platform is to establish a forum for dialogue and methodological development between all European organisations and associations taking part in decision making of protective actions in nuclear and radiological emergencies and recovery in Europe. NERIS has an active programme of education and training covering both the practical aspects of responding to an emergency, and the science basis necessary for making decisions when faced with an emergency situation. In each of the following examples there are opportunities for training students new to the field as well as experienced personnel. Each of the courses of 2017 was assisted by grants from CONCERT Task 7.3.

Preparedness and response for nuclear and radiological emergencies (20-24 March 2017, Mol, Belgium): this training course focused on the early to intermediate phases after a nuclear/radiological accident, and addressed the state of the art in nuclear and radiological emergency management including the international recommendations and the lessons learned from the Fukushima accident. It included principles of intervention; radiological evaluations; decision-support tools; different aspects of planning and organization in off-site emergency response; economic, social and psychological impact.

Late phase nuclear accident preparedness and management (19-23 June 2017, Gomel) The main objective of the course for late phase nuclear accident preparedness and management is to provide principles and practical guidance for the key players involved in the preparedness and recovery of living conditions in contaminated areas in the aftermath of a nuclear/radiological accident. The course offers a comprehensive overview of the various dimensions and challenges of the long-term rehabilitation. It includes also practical elements for the implementation of countermeasures for managing long-term contaminated rural and urban environments, notably through the planning of direct meetings and dialogue with local stakeholders (inhabitants, pupils, local authorities, etc.) living in the areas affected by the Chernobyl accident.

Modelling and measurement (6-17 March 2017, Roskilde, Denmark): The course was aimed at providing the participants with an understanding of how to assess by measurements and modelling the long-term radiological risks from releases to the environment of radionuclides. The course built on decades of international research work, including unique experience from extensive practical investigations in contaminated areas and laboratory assessments. It comprised a hands-on introduction to laboratory measurement techniques including state-of-the-art radiochemistry methods for determination of radionuclides that can not easily be determined. It also included a hands-on decision support modelling session using a state-of-the-art computerised decision support system for nuclear and radiological emergency management.

Analytical platform – scientific methods and tolls for information collection and exchange (7-9 October 2015, Trnava, Slovac Republic): The training course was developed providing the necessary information on the Analytical Platform, the scientific methods and tools developed for collecting information, analysing any nuclear or radiological event and providing information about the consequences and its future development. A particular attention was

given to the conditions and means for pertinent, reliable and trustworthy information to be made available to the public in due time and according to its needs in the course of nuclear emergency and post-emergency context.
The main objective was to train participants to use the new tools for the purpose of further active participation in exercises and to use the Analytical Platform as a focal point for collecting information, analysing any nuclear or radiological event and providing information about the consequences and its future evolution.

4.4 EURADOS (www.eurados.org)

EURADOS is a non-profit association, made up of more than 50 European institutions and 250 scientists, for promoting research and development and European cooperation in the field of the dosimetry of ionizing radiation. There are 8 Working Groups focusing on different applications of dosimetry in the fields of occupational, medical, environmental, and public exposure, and also technological development. The policy of EURADOS is not to duplicate or overlap with any other EU projects and international organisations activities, but to promote collaborations in existing international activities. The focus is on radiation dosimetry, which is only one of the various topics of radiation protection. While EURADOS provides education and training it does not to test or provide a certificate of competence.

EURADOS activities contribute to education and training through:

- Working Groups: senior and junior researchers work together and for the younger the work within of the WG is itself a learning process mainly for the younger members
- Workshops and training courses sponsored by EURADOS to respond to the need for training in the field of radiation dosimetry and implementation of technical recommendations and/or good practice in dosimetry
- Winterschool: a one-day refresher course held in conjunction with the EURADOS Annual Meeting
- Grant&Award: collaboration and contribution of young scientist in EURADOS WG is promoted; grant support a research stay of young scientists within the WG activities and the grant is a gift for an excellent research scientific work within the activities of an EURADOS working group.
- Support of organization conferences: IM series, NEUDOS series, occasionally support for attendance of young scientists in various international events ondosimetry (e.g. Individual Monitoring series, NEUDOS series),
- Publications: Eurados Reports and European Technical Recommendations in the Radiation protection series through EU project funding (DG TREN) (e.g. EU RP160 "Technical Recommendations for Monitoring Individuals Occupationally Exposed to External Radiation (2009), EU RPXX Technical Recommendations on Internal Dosimetry, in press)

4.5 EURAMED (www.eibir.org/scientific-activities/joint-initiatives/european-alliance-for-medical-radiation-protection-research-euramed)

The EURAMED platform was formed in 2016 to jointly improve medical radiation protection through sustainable research efforts, and is made up of the five medical societies involved in the application of ionising radiation (European Association of Nuclear Medicine, EANM; European Federation of Organizations for Medical Physics. EFOMP; European Federation of Radiographer Societies, EFRS; European Society of Radiology, ESR; European Society for Radiotherapy and Oncology, ESTRO). The platform has identified research areas of common interest and developed the first edition of the Common Strategic Research Agenda (SRA) for medical radiation protection. The SRA identifies two areas where sportive E&T is needed: education of staff to gain greater awareness and competence in dealing with radiation protection issues, and education of researchers.
Education of researchers is essential to provide the expertise for carrying out the investigations and development identified in the SRA. This includes the aspects of research

methodology particularly required in medical research. This especially holds true for research working with humans or biological material, but also with any data related to humans. There needs to be a programme of training reflecting the actual state of the art for research procedures, with the goal of fostering the efficiency of projects reflecting the research topics identified above especially in terms of optimal patient care and radiation protection.

In this respect it is important to deal with best practice regarding:

- literature and citation practices;
- statistical power of investigations;
- uncertainty budget calculation of measurements and calculations/simulations;
- clear hypothesis-driven project definition;
- pre-research feasibility estimates of proposed outcomes.

4.6 Social sciences and humanities

The SSH do not have a platform dedicated to radiation protection, but there are activities in CONCERT that explicitly engage expertise in this area. Input and comments from the SSH are actively encouraged in Workpackage 2 where the platform Strategic Research Agendas are developed and research priorities identified. Also, Workpackage 5 is concerned with development of dialogue with stakeholders, and this is an area where topics such as risk perception and the ethics of accepting risk as part of the use of radiation must be considered. There is a provision for courses in this area within CONCERT Task 7.3. One of the suggested course topics is “Risk governance and stakeholder dialogue”.

5. Conclusion

The CONCERT European Joint Programme is providing co-funding support and coordination for the European programme of research into radiation protection, in collaboration with the platforms MELODI, ALLIANCE, NERIS, EURADOS and EURAMED. As well as supporting research, the EJP has integrative activities designed to facilitate and develop EU research capability and resources in the area of radiation protection. One of the integrative activities is carried out by Workpackage 7, which provides a programme of support and integration of E&T initiatives in the radiation protection research area. The Workpackage provides encouragement for new students to enter the topic area by awarding grants to present at conferences and to go to training courses, and also sponsors short courses in topics relevant to the RP platforms so that students can be offered attendance at no cost.

CONCERT will run until 2020 and is providing a valuable point of entry for new researchers, and a source of continuing education, dialogue, and collaboration for the present research community.

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TRAIN-THE-TRAINER COURSE FOR RADIATION PROTECTION EXPERT: ESSENTIAL TO DEVELOP COMPETENCES

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ABSTRACT

The perceived growth of the use of ionizing radiation (medical, industrial and research), requires an advanced understanding of radiation protection in order to protect workers, the public and the environment from the potential hazards of ionizing radiation.
Within this perspective, maintaining a high level of competences in radiation, assuring the ongoing skills development of personnel and adequate knowledge management, is crucial to ensure future and safe use of ionizing radiation and the development of new nuclear activities in a safe way.
The ENETRAP III project is a proactive leader for bringing forward solutions in the development of competences for RPEs and/or RPOs.

Until now, radiation protection E&T projects focused mainly on the development of scientific and technical training contents. Little consideration has been given to help lecturers with developing the programs following the European standards and guidelines such as ECVET and EQF, or to update those providing training with information on recent developments in the use of modern learning tools.

Aware of the importance of appropriate didactic and andragogic skills, the ENETRAP III project dedicates a work package to the development and implementation of a train-the-trainer course in order to enable lecturers to acquire the necessary teaching and training competences to ensure their mission as trainer. Since the Euratom BSS describes training as one of the outstanding tasks of RPEs and RPOs, this train-the-trainer course is designed to meet their specific needs.
As such, the RPE train-the-trainer course has the following objectives:
- Design training activities using the ECVET approach
- Identify the different European tools designed to support professional mobility

- Design playful and relevant learning situations, involving participants in applicable situations
- Identify innovative learning resources training tools
- Implement the basic principles and good practices of training
- Give a short training session in front of a specialized audience

The training course consists of a one-week face-to-face session. To achieve the above objectives, the course consists of various innovative teaching tools and methods: lectures, pedagogical scenarios, digital tools, workshop, discussions and role-play. Activities are built to stimulate, involve and interact constantly with the participants.
Participants will be assessed throughout the training course through reflective questions (using an interactive training animation tool), individual and/or group practical exercises and case studies. A learning assessment, covering all the themes of the training, will be held at the end of the training.
Two training sessions are scheduled (February in French and June 2017 in English). The February session reached a maximum capacity (in two weeks only). It shows the interest and willingness of radiation protection professionals to improve their E&T skills.

1. Introduction

The ENETRAP III project is a continuation of the ENETRAP and ENTRAP II projects, created and implemented with the aim of developing high-quality technical training programs on the topic of radiation protection. The perceived growth of the use of ionizing radiation requires an advanced understanding of radiation protection, in order to adequately protect workers, the public and the environment from the potential hazards of ionizing radiation.
Until now, E&T projects in radiation protection focused mainly on the development of scientific and technical training contents. Little consideration has been given to help lecturers and trainers with developing the programs following the European standards and guidelines such as ECVET and EQF, or to update those providing training with information on recent developments in the use of modern learning tools. Acknowledging the importance of appropriate didactic and andragogic skills, a train-the-trainer course for radiation protection professional has been developed to enable trainers to acquire the necessary teaching and training competences to ensure their mission as a trainer in radiation protection matters.

2. Inventory of the existing train-the-trainer courses

An inventory of existing TTT courses allows to compare the available programs and used methodologies, and highlight the points of convergence and divergence between these offers. Both generic as specialized TTT courses are considered without the intention to serve as an exhaustive benchmark on the subject.

2.1. Generic train-the-trainer courses

Examples of training centers and number of trainings		Programme / themes covered	Pedagogical methods
French TTT courses	Demos : 18 trainings Duration : Face-to-face: 2 to 5 days Certification: 14 days	*Sample programme* The fundamentals of teaching adults Prepare training Animate his training to create interest and encourage learning Manage a training group Evaluate the effectiveness of training	role play, group exchanges, theoretical contents and practical case studies

	Examples of training centers and number of trainings	Programme / themes covered	Pedagogical methods
	MMC formations : 3 trainings Duration : 1 or 2 days	Mastering pedagogy Designing a training action Select and control the training materials The 4 highlights training Master training Facilitate a group	Not indicated
	Cégos : 21 trainings Duration : Face-to-face: 1 and days Certification: 9 or 11 days	*Sample programme* Appropriating specifications Set a course suitable to participants and objectives Develop good training materials (trainers / participants) Facilitate training with ease Create a group dynamic Assessing learning outcomes Adopted a trainer posture oriented participants	Training action: case studies and practical workshops
English TTT course	ATD : 11 trainings Duration: Face-to-face: 0,5 to 3 days Certified: 1 year	*Sample programme* Purpose & assessment : needs, date analysis, learning objectives Planning & preparation : adult learning principles, preparing the material, environment & yourself, the 4 dimensions of learning Presentation & facilitation: establishing a positive learning environment… Performance: level of evaluation, self-assessment …	Not indicated
	AMA : 1 training Duration: 3 days	Active adult learning Assessment Objectives, planning active training Facilitating presentations & activities : opening exercises, brain friendly-lectures, lectures alternatives, experimental activities Extending the value of training Evaluating training Closing activities	Workshop, performance, discussion, role-play, games and simulation,
	Total Success : 2 trainings Duration: 1 or 2 days	Fundamentals for becoming a trainer Running a training course Delivering a training session successfully How to write and structure training Factors for effective training skills What makes a good trainer? Effective training practice and procedure Body language and voice projection skills Classroom training versus one-to-one training	Lectures, performances

Table 1: Comparison of French and English generic train-the-trainer courses

<u>Points of difference</u>

Table 1 above, highlights two points of divergence

- The number of French TTT courses seems much larger and varied than those in English. This may be due to the fact that internet searches were conducted from a French browser or from ignorance of UK or US training centers.
- The types of French TTT courses seems more diverse than the English versions.

<u>Points of convergence</u>

Regarding the other comparative point of Table 1, namely the program and the topics covered and the pedagogical methods, the generic French and English TTT courses are very similar.

- Program and themes covered: training design and animation (at different levels depending on the programme)
- Various pedagogical methods fostering interactivity

2.2. Specialized train-the-trainer courses

Training centers and number		Programme / themes covered	Pedagogical methods
Aeronautics	NAWC: not a training but only a guide No duration provided	Psychology of learning Prepare the lesson plan Instructional methods How to conduct classroom presentations The use of transitions Advantages of questions Quick list of hints for good instruction	Not provided as it is a guide and not a training
	APAVE (FR) Duration: 5 days	Pedagogical methods and techniques with the aim to share their knowledge and skills Communication and management of group dynamics	Interactive lecture Case studies
Aviation	IATA: 1 training Duration: 5 days	Developing a course: needs, objectives, lesson plans Delivering a course Teaching aviation security Closing a course	Practical exercises Performances Oral presentation
	Plane Training : 9 trainings Duration: between 1 & 5 days according to the subject	Teaching and learning process Training preparation Training delivery and feedback Group dynamics, practice session, report writing How to design and deliver technical knowledge Technical knowledge depending on the training course	Practical exercises Performances + video Group discussion
	Squadra consultants (FR) Duration: 5 days	The pedagogical situation The relationship process The teaching process The learning process The human factors applied to instruction	Lectures Discussions Performances
Automotive	SMRT Duration: 60 days (certification)	Training skills, curriculum design and assessment development Develop performance and learning strategies Develop and deliver competency-based training Develop and deliver competency-based assessment	Not indicated
	Joe Verde Sales & Management Training Duration: 2 days	Create a continuous 30-60 day training plan to develop the specific skills you know you need Prepare for daily training in 10 minutes or less Get every salesperson involved in every meeting, every time, without exception Get everyone involved in practicing each topic so they can develop the skills they need to improve Get verifiable results from every meeting you hold	Very interactive course
Nuclear	IAEA (FR/EN) Duration: 5 days	Learning factors (motivation, perception, memorization, understanding); Communication phenomena (active listening, teaching styles); Training rules and techniques; Designing a training programme; Tools and teaching aids. Familiarize participants with the training material developed by the IAEA	Interactive: discussions and course delivery on technical topics
	CEA / INSTN (FR/EN) Duration: 5 days	Information-sharing and experience feedback in your mission as an occasional trainer: success, difficulties, needs and ideas for improvement The ECVET approach: principles and implementation Training design methodology The training basic principles and good practices Innovative teaching tools: digital training tools Technical visits and experimentation of training materials developed by the INSTN within the framework of specific trainings	Various innovative teaching tools and methods : lectures, pedagogical scenarios, digital tools, workshop, discussions and role-play

Tab 2: Comparison of specialized TTT courses

<u>Points of difference</u>

Table 2 above does not highlight fundamental differences.

Some areas, in particular aviation and aeronautics, offer a sizeable offer of train-the-trainer courses and for different audiences. It seems that these sectors are committed to the quality of trainings and that « training [shall be] conducted by 'suitable qualified persons' [i]».

Points of convergence

Similarities are identified in Table 2 on items such as: the program and themes, duration (except certified training) and pedagogical methods, the different trainings – regardless of specialty:

- Program topics: training design and animation (at different levels depending on the program) with specific sequence linked to the area of expertise (tools, regulations, technical knowledge ...)
- Duration: between 1 and 5 days
- Varied pedagogical methods fostering interactivity

2.3. Advantages and interest for a train-the-trainer course of specialization

When analyzing the two tables and their data, the main difference between a generic TTT course and a specialized TTT course appears to be the programme and themes.

While the two types of trainings (generic & specialization) clearly cover aspects of training design and animation, specialized TTT courses incorporate one or more specific sequences related to the area of expertise in their program, for example with regard to pedagogical tools, regulations or technical knowledge.

This point in particular is discussed later in this article.

3. ENETRAP III train-the-trainer course for radiation protection professionals

3.1. Objectives and programme

Objectives

As it has already been mentioned in the introduction, the ENETRAP III project dedicates a work package to the development and implementation of a TTT course in order to enable lecturers to acquire the necessary competences to ensure their mission as a trainer in radiation protection matters.

As such, the train-the-trainer course for radiation protection professionals has the following objectives:

- Design training activities using the ECVET approach
- Identify the different European tools designed to support professional mobility
- Design playful and relevant learning situations, involving participants in applicable situations
- Identify innovative learning resources training tools
- Implement the basic principles and good practices in training
- Give a short training session in front of a specialized audience

Programme

The TTT course consists of a one-week face-to-face session:

	Morning	**Afternoon**
Day 1	*S1. Introduction to the training session* : Objectives, programme, rules, training organization, trainers presentation Self-assessment of one's learning (**before**/after) *S2. Round table & sharing experience:* Crossed presentation, sharing and feedback experience *S3. ECVET approach:* Context and methodology	*S3. ECVET approach:* European tools to promote occupational mobility Principles of the approach Group workshop: design a learning unit according to the ECVET approach

	Morning	Afternoon
Day 2	*S4. Training design methodology:* Group workshop and contribution: how to design a training course Practical work *S5. The fundamentals of training adults:* Self-assessment: what kind of trainer are you?	*S5. The fundamentals of training adults:* Learning factors and good practices *S6. INSTN teaching tools & innovations:* Practical field school
Day 3	*S6. INSTN teaching tools & innovations:* Digital tool to create training resources Calculation software for dose calculation: how to design exercises?	*S6. INSTN teaching tools & innovations:* DOSEO workshop VERT virtual space: presentation of the tool and developed scenarios
Day 4	*S6. INSTN teaching tools & innovations:* Works and demonstrations: detection of ionizing radiation *S7. Teaching practices* Designing relevant training materials	*S7. Teaching practices* Practical work: prepare a training session
Day 5	*S7. Teaching practices* Deliver a training session in front of a specialized audience Self-assessment of one's training sequence	*S7. Teaching practices* Analysis and debriefing of the training sessions *S8. Evaluation and conclusion of ENETRAP III training session* Self-assessment of one's learning (before/**after**) Assessment of learning

Tab 3: Programme of the TTT course

3.2. Pedagogical tools and methods

To achieve the training objectives, various innovative teaching tools and methods are implemented for every sequence.

	S1	S2	S3	S4	S5	S6	S7	S8
Lectures	X		X	X	X	X	X	
Performances							X	
Digital tools					X	X	X	
Practical exercises				X		X	X	
Questionnaire	X				X		X	X
Workshop			X	X				
Discussion		X	X	X		X	X	X
Technical visit						X		

Tab 4: Use of tools and methods during the TTT course

The whole training course and associated activities are built to stimulate, involve and interact continuously with the participants to enhance the group dynamics and facilitate an acquisition of the different sequences and contents.

3.3. Evaluation activities

« *To "evaluate training" means finding out what the "value" of training really is – to the trainees, their managers, their colleagues, the organization for which they work, and for the wider community. Thus, it is important to define clearly the training objectives so that the results of the training can be measured against them.* »[ii]

To echo the World Health Organization (WHO) study, the Kirkpatrick evaluation model (4 levels) was used for the TTT course for radiation protection professionals.

Evaluations implemented in the context of the training

Level 1: Lecturers evaluation – Participant opinion

Each training sequence is subject of an evaluation from the participants, at the very end of the instructional sequence. This assessment focuses on five criteria: Interest for the subject, Duration, Pedagogical expertise, Presentation documents, Documents distributed.
The scoring is made according to four-level Likert scale: **++** very satisfactory / **+**: satisfactory / **-**: unsatisfactory / **- -**: really unsatisfactory

Level 1: Evaluation of the training – Debriefing at the end of the 5 days
At the end of one-week training, a comprehensive debriefing of the whole training is scheduled. It seemed necessary, in addition to a written evaluation, to have a roundtable discussion allowing each participant to express their opinion about the training: whether in form and/or content. The aim is obviously to capitalize and improve the programme of this pilot training session.

Level 2: Knowledge assessment – Self-assessment (before / after)
At the start of the training session, the participants are requested to self-assess their knowledge on the topics that are addressed during the training. The aim for the participants is to measure their progress at the end of the training.
This self-assessment focuses on the 3 main themes of the training, each with 4 sub-themes.

Themes	Sub-themes
The ECVET approach and tools for occupational mobility	• The various existing tools • What is the ECVET approach • Principles of the approach ECVET • The learning outcomes approach
Designing a teaching sequence	• Training design methodology • Formulation of consistent learning outcomes • The different teaching methods and activities used in training • Rules of relevant training material
The fundamentals of adult learning	• Adult learning factors • Managing a training group • Training technics and good practices • Distance on my practices as a trainer

Tab 5: Themes and sub-themes of self-assessment before and after

Participants' self-assessment according to a four–level Likert scale:

- I have vague notions or it does not mean anything to me
- I generally understand what it is but I need to deepen the subject
- I understand and I feel able to implement it
- I master the subject very well and I feel confident to implement it

Level 2: Learning assessment – After the training
To measure the knowledge and understanding at the end of the training, participants are asked to complete a learning assessment. 25 questions (+ 1 extra issue that dealt with a subject that was not addressed during the training) on the three main topics of the training are treated: The ECVET approach, design of a training sequence, the fundamentals and good practices of adult learning.
The 25 questions are of a various type: multiple-choice, open questions, connect the related definition, order logically and open questions, thus avoiding to leave nothing to chance.

Complemented by the evaluations formalized on paper, the suggestions made throughout the training session of the first pilot session (in French) were also taken into account to optimize the first pilot session (in English).
The result of these evaluations are presented in the following chapter.

4. Results of the pilot session in February 2017 and areas for improvement

4.1. Analysis of results

Level 1: Lecturers evaluation – Participant opinion

As mentioned previously, an evaluation was made after each sequence: 5 criteria were evaluated according to four levels of satisfaction (see section 3.3).

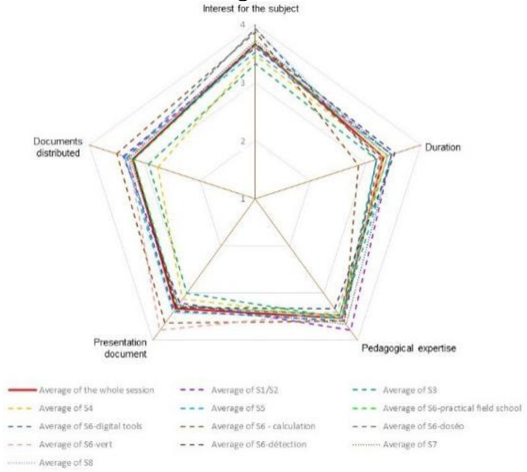

Fig. 1: Lecturers evaluation

	Highest average	Lowest average
Interest for the subject	Tie: S6 (digital tools) & S8	S3
Duration	S6 (calculation software)	Tie: S3 & S6 (Digital tools)
Pedagogical expertise	S1/S2	S6 (VERT)
Presentation document	S3	S6 (VERT)
Documents distributed	S6 (calculation software)	S4

Tab 6: Highest & lowest average of lecturers evaluation

The evaluations were sometimes accompanied by comments, providing additional information on the sequence. Given the number of comments, they are not included here but are taken into account in the part “New course programme”.

Level 1: Evaluation of the training – Debriefing at the end of the 5 days

Questions	Answers
What do you think of the size of 5 consecutive days?	Mixed opinions: some found the training too short (not enough time to assimilate and practice some points), others too long (in particular the first day) but overall the duration of 5 days is well appreciated
What do you think of the structure and sequence of the sequences?	• Bring a better balance between theoretical contribution and technical visits: the first 3 days were very dense
What sequence did you find most relevant? Why?	• Footage sequence: useful to have an outsider’s view and matches to the reality on the ground • Technical visits are good illustrations • Formalization of the training design methodology • The self-assessments: helpful to learn how to analyze one’s trainer practices
And the least relevant sequence? Why?	• Some technical visits because the educational value was low and difficult to reproduce • Self-assessment: what trainer are you? Because no nuances in the proposals
What would you add, delete, and see differently in this training (sequence, type of activity, theme ... for example)?	• Evaluation of learning to answer every day: allows everyone to make a synthesis of acquired • The ECVET approach arrived too early / too technical • Give more time on practical work sequences: writing LO + preparation • Add a sequence on speaking, oral fluency with improvisational theater exercises + add other footage, group management • 1 or 2 days REX 6 months after the training • Present digital tools earlier

Level 2: Knowledge Assessment – Self-assessment before / after

Fig. 2: Evaluation of knowledge – average before-after

This graph shows that most participants consider to have improved their knowledge throughout the training.

The ECVET approach is the sequence for which the progress of learning seems to be the most significant. The "after" average of the ECVET theme, however, is lower than the 2 other themes.

Level 2: Learning assessment – After the training

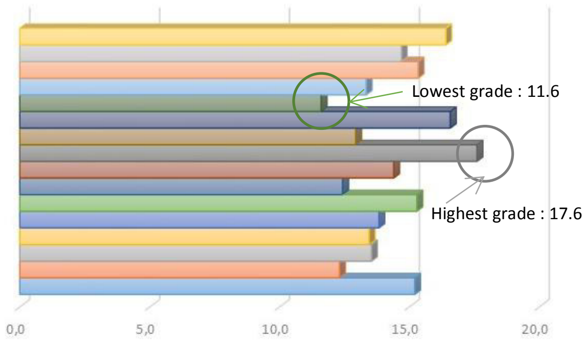

Fig 3 : Learning assessment – grades of the 16 participants

The session average is 14,3/20. The bonus issue is not taken into account. 2/3 of the participants scored between 10 and 15/20 and 1/3 scored higher than 15/20.
The evaluation was made on the last day of training (on Friday afternoon). It took longer than expected (1:20 h instead of 30 minutes). Some participants did not respond to several questions. Thus, the scoring system was adapted not to penalize the grades.

The unanswered questions were not taken into account. Thus, the grades of figure 3 scheme may not be the real reflection of learning.

Evaluations to come
As mentioned in the WHO study, "The assumption that training automatically leads to changed behaviour or improved work standards is simply not valid. Not all trainees change their work methods, or their approach to work, after training – even if they say they appreciate and enjoy the training sessions", or got a good grade for learning assessment. Indeed, assessments of level 1 and 2 reflect assessments made at a time T. To measure the impact of training, medium-term, level 3 "Behavior "and level 4" Results " evaluations are planned.
These evaluations would be executed by individual interviews and would include the following points:

- Level 3 "Behavior": evaluating participants' changes following the training and implementation of the learning in their work environment.
  Sample questions (to participants):
  - What has changed in your way of designing or delivering trainings since the training?
  - Which learning (methods, activities, etc.) have you implemented after the training?
  - Which learning (methods, activities, etc.) do you think are not suitable, and why?

  Most participants have agreed to take part in this evaluation.

- Level 4 "Results": evaluation of the benefits of training in the company in terms of objectives and quantifiable results.
  Sample questions (to managers):
    - What did you expect from the train-the-trainer course for radiation protection expert in terms of objectives and results?
    - What improvements could you note?
    - What indicators are not satisfactory?

  Managers who would accept to be interviewed need to be found.

A feedback day could be organized 6 months after the training to make a review of operational learnings and give additional advice and information on a particular topic.

4.2. Possible suggestions for improving the future TTT courses

The following suggestions were taken into account when designing the programme of the next TTT course:

- Sequence on the ECVET approach: not at the beginning of the training course
- Distribution of face-to-face training and technical visits: better balance between classroom time and visits
- Incorporation of animation techniques: improvisational theatre exercises, group management, posture and public speaking
- Delivery of a short course in front of a specialized audience: additional sequence to measure the improvement
- Learning assessment: to be distributed during the whole course week
- Self-assessment « What trainer are you ? »: provide better instructions and support to participants to answer the questionnaire

Next to these improvements, one of the five technical visits (DOSEO workshop) was removed and the virtual space VERT was made optional for participants who are available after the training day.

New course programme

	Morning	Afternoon
Day 1	<u>*S1 – Introduction of the training session*</u> Objectives, programme, rules, training organization, trainers presentation Self-assessment of one's learning (**before**/after)	<u>*S3. Training:*</u> Short-training delivery (5 min) + debriefing Theory: learning process
	<u>*S2. Round table & sharing experience:*</u> Crossed presentation, sharing and feedback experience	<u>*S4. Technical visit*</u> Practical field school + debriefing
	<u>*S3. Training:*</u> Self-assessment: what type of trainer are you? + debriefing Short-training preparing	<u>*Learning evaluation*</u>
Day 2	<u>*S4. Training design methodology:*</u> Group workshop and contribution: how to design a training course Practical work	<u>*S5. Training basic principles and good practices*</u> Different teaching methods
	<u>*S5. Training basic principles and good practices*</u> Learning factors and good practices	<u>*S6. Technical visit*</u> Works and demonstrations: detection of ionizing radiation
		<u>*Learning evaluation*</u>
Day 3	<u>*S7. Training materials*</u> Digital tools: create training resources How to design relevant training materials	<u>*S8. Speaking*</u> Improvisational theatre exercises
		<u>*S9. Technical visit*</u> Calculation software for dose calculation: how to design exercises?
		<u>*S10. Optional technical visit*</u> Virtual space VERT
		<u>*Learning evaluation*</u>
Day 4	<u>*S11. ECVET approach*</u> Context + exercise + SAT method	<u>*S13. Prepare a training session*</u> Practical work
	<u>*S12. Training good practices*</u> Group management	<u>*Learning evaluation*</u>
Day 5	<u>*S14. Deliver a training session to a specialized audience*</u> Performances Self-assessment of one's training sequence	<u>*S14. Deliver a training session to a specialized audience*</u> Analysis and debriefing of the training sessions: what improvement?
		<u>*S15. Conclusion*</u> Self-assessment: before-after Conclusion of the training

5. Conclusion

Although there are still points of optimization, the first pilot session of the train-the-trainer course for radiation protection professionals is perceived relevant, effective and useful to participants. Indeed, most of the participants are experts in radiation protection – medical or industry – and carry out their mission as trainers without any training on didactic and andragogic skills. Any pre-existing knowledge and skills were learned on-the-job, without completing a train-the-trainer course.

This training-the-trainer training is focusing on radiation protection (including technical visits) and delivered by experts in radiation protection. «Without this technical side, the training loses its unique character (possible to find at any training center)"iii.

This train-the-trainer course for radiation protection professionals can be extended to other areas of nuclear expertise: nuclear safety, safety culture, reliability interventions, dismantling for example. In this case, the technical part (visits, experts, examples ...) must be adapted to meet the target audience.

The ENETRAP III project is committed to improve the didactic and andragogic skills of professionals who are tasked to provide training in radiation protection matters. The evaluations of both pilot sessions (French and English edition) will be made available in deliverable 4.3 on the ENETRAP website http://enetrap3.sckcen.be/.

6. References

i Plane Training : http://www.planetraining.com/train-the-trainer-courses.htm
ii Evaluating Training in WHO (World Health Organization)
iii Comment of a participant of the (French) training session of February 2017

Generic training centres	Specialized training centres
• Demos (FR) • Cegos (FR) • MMC formation (FR) • ATD • Impact Factory • Total Sucess	• NAWC (Naval Air Warfare Center) • APAVE (FR) • IATA (International Air Transport Association) • Plane training • Squadra Consultants (FR) • SMRT (Safety & Service, Excellence, Mastery, Responsibility & Respect, Teamwork) • Joe Verde Sales & Management Training • IAEA (Internation Atomic Energy Agency) • CEA INSTN (FR) (Institut National des Sciences et techniques Nucléaires)

POSITIVE SCHOLAR - AN EXPERIENCE BASED ON POSITIVE PSYCHOLOGY AND POSITIVE EDUCATION IN THE POSTGRADUATE PROGRAM OF THE INSTITUTE OF RADIOPROTECTION AND DOSIMETRY - IRD IN BRAZIL.

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ABSTRACT

Stress, depression, anguish, and other emotional disturbances among students, teachers, and researchers in postgraduate and research academic settings are increasing because of charging for articles publications, lack of resources, and career advancement. This scenario requires initiatives that prevent or reduce these occurrences that end up compromising academic performance. The application of the Positive Scholar, based on Positive Psychology and Positive Education, at the graduate program of the Institute of Radioprotection and Dosimetry - IRD in Brazil, is an attempt to inhibit their students from experiencing these states and to favor in some way the possibility of improving the performance in its postgraduate courses, despite of the sensitive and serious subject as the nuclear area. Pilot experience of the Positive Scholar in the Graduate Program of the IRD allows concluding that it is possible to introduce Social Science disciplines like Positive Psychology in order to disseminate human knowledge subjects that can support the students during their research work and classes activities.

1. Introduction

The dysfunctional state - whether physical or emotional - of individuals participating in postgraduate Scholar life is growing, not only in classrooms, but outside them, in research or in the overwhelming environment of charging for publications, performance-related notoriety and lack of funding for the projects.
Alarming rates of stress, depression, burnout and anxiety have been growing over the years. Research shows that this situation is not only restricted to the Brazilian context and to an specific region or type of university or educational institution, public or private. It is making itself strongly present and the losses grow in a rampant way. (Corrêa, forthcoming 2017)
Considering the growth of the numbers of graduate students, in the Institute of Radioprotection and Dosimetry - IRD, this situation of stress between students and faculty and the need of increasing number publications to maintain the quality of courses also outlines the same scenario. In addition, the topic of the nuclear area, the focus of the postgraduate, masters and doctorate courses, carried out at the IRD, requires experimental research activities, with high and detailed safety procedures, oriented in international standards, due to the implications, even fatal, that can originate from a state of unpreparedness, physical or emotional instability, stress, anxiety and many other aspects in students, teachers and researchers, as will be discussed in this article.

This situation has consequences that need to be changed in order to improve the performance of these participants and the institution itself, and preventive actions may be the most favorable way to collaborate to modify this situation.
To act protectively and correctively in this environment with initiatives that favor, in a serious and scientifically proven way, the improvement of well-being is one of the possible paths and that is presented in the proposal Positive Academic (Corrêa, forthcoming 2017). This project is defined as :
The Positive Scholar is a workshop, methodologically modeled based on Positive Psychology and Positive Education, with application through group coaching, which aims to improve academic performance, from the improvement of subjective well-being, considering the benefits That a state of higher happiness and the use of positive human qualities can be generated in the participants - students, teachers and researchers - of the postgraduate courses of the academy. (Corrêa, forthcoming 2017)

In order to contribute to the improvement of the performance of the IRD's graduate students, the Positive Scholar workshop was introduced and developed by Corrêa in 2016 and this initiative was approved by the IRD's Graduate Program Committee. This pilot experience is the main focus of this article.

2. The Alarming Situation of the Participants of the Academy

Increasingly, new opportunities and initiatives arise in courses, studies and research in the academic context, apart from the possibility of building a career in this professional field. (Corrêa, forthcoming 2017) In Brazil, for example, according to information from the Ministry of Education (Faria, 2017), based on a survey carried out by the Coordination for the Improvement of Higher Education Personnel - CAPES, there are 122,295 postgraduate students. Where 76,323 are academic master's degree students, 4008 are professional master's degree students and 41,964 are doctorate students. Comparing the current data to the year 1996, there were 67,820 post-graduate students in Brazil and in 2003 there were 112,237 graduate students, which shows a significant evolution. (Faria, 2017)
Due to globalization, the number of universities, research institutes and development organizations are growing and further narrowing their borders, generating numerous possibilities for development in this area. (Corrêa, forthcoming 2017). Considering the last eight years the CAPES 'postgraduate course approvals increased in 9%, with emphasis on humanities and engineering, computer science and health sciences, were verified. (Faria, 2017)
Notoriously, the perspectives in the academic segment are promising, but just as it happens in organizational environments, it is an area whose dedication, responsibility, and often exclusive dedication is required. This is seen in two significant respects. (Corrêa, forthcoming 2017) In the federal universities in Brazil, between the years 2003 and 2016 the number of doctoral professors at federal universities increased about 189%. In 2003, there were 20,711 professors, while today, 2017, this number is 59,658. The second important aspect is that, among the teachers hired, teaching activity is the main activity, reaching a total of 88.5% of those who work with exclusive dedication.
Of course, the time of exclusive dedication is not restricted to the time in the classroom of these teachers. The need of producing knowledge through academic research is a constant task from the beginning of the career - when still early in life in graduate school as a student - as well as throughout career progression. In addition, the number of articles published demonstrating scientific production and it is used for academic and institutional evaluation. (Corrêa, forthcoming 2017)
One aspect that ends up agglutinating even more tension to this unbridled scientific production are the publication deadlines that even end up compromising, which is quite serious, the quality of the knowledge production. The qualification of the courses by means of scores, based on numbers of publications, ends up being another aspect that contributes to this production on a large scale, bringing great tension to the students of the postgraduate

courses and also to the teachers. (Corrêa, forthcoming 2017) According to Oswaldo-Cruz (2013), in the affirmation of Marcelo Menin and Bruno Duarte Gomes, regarding this productivity "... there are great disadvantages, both for institutions that create numeric artifices and for the scientific research community that suffers with the excessive stress, evasion / abandonment of research and the production of incomplete work and, therefore, the low qualities in scientific innovation "

Another point of extreme attention, and in many cases of tension, for Scholars, concerns the aspect of methodological quality and accuracy considered sine qua non to seek publications in better recognized journals and with higher impact factors for indexed publications, for those who want to progress in the academic career. (Corrêa, forthcoming 2017)

Faced with all these aspects that involve academic study and career in this segment - whether as students or as teachers - stress, anxiety, anguish and quitting the activities ends up restrict everyone in some way, sometimes very alarming , generating in the most acute cases serious disorders that compromise health and well-being. (Corrêa, forthcoming 2017)

This picture about the consequences of stress is not something of the present day, but a situation has already has been deserving attention of studies in Brazil since 2003 (Meis et al., 2003), Several research in this subject has been performed and their results are published by Junta (2017) and (Gewin,2012)

Furthermore, in 2003, in a research carried out with students and academic staff in the Department of Medical Biochemistry of the Federal University of Rio de Janeiro (Meis et al., 2003), considering the necessary productivity of the academic area and the restriction of funds, Some points were highlighted:

- Emphasis and absolute involvement in research works that produce publications in magazines of high impact factor and great stress and personal frustration when articles are rejected; (Meis et al., 2003, p.1138);
- Lack of financial support for research generates a state of frustration and insecurity; (Meis et al., 2003, 1139);
- The "rites of passage" impose on the researcher to prove incessantly their competence, always putting themselves at risk of being eliminated or demoralized; (Meis et al., 2003, p.1140);
- A state of mental and emotional exhaustion (burnout syndrome), caused by frustrated hopes and expectations, by a feeling of inadequate control over one's work and loss of life's meaning. (Meis et al., 2003, pp. 1140-1141).

Considering the constraints pointed out in these publications, it can be seen that the academic environment, in which individuals participate as students, teachers or researchers, can inevitably generate situations of acute or chronic tension, triggering serious states of stress, depression and anxiety, loaded with all of its sweeping symptoms, which produce extremely negative changes in aspects related to behaviors, attitudes, physical and emotional health, dissatisfaction with unmet expectations, low well-being among other deteriorating aspects of happiness.

Faced with all these factors, there is a need to include, in the academic contexts, initiatives, predominantly of a behavioral nature, that allow the participants in these environments to fulfill all the constraints required for it to be as student, teacher or researcher, succeed in their work, but, above all, that this happens by safeguarding their emotional physical well-being (Corrêa, forthcoming 2017)

3. The Scientificity of the Study of Happiness and Positive Human Qualities - Positive Psychology

In 1998, Seligman asserts that psychology is not only the study of weakness and harm, but also that of human qualities and virtues, considering that treating someone should not only mean fixing what is wrong but nurturing what is best In each person. (Seligman, 1998). In the same way, Csikszentmihalyi and Seligman (2000) reiterate that the treatments should not only repair what is broken, it is necessary to nourish the best, and Psychology must also study strengths and virtues. (Csikszentmihalyi & Seligman, 2000). For Csikszentmihaly and Seligman (2000), Positive Psychology is a science:

> *- At the subjective level is about valued subjective experiences: well-being, contentment, and satisfaction (in the past); hope and optimism (in the future); and flow and happiness (in the present).*
> *- At the individual level It is about positive individual traits the capacity for love and vocation, courage, interpersonal skill, aesthetic sensibility, perseverance, forgiveness, originality, future mindedness, spirituality, high talents, and wisdom.*
> *- At the group level it is about the civic virtues and institutions that move individuals toward better citizenship: responsibility, nurturance, altruism civility, moderation, tolerance and work ethic. (Csikszentmihaly & Seligman, 2000, p. 5)*

The outstanding scientificity of Positive Psychology is included in Peterson's definition when he states that "Positive Psychology is the scientific study of what goes right in life, from birth to death and in all stops between." (Peterson, 2006, p.4) And that it is a newly baptized approach within Psychology that takes seriously the things that make life worth living. (Peterson, 2006).
In order to encompass many aspects and topics addressed in the field of Positive Psychology, Corrêa (2013, 2016a, p.40) defines it as:

> *Segment of Psychology that focuses absolutely on the scientific study and the empirical proof of actions that allow to identify, measure, maximize and improve the qualities of human beings, including virtues, character strengths, talents, resilience, self-efficacy , Optimism, among many others, in order to allow their lives to be happier, fuller and meaningful.*

Nowadays, researches developed in the field of Positive Psychology on happiness and well-being have already identified that, both in the academic environment and in the organizational environment, the best and most successful results are obtained by the most Happy (Achor, 2012); Thus reversing the belief that you had until then that "you will be happy if you succeed." Today, the valid expression is: happiness predates success.
Beyond success, emotional states, where positive emotions prevail over negatives, such as stress, allow people to develop "reserves" of positivity, which they can tap into in times of adversity in more troubled situations. (Fredrickson, 2009).
Positive Psychology comes from its formal conception, already 18 years ago, growing both in theoretical terms and in fields of applicability. Originated in the academy of the science of psychology, its proposal is not restricted to this field, but also to others due to its multidisciplinary, including the area of education, scene of the proposal of the Positive Scholar (Corrêa, forthcoming 2017)
Another aspect refers to the research on the positive human qualities and the benefits they generate in different contexts when used and/or used in new way in our daily lives. At present, globally recognized assessments are available, such as the StrehgthsFinder (Buckingham & Clifton, 2008), which identifies human talent themes and the VIA Inventory of Strengths - VIA IS (Peterson & Park, 2009; Peterson & Seligman 2004) which identifies the character strengths of individuals. According to Seligman, Steen, Park and Peterson (2005), as scientific studies show, the simple identification of strengths of character, for example, already allow for increased well-being and its use in a new way, also achieve significant positive results. (Corrêa, 2016b; 2016c)
Considering the academic context, in particular, the activities related to research and completion work - monographs, dissertations or theses - and that positive emotions and human qualities generate greater well-being, innumerable are the benefits that can be obtained from a better state of happiness, to the accomplishment of works and research, according to some suggestions of hypotheses of contributions that were considered in the Positive Scholar's conception (Corrêa, forthcoming 2017).

4. Positive Education - Positive Psychology Applied to the Educational Scenario

As already pointed out, Positive Psychology and its themes have applicability in several contexts and the field of education has become increasingly fertile in the production of initiatives that promote the well-being and the use of human qualities. Most of these actions have been produced in several countries around the world, and their initial growth has notoriously developed in high school or high school scenario. In Brazil, even in this segment, these actions are still scarce, just as it was recently the attention to Positive Psychology that has been strengthening day after day. (Corrêa, forthcoming 2017)

Positive Education is defined as education for both traditional skills and for happiness (Seligman *et al*., 2009, 293) or simply as Positive Psychology applied to Education. The term emerged in an application of Positive Psychology at the Geelong Grammar School in Australia, with the following description: The bringing together of the science of Positive Psychology with the best practices teaching, to encourage and support schools and individuals to flourish . (Nourrish, 2015, XXVIII)

According to Seligman (2011), at the heart of Positive Education, there is an overwhelming problem related to stress and cases of depression in the school context, both students and teachers, leading to the first negative results that persist in their lives over the years. In addition, it highlights the incompatibility of what we expect for our children in their lives - which includes happiness, fulfillment, satisfaction with life and joy - contrasting with what traditional teaching offers: intellectual and technical knowledge on areas of knowledge, without putting up with it generates greater well-being in the individuals it forms. (Corrêa, forthcoming 2017)

In this sense, Seligman and others (2009) point out that well-being can be taught in schools for three reasons: as an antidote to depression, as a vehicle to increase satisfaction with life and as an aid to better learning and more Creative thoughts.

Although most global initiatives on Positive Psychology fall back on education to the equivalent of high school education in Brazil, actions are beginning to be considered contemplating a resumption of moral and character-building aspects in the "higher education" segment (Schreiner, 2015); In this case, what in Brazil would roughly equate to undergraduate level. (Corrêa, forthcoming 2017)

Considering this new approach that contemplates the well-being and the use of human qualities in teaching, learning and research environment, to reflect on a methodology of migration of the scientific research findings of Positive Psychology and Positive Education, for application in the context of the academy either for students, teachers or reseachers, is an initial step to improve the cases of cognitive, physical and emotional malfunction of the participants, which end up generating commitment to the courses and educational institutions, of the academic environment. (Corrêa, forthcoming 2017)

5. The Positive Scholar Methodology

5.1. Themes Used

The field of Positive Psychology among its themes offers a significant source of research that favors the increase of subjective well-being, either by the increase of positive emotions or by the use of human qualities, fields of study that are absolutely relevant in the scientific researches that are developed.

In Positive Psychology: Theory and Practice, Corrêa (2016d) shows that, according to Diener (2013), subjective well-being is the scientific name of how people evaluate their lives, emphasizing that these are cognitive and affective evaluations of someone about your life as a whole. These assessments include emotional reactions to events, with cognitive judgment of satisfaction and fulfillment. (DIENER; OISHI & LUCAS 2009; DIENER 2013)

Contributing to the increase of our subjective well-being, we consider the importance of positive emotions, whose research dates back to studies, originally, by Fredrickson (2009). According to the author, contrary to the negative emotions that limit the idea of possible actions, positive emotions extend judgment over them, opening our consciousness to a wide range of thoughts and actions, thus arising what she calls the first truth: “Positivity opens us. "(Fredrickson, 2009, p. 28) Another point raised by the author is that positive and negative emotions were important at different times for our ancestors. While attitudes from negative emotions were important in situations threatening survival, innovative and creative attitudes of positive emotions were important in the long run, by building resources, encouraging the development of versatility, skills, and useful characteristics, functioning as, what The author calls reservations, equipping our ancestors for future threats. (Fredrickson, 2009, p.31) These two essential assumptions about positive emotions are what define Fredrickson's theory of magnification-and-construct (2009)

Another relevant theme to be highlighted is the inventories currently in the field of Positive Psychology, about positive human qualities, such as the twenty-four character strengths and six human virtues, contemplated in the inventory produced by Peterson and Seligman (2004) and by a large Team of researchers. It is also added the work developed in the Gallup Organizations by Buckingham and Clifton (2008), in which they present thirty-four themes of human talent. Both projects contemplate the increase of well-being or happiness, when used these human qualities, inherent and particular to each individual, that can be identified by respective assessments, already indicated in this work. (Corrêa, forthcoming 2017)

Subjective well-being, positive emotions and human qualities, relevant themes of the scientific study of happiness, were used, not only, but mainly, as a basis for the construction of the proposal for the development of methodology for application in the academic context, for the problems already presented in this environment conducive to stress, anxiety, anguish, burnout that compromise the performance of students, teachers and researchers. In addition, the results that have been obtained with Positive Education in several educational contexts, ratifies the assumption that initiatives with the use of Positive Psychology can be successfully applied, concurrently, to the use of traditional formal education practices, in favor of Improving well-being and better results. (Corrêa, forthcoming 2017)

Having these aspects as a central point, Corrêa defines the Positive Academic as a workshop, methodologically modeled based on Positive Psychology and Positive Education, with application through group coaching, aimed at improving academic performance, from improvement of subjective well-being, considering the benefits that a higher state of happiness and the use of positive human qualities can generate to the participants - students, teachers and researchers - of an academy graduate. (Corrêa, forthcoming 2017)

5.2. Contributions for Improvement Performance in Positive Academic

To reach the proposed objective of the Positive Scholar, Corrêa (forthcoming, 2017) lists possible contributions to be achieved to improve the academic performance of students, teachers and researchers, correlating them with the benefits that happier people, in the case, with more positivity can produce, based on the work on positive emotions of Fredrickson (2009)

MORE HAPPY PEOPLE	POSSIBLE CONTRIBUTIONS TO IMPROVE ACADEMIC PERFORMANCE
They present the expansion of the conceptual connections of what they do and that promote better ideas *	It favors the analysis by the students / professor / teacher of the literature review data, facilitating the identification of points of contact or divergence, allowing the elaboration of more pertinent researches and Creative. It assists in the improvement of learning from an easier understanding of the topics presented in the classroom.
They allow you to broaden your mind and build a better future, as happiness broadens your vision and	Allows the student / teacher / researcher to better understand their projects and to see what types of answers their research needs to obtain, besides assisting in the planning and execution of the research steps.

your field of action *	
They are more able to deal with adversities in a more rational way, because they see more solutions *	It empowers the student / teacher / researcher to redirect and unfold the research that may occur during their study; It favors a more adequate receptivity of the considerations made by the examining rooms during qualifying moments or analysis of newsstands It helps to better deal with unfavorable outcomes / grades in the subjects if they occur.
They tend to have high levels of confidence.	The belief in self-efficacy can cause the student / teacher / researcher to believe in their potential of doing academic work, which is often a big question; It can contribute, in the case of the student, to the conclusion of credits of the disciplines in a more facilitated way; It can contribute to the attainment of goals of publications by the student / professor / researcher..
They present multiple adaptive strategies *	It favors the necessary adaptations in diverse contexts of the life of the student / professor / researcher, considering the indispensable dedication of time that must be reserved during the elaboration of an academic study and of the course.
They have more confidence in each other and relate better and more deeply to people. *	It encourages group work during the disciplines; It favors the conduction of research with teams of researchers; It may favor relations with development agencies and better negotiations in mutual cooperation agreements; It contributes to the counselor / counseling
They have greater psychological well-being and better health because of stronger immune systems *	It contributes to balance during participation / teaching in the course or during the research It allows greater attendance to the classes and stages of programmed research, as well as in scheduled meetings which allows the continuous dedication to the works,
They are more proactive and have greater capacity for problem solving *	In the face of unexpected situations, in the academic or personal context, it is possible to identify new alternatives that make it possible to re-establish the research or the course activities.

Table 1: Possible contributions to the improvement of academic performance according to work Fredrickson * (2009). Source: Corrêa (forthcoming 2017)

5.3. Possible Objectives of the Positive Scholar

Aligned with the proposed general objective, the Positive Scholar has the following possible objectives (Corrêa, forthcoming 2017):

- Structuring a plan of steps and actions to perform the academic research;
- To favor compliance with the delivery deadline and / or defense of academic research, in order to maintain the course level the highest as possible according to CAPES evaluation score;
- Encouraging the achievement of publication goals for career advancement;
- Improving the performance of students in the disciplines, the performance of the teachers in the classroom and guidelines;
- Promoting greater dedication of the students and teachers n their academic research aiming a high quality standard;
- Awaken students and teachers the interest in producing more academic articles;

- Encouraging greater interaction and trust among students , student and teacher, student and advisor, peer-teacher-informer, or mutual cooperation agreements;
- Innovating in the implementation of a behavioral improvement initiative aiming to improve performance in postgraduate courses with support of the Positive Academic subjects;
- Identifying and encouraging the experience of the experiences that generate positive emotions and identify the positive human qualities of the participants, aiming at enhancing well-being so that the objectives could be achieved.

5.4. Application Methodology

According to Corrêa (forthcoming 2017), the initial model proposed in the Positive Scholar foresees the Coaching process application, using Positive Psychology interventions, practices and assessments, and behavioral coaching tools, applied in group and a short form and its duration can vary from 12 to 20 hours, being divided in 2 or 3 meetings, with a 15 days interval, not exceeding to exceed more than this limit.
The groups' formation can occur through voluntary adhesions or by mandatory convocation, depending on the intention and decision of the institution in which it is to be carried out, considering conditions such as: motivation, available time, number of participants, and availability of resources among other factors. The ideal number of participants in the groups varies between 10 and 30 people, and can be performed exceptionally for smaller or larger number of participants.

5.5 Applicable Evaluations

In order to evaluate the accomplishment of the workshop, as well as the results obtained with its application, Corrêa suggests that the following evaluation models should be performed:
Reaction Assessment: applied at the end of the second or third meeting, where aspects will be raised about the contents presented, the practices developed, and the applicability of the themes and the coach. **Results Assessment:** It is applied one month after the second or third meeting, when aspects related to the participants' subjective perception about the benefits to their performance in class, the research work, and the relationships with classmates, teachers, and advisor. Both evaluations will be composed of questions with quantitative as well as qualitative measurement.

6. The Positive Scholar Experience at the IRD

6.1 IRD Graduate Courses

The IRD graduate program is concentrate in the area of Radioprotection and Dosimetry approved by the Brazilian Ministry of Education in 2002. Around 80 students are regularly enrolled in the program and their researches and classes activities are supported by 35 professors. The graduate program is managed by an academic committee and five staff members.

6.2. Positive Scholar Application Conditions

In 2016, the Positive Scholar was applied to the IRD graduate program, after approval by the Institute's Board of Directors and under the recommendation of the Graduate Program Committee, which was submitted to analyze the pertinence of the project, with a view to improving the performance of students.
The application was suggested as a pilot experiment only for the students. The workshop was coordinated by the IRD Teaching Division and carried out by Corrêa.
The enrollment of the students in the workshop was voluntary and no credits for participating were offered.

6.3 Development of the Positive Scholar Activities

In order to publicize the Positive Scholar the invitations were sent by e-mail for all graduate students and shorts presentations about the activities were made during the period of the normal classes. As of this disclosure, twelve voluntary registrations were made by master degree students.

The Positive Scholar was held in two meetings, each one of 7 hours with one lunch hour, as foreseen in the methodology. The first meeting was held on May 3rd, 2016 and the second on May 17th, 2016, respecting the 15 days interval, foreseen in proposal implementation. The first meeting was attended by seven participants and the second with five participants, and there were reasons for absences for some of the participants, considering the progress of researches work and deadlines of their academic activities, which made participation impossible.

All sessions proposed by the Positive Scholar were held. Two of them were held entirely in the first meeting, one started in the first meeting and finished in the second meeting, which included a fourth session. In the sessions, the Positive Psychology topics and practices were applied such as positive emotions, flow, mindfulness, character strength assessment, life satisfaction scale, gratitude, interventions, happiness formula, intentional actions - and coaching - administration of the time, building a positive agenda, setting goals and planning agenda for a week, a month and a year - using expository subject individual or group presentations, coaching sessions, mindfulness practices, video recordings, and testimonials.

6.4. Applied Assessment

At the end of the second meeting, Reaction Assessment was applied, and the following results were verified on the raised issues:

- On a scale of five items (nothing, little, more or less, very much and everthing), one participant affirmed that as far as the knowledge transmitted "everything" could be applied, by its usefulness, to the day to day of the course and / or in the conduction of the his academic work, while the others four participants stated that "very much" could be applied.

- In a descriptive account by the respondent himself, the following statements were made about what most attracted the attention of the participants, after the practices and reflections experienced in the Positive Academic: "To know that I can fulfill the academic works in a happy way"; "It called the attention how I can improve myself in the conduction of my master research and activities"; "We are capable of doing more"; "I realized that I can do more than I can, that I can fully exploit my ability to dedicate myself and probably prove to be more successful later on"; "About how I was organizing my time and how to learn to optimize it."

- About the yes / no answers, all the respondents affirmatively answered that they would indicate the Positive Scholar to their colleagues of course.

- On a scale of 1 to 10, where 1 is the lowest and 10 is the highest, all the respondents assigned the score 10 to the Positive Scholar.

- In an open-ended question about feedback and comments, the following responses were given: "It was great, but only two meetings are not enough, I suggest having more workshops like this one"; "I recommend or rather suggest more sessions like this one today, if possible, one per month. I congratulate the graduate program "; "I loved to be an participant of the Positive Scholar and I think that it should have more meetings. The meetings were very gratifying"; "I think the Positive Scholar program should have more meetings after those two. It is important to have a monitoring program after these two meetings, at least two or three months after the end. "; "The workshop could be more extensive, more time/days."

7. Conclusion

With the application of the Positive Scholar in the Graduate Program of the IRD, considering the evaluations carried out, it was possible to verify that, even in the case of postgraduate courses with subjects related to the science and nuclear knowledge areas, the participants considered Social Science subjects like Psychology / Positive Psychology are applicable in order to support all the academic research work.

To affirm that there was any improvement in the academic performance of the students in the course, proposed as a general objective by the Positive Scholar , it is necessary in the future to perform a follow up of the students' performance by an impact analysis of the workshop in their academic activities.

However, it was possible to analyze that the participation in the workshop may have generated an increase in self-efficacy in the participants which may favor an improvement throughout the academic activities.

It is clear that the participants would like that the program should be continued through more meetings, and this was confirmed by the high level of satisfaction (maximum score) for participation in the event. Considering this aspect, it is pertinent to analyze the possibility of increasing the number of meetings, to distribute the same sessions in more moments or to include new topics, besides those applied in this experience in the Graduate Program of the IRD. This aspect was not clarified by in the testimonials of the participants.

Considering the small number of registrations made, there is a need for more efficient dissemination actions, in addition to a scheduling of dates more compatible with the availability of the students, considering their commitments with disciplines and research activities schedules.

Considering the applied evaluation (100% of the participants would indicate the workshop to their classmates, 100% of the participants assigned grade 10 to the event), it is very useful to evaluate the possibility of inclusion of the Positive Scholar as a mandatory event for all graduate students, even if it is not part of the course curriculum.

The experience of the Positive Scholar in the Graduate Program of the IRD allows concluding that it is possible to introduce Social Science disciplines like Positive Psychology in order to disseminate others human knowledge subjects that can support the students during their research work and classes activities.

References

Achor, S. (2012) *O Jeito Harvard de Ser Feliz.* São Paulo: Saraiva.

Buckingham, M. & Clifton, D. O. (2008) *Descubra Seus Pontos Fortes*. Rio de Janeiro: Sextante.

Corrêa, A. P. (2013) *Coaching e Psicologia Positiva Reciprocamente Contributivos e Intencionalmente Catalisadores da Melhoria do Bem-estar.* Graduate Work, AVM Faculdade Integrada, Rio de Janeiro, RJ, Brasil.

Corrêa, A. P. (2016a). *Introdução à Psicologia Positiva*. In: Corrêa, Andréa Perez (Ed.) & Roma, Andréia (Coord.) Psicologia Positiva: Teoria e Prática. São Paulo: Editora Leader, pp.34 -63.

Corrêa, A. P. (2016b) *Qualidades Humanas Positivas*. In: Corrêa, A. P. (Ed.) & Roma, A. (Coord.) Psicologia Positiva: Teoria e Prática. São Paulo: Editora Leader,153- 159.

Corrêa, A. P. (2016c) *Intervenções e Práticas Positivas*. In: Corrêa, A. P. (Ed.) & Roma, A. (Coord.) Psicologia Positiva: Teoria e Prática. São Paulo: Editora Leader, pp 257- 265.

Corrêa, A. P. (2016d) *Felicidade, Bem-estar Subjetivo e Emoções Positivas*. In: Corrêa, A. P. (Ed.) & Roma, A. (Coord.) Psicologia Positiva: Teoria e Prática. São Paulo: Editora Leader, pp.111- 127.

Corrêa, A. P. (forthcoming, 2017) *Acadêmico Positivo: Educação Positiva aplicada ao contexto acadêmico de pós-graduação e pesquisa.* In: Corrêa, A. P. (Ed.) & Roma, A. (Coord.) Educando Positivamente. São Paulo: Editora Leader.

Csikszentmihaly, M. & Seligman, M. E. P.(2000) *Positive Psychology – An Introduction.* In: American Psychologist – Special Issue on Happiness, Excellence, and Optimal Human Functioning. Washington,DC. American Psychological Association.

Diener, E. Frequently Answered Question: A primer for reporters and newcomers. Ed Diener Website. Retrieved November 04, 2013, from http://internal.psychology. illinois.edu/~ediener/faq.html.

Diener, E.; Oishi, S.; Lucas, R. E. (2009) *Subjective Well-Being: The Science of Happiness and Life Satisfaction*. In: Lopez, Shane J.; Snyder, C.R. The Oxford Handbook of Positive Psychology. Oxford: Oxford University Press.

Duque, J.C.; Brondani, J. T.; Luna, S.P.L. (2003) *Estresse e pós-graduação em Medicina Veterinária.* Revista Brasileira de Pós-graduação. Retrieved April 09, 2017, from file:///C:/Users/Andr%C3%A9a%20Perez/Downloads/63-130-1-SM.pdf.

Em 13 anos, número de professores com doutrado em universidades federais cresce 189%. (n.d.) *Portal Brasil.* Retrieved April 09, 2017, from http://www.brasil.gov.br/educacao/2016/05/em-13-anos-numero-de-professores-com-doutorado-em-universidades-federais-cresce-189

Faria, S. (2017) "Número de pós-graduandos cresce no Brasil." Retrieved April 09, 2017, formhttp://portal.mec.gov.br/conselho-nacional-de-educacao/180-estudantes-108009469/pos-graduacao-500454045/2583-sp-2021081601

Fredrickson, (2009). *Positividade_–* Descubra a força das emoções positivas, supere a negatividade e viva plenamente. Rio de Janeiro: Rocco.

Gewin, Virginia. (2012). *Under a Cloud – Depression is rife among graduate studentes and postdocs. Universities are working to get them the help they need.* Nature, Macmillan Publishers Limited; 490; pp.299 – 301.

Junta, Cristiano. (2017). *Estresse e Depressão na pós-graduação: uma realidade que a acadeis insiste em não ver*. Associação Nacional de Pós-Graduandos. Retrieved April 09, 2017, from http://www.anpg.org.br/estresse-e-depressao-na-pos-graduacao-uma-realidade-que-a-academia-insiste-em-nao-ver/

Meis, L. de; Velloso, L.de M.; Lanes, D.; Carmo, M.S. & Meis, C. de (2003). *The growing competition in Brazilian Science: rites of passage, stress and burnout*. Brazilian Journal of medical and Biological Reasearch, 36; pp.1135-141..

Novaes Malagris, Lucia Emmanoel, Rocco Suassuna, Ana Teresa, Bezerra, Débora Ventura, Hirata, Heitor Pontes, Fontes Monteiro, José Luiz, Silva, Leila Rodrigues da, Morais Lopes, Marília da Conceição, & Santos, Tama Souza. (2009). *Níveis de estresse e características sociobiográficas de alunos de pós-graduação*. *Psicologia em Revista*, *15*(2), 184-203. Retrieved April 09, 2017, from http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1677-11682009000200012&lng=pt&tlng=pt.

Norrish, J. (2015). Positive Education. New York: Oxford University Press.

Oswaldo-Cruz, E. (2013) "Produção científica e qualificação das universidades." Academia Brasileira de Ciências. Retrieved April 09, 2017, from http://www.abc.org.br/article.php3?id_article=2758.

Peterson, C..(2006) *A Primer in Positive Psychology*. New York: Oxford University Press.

Peterson, C. & Park, N. (2009). *Classifying and measuring strengths of character*. In S.J. Lopez & C.R. Snyder (Eds.), Oxford handbook of positive psychology, 2nd edition (pp.25-33). New York: Oxford University Press. www.viacharacter.org

Peterson, C. & Seligman, M.E.P. (2004) *Character strengths and virtues: A handbook and classification*. New York: Oxford University Press and Washington, DC: American Psychological Association. www.viacharacter.org

Seligman, M.E.P. (1998) *Building Human Strength: Psychology`s Forgotten Mission* – in APA Monitor, American Psychological Association.

Seligman, M. E. P.(2011) Florescer. Uma Nova Compreensão sobre a Natureza da Felicidade e do Bem-estar. Rio de Janeiro: Objetiva.

Seligman. M.E.P.; Ernst, R. M.; Gillham, J.;Reivich, Karen; Linkins, M. (2009) *Positive Education: positive psychology and classroom interventions.* Oxford Review of Education, 35(3), pp. 293-311.

Seligman. M. E.P.; Steen, T. A.; Park, N.; Peterson, C. (2005). *Positive Psychology Progress.* Positive Psychology.

Schreiner, L.A. (2015) *Positive Psychology and Higher Education. The Contribution of Positive Psychology to Student Success and Institutional Effectiveness*. In: Wade, Jo. C; Marks, L.I.; Hetzel, R. D. Positive Psychology on The College Campus. Oxford University Press: New York, pp. 1-25.

SPREADING KNOWLEDGE ON RADIATION PROTECTION IN NUCLEAR TECHNOLOGY INFORMATION CENTRE

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ABSTRACT

Nuclear Training Centre was founded to support training of Krško NPP workers. In mid-nineties activities were expanded and Nuclear Technology Information Centre with permanent exhibition on nuclear technology was established. A vision was to become reliable and respected source of knowledge about nuclear technologies for general public. To compensate for deficient information about radioactivity and ionising radiation in primary and secondary schools, we added radioactivity workshop and hands-on experiments to our exhibition. In radioactivity workshop, we combine demonstrations and explanations about radiation, radioactivity, effects of radiation to human beings and radiation protection principles and practice.

We have also prepared “Mini Encyclopaedia of Nuclear Energy” which is freely distributed to our visitors. Significant part of Mini Encyclopaedia is devoted to radiation protection and related subjects.

More than 170,000 teachers, pupils, students and other people has visited our Information Centre till now and almost 100,000 visitors have seen our demonstrations and listened to our explanations about radioactivity, radiation and radiation protection. Almost 90,000 Mini Encyclopaedias were distributed since 2001. All these numbers show that the impact of our activities is significant.

1. Introduction

Nuclear Training Centre, which is a part of Jožef Stefan Institute, Ljubljana, was founded in 1989 to support training of Krško NPP workers. Number of courses for control room staff, system and equipment operators and other technical staff were prepared and implemented since then. Beside Krško NPP workers, members of Slovenian technical support organisations, authorities and experts employed by Krško NPP subcontractors attended these courses.

Soon after successful conclusion of the initial courses, the decision has been made to expand our activities. At that time, the public opinion in Slovenia was heavily influenced by Chernobyl accident and there were serious debates in media and among politicians about danger of nuclear energy and about the necessity to close Krško NPP. As a result of a change of political system, number of political parties were founded, among them also a Green party which became quite influential in parliament, mainly due to antinuclear position and request for immediate abandoning of nuclear energy in Slovenia. They have also demanded referendum about the closure of Krško NPP, but other parties were not prepared to support this radical approach immediately, also due to expert opinion that the similar accident cannot happen in our NPP. However, this opinion and explanations related to safety of our plant were originally targeted to decision makers, and less to opinion makers. The information was presented and distributed within limited circles, also due to limited interest of majority of media for, what was then called “biased” opinion of nuclear experts.

Our aim at that time was not to join those discussions, but to approach general public and to contribute to general opinion on long term basis. Since we were aware that the discussion on nuclear energy would follow into forthcoming years, we have decided to establish nuclear technology information centre with permanent exhibition on nuclear technology. The vision was to become reliable and respected source of knowledge about nuclear technologies for general public. Since we had free basement at our premises, we were able to commission big lecture room and exhibition with some posters without huge investments and lasting constructions.

At the beginning (in the mid-nineties), emphasise was given to the Krško NPP technology and operation, but later a part related to radioactive waste management was added to exhibition. In the last decade, exhibition was complemented with overview of nuclear fusion technology research.

From the very beginning of the Information centre operation, our most numerous and regular visitors are pupils and students from primary and secondary schools in Slovenia. In addition, other groups visit our Centre – groups of university students, teachers, members of different professional associations, firefighters, groups of retirees, etc. Annually, our Centre visit more than 150 groups and more than 6500 visitors. Altogether, more than 3,500 school groups and more than 170,000 pupils, students, teachers and other persons visited our information centre since 1993.

All these years we are trying to provide our visitors with honest, clear, thorough and attractive information about nuclear technology and related subjects. At the beginning of Information Centre operation, our lectures were concentrated on NPP operation and possible nuclear accidents. The main reason was short time distance to Chernobyl accident that occurred in 1986. With time, additional lectures on radioactive waste management, nuclear fusion and just recently, on isotopes in everyday use were prepared.

At the beginning of Information Centre operation, the exhibition was usually short addition to the lecture for our visitors. Posters with information were prepared to support lectures with some additional data or visual material, and to provide explanation of some concepts from physics or engineering which are important for understanding NPP operation. What we have discovered at that time is that explanations of basic concepts of radioactivity and ionising radiation have de facto disappeared from school programmes. They were either pushed in schedule somewhere at the end of school year, in parallel with final exams like filler, or were considered optional, leaving decision on presenting these contents to individual teacher.

It was also obvious that majority of teachers are not competent to speak about these subjects and they avoided it. Radioactivity used to be one of the subjects discussed in physics classes, but was later added to chemistry classes. It would work in "old" times, but after Chernobyl accident radioactivity and ionising radiation were considered result of reactor operation and considering the consequences of accident, also extremely dangerous. The other problem was that just few schools had any equipment that can be used for classroom demonstration, and if they had the equipment, teachers did not know how to use it properly.

What we have learned is that if we want to effectively transfer our messages to our visitors, especially pupils and students, and if we want them to become active subjects in debates and decision process related to nuclear energy in Slovenia, we have to provide them with basic information about radioactivity, radiation and radiation effects to human beings. This knowledge should serve as a tool for evaluation and judgment of problems and questions that must be resolved if we want to continue living with nuclear energy in near future.

We felt that adding or expanding existing lectures would not be productive, and we decided to add some hands-on experiments and to prepare small radioactivity workshop (Fig. 1) with practical demonstrations of ionising radiation properties, demonstration of natural background radiation and radon.

Fig. 1: Radioactivity workshop in Nuclear Technology Information Centre

We were also considering idea to prepare hands-on experiments for all our demonstrations, but it would be costlier and we also had to comply with limited time that participants spent at our site. Therefore we came to conclusion that the most effective approach would be to combine hands-on experiments at the exhibition with practical demonstrations in radioactivity workshop and to complement demonstrations with physical background explanation.

2. Radioactivity workshop

2.1 Demonstrations and hands-on experiments

We wanted to keep all our experiments and demonstration simple and clear, without any sophisticated equipment and detectors. Therefore, we decided for simple ratemeters with a large pointer and audible indication of detection event. The sound is very important since it reaches every person in vicinity regardless of person's attention and concentration. To avoid legal complications, we decided for small sources (i.e. sources under exemption level). At the same time, we wanted to have "strong" signal, i.e. high rate for every source. For that purpose high volume End Window GM tubes were chosen. They are sensitive to gamma radiation from the environment (natural background is not disturbance here and should be noticeable) and capable of detecting alpha, beta and gamma radiation. Therefore, same or similar detectors can be used for all demonstrations. We were able to buy suitable ratemeters and detectors and get additional equipment (holders for sources and detectors, absorbers/shields for alpha, beta, and gamma radiation, rulers) which is required for basic experiments and demonstration.
All equipment which we use for demonstration of properties of alpha, gamma and beta radiation is presented in Fig. 2.

For demonstration of radon progeny, we use End Window GM tube with ratemeter, and simple vacuum cleaner with a mesh fastened on the intake opening and a kitchen vents grease filters or pieces of filter cut from vacuum cleaner paper bag (Fig. 3, left). As alternative "catcher" for radon progeny, we use toy balloons (one for each experiment, Fig. 3, right). In our basement, demonstration of radon progeny with filter or balloon takes just a couple of minutes, which is more than suitable for demonstration.

Fig. 2: Equipment for demonstration of radiation properties

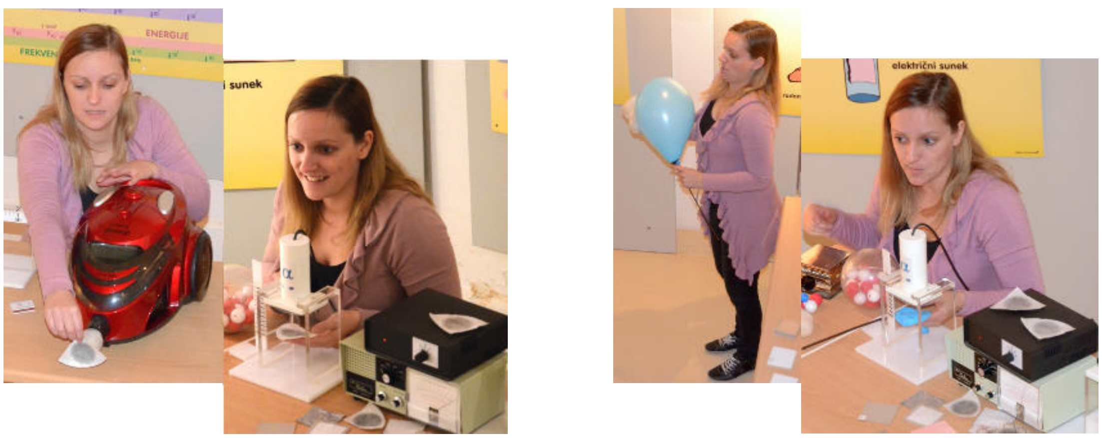

Fig. 3: Demonstration of radon progeny with filter and vacuum cleaner (left)
and toy balloon (right)

As we mentioned, all our sources are under exemption level. Nevertheless, for demonstrations of properties of radiation, it is necessary to have "clean" sources with only one kind of radiation. Therefore, we bought set of small disk sources for alpha (^{210}Po), beta (^{90}Sr) and gamma radiation (^{60}Co). Instead of original alpha source (half-life of ^{210}Po is only 138 days and our first source have soon decayed) we now use ^{210}Po sources prepared by one of our colleagues from Nuclear Chemistry Laboratory. For all other demonstrations, we use consumer products with elevated activity: radioluminescent wristwatch, thoriated welding rods or thoriated gas mantle.

Listed equipment and sources enable us to perform following demonstrations [1]:

1. Demonstration of natural background (some additional "check" source should be also used to verify operation of instrument and different dose rates),
2. Demonstration of alpha radiation and alpha radiation range in air, paper, kitchen aluminium foil,
3. Demonstration of beta radiation and beta radiation range in cardboard, aluminium and acrylic glass,
4. Demonstration of gamma radiation, attenuation of radiation in lead, and of half-value layers in aluminium, steel, lead, and concrete,
5. Demonstration of count rate over distance dependency,
6. Demonstration of radon progeny.

We have also prepared demonstration carousel ("Radioactivity carousel", Fig. 4) with different sources, which is used as hands-on experiment in exhibition. Samples were acquired from "environment": potassium chloride (KCl), fertiliser, uranium glass, radioluminescent wristwatch, thoriated welding rods, thoriated gas mantle and a piece of plate with radioactive (uranium) glaze. Samples are fastened on the round table and visitor turns the plate and observes the response from instrument with pancake GM tube.

Fig. 4: Radioactivity carousel

Next to the carousel is an instrument without any sample where visitors can check their own "samples" (Fig. 5). As could be expected nowadays, the instrument is mostly used for checking mobile phones, which is also instructive, since mobile phones are also sources of radiation and the difference between ionising and nonionizing radiation can be discussed.

Fig. 5: Instrument for visitor's samples

Our last acquisition is small cloud chamber. Unfortunately, the chamber cannot operate without operator's support and cannot be used as a hands-on experiment on the exhibition.

Therefore, cloud chamber is used as an addition to demonstrations in the workshop. We use small computer camera to project the image of traces on a TV screen.

2.2 Scope of presentations and explanations in workshop

Our workshop is not only devoted to demonstration of radioactivity, it is also intended to give basic explanations and to position radioactivity and ionising radiation in our life. Therefore, we start our demonstrations with general explanation of expression “radiation” and different kinds of radiation. We use big poster with list of different types of electromagnetic radiations and we describe and distinguish the effects of different types. Our typical visitors are already familiar with structure of the matter and atoms, so we can speak about radioactivity and describe what alpha, beta and gamma decays and radiations are. These explanations are combined with demonstrations of these nuclear radiations interactions with different absorbers, mostly to illustrate differences in penetrating ability of different radiations.

The most attractive for our visitors are demonstrations related to radon. As we have already mentioned, the concentration of radon in our basement is elevated and it takes just a few minutes to collect enough progeny on paper filter or balloon to get an impressive signal on ratemeter. Demonstration of radon and demonstration of background radiation are usually starting point for a description of effects of ionising radiation to human beings, without going into the discussion of biological particularities. We limit to basic explanations and use the term “dose” as a measure of irradiation and we state that biological effects are approximately proportional to dose. Depending on the visitor’s profile, we can go into more detail explanation, even describing the deterministic and stochastic effects and the short explanation of principles of protection, but this is exceptional. What we do regularly is explaining how to protect from radiation and demonstrate how shielding and distance can be used as an effective protection.

Our final message is that radioactivity and ionising radiation are natural phenomena that we may not be aware of, but we live with them. In addition, radioactivity and ionising radiation could be dangerous, but if we know how to protect ourselves from them we can even use them for our benefit.

3. Publications and other activities

Many of our visitors would like to learn more than just basic facts about nuclear technology and related subjects, also about radiation protection. For them and for others interested in status and future of nuclear energy, we have prepared “Mini Encyclopaedia of Nuclear Energy” [2], which is a freely distributed among visitors. The Encyclopaedia is bilingual (Slovene and English) and it covers following areas:

- energetics,
- radioactivity,
- nuclear power plants,
- fusion,
- uses of radiation in industry and medicine and,
- radioactive waste.

This Encyclopaedia was originally prepared as a compendium of posters from our exhibition, but later it was supplemented and expanded with additional subjects. Nine out of seventy pages in this publication are related to radioactivity, ionising radiation, measurement of radiation, background radiation, radon, effects of radiation to human beings and radiation protection principles and practice. Since 2001 we have prepared five editions of Encyclopaedia (originally, the title was “Atlas of nuclear technology”), 100,000 issues were printed and more than 90,000 distributed. Considering that in the same time we had approximately 120,000 visitors it means that three out of four visitors took their copy of Encyclopaedia home.

In addition to lecturing, performing demonstrations and providing a copy of Encyclopaedia, we also guide our visitors to TRIGA Mk II reactor, and TANDETRON accelerator. These are nuclear and radiation facility and can also be considered as practical demonstration of radiation protection practice.

We also encourage our visitors to keep in touch after they leave. They can either call us or submit a question through our homepage. We have also prepared basic instruction for teachers about detectors for ionising radiation and sources suitable for demonstration of radioactivity in schools taking into account legal requirements and available equipment [3].

4. Conclusions

Our Nuclear Technology Information Centre was established to become reliable and respected source of knowledge about nuclear technologies for general public. It seems that we succeeded in that respect since every year more than 7,000 visitors, mostly teachers, pupils and students visit our Centre.

Important part of the Information Centre are hands-on experiments and radioactivity workshop where demonstrations related to properties of nuclear radiations, demonstration of natural background and radon are performed. These demonstrations are combined with explanations related to radiation and ionising radiation, biological effects of exposure, dose and protection principles.

We also provide free bilingual “Mini Encyclopaedia of Nuclear Energy” to our visitors where significant part is devoted to radiation protection, especially to natural sources and principles of protection. We think that awareness of natural sources is essential for everyone who considers nuclear energy and nuclear technologies in general.

Altogether, almost 170,000 visitors have visited our Information Centre since mid-nineties and almost 100,000 visitors have seen our demonstrations and listened to our explanations about radioactivity, radiation and radiation protection.

5. References

[1] KOŽELJ, Matjaž, ISTENIČ, Radko. Radioactivity for everyone or twelve years of radioactivity demonstrations in Milan Čopič nuclear training centre. JENČIČ, Igor (ed.). Proceedings, 20th International Conference Nuclear Energy for New Europe 2011, September 12-15, 2011, Bovec, Slovenia. Ljubljana: Nuclear Society of Slovenia, 2011, 8 p

[2] ‘Mini Encyclopaedia of Nuclear Energy | ICJT’. [Online]. Available: http://www.icjt.org/en/jedrska-tehnologija/mala-enciklopedija-jedrske-energije/. [Accessed: 14-Apr-2017].

[3] KOŽELJ, Matjaž, ISTENIČ, Radko. Radioactivity experiments for schools. CIZELJ, Leon (ed.), LESKOVAR, Matjaž (ed.), URŠIČ, Mitja (ed.). Proceedings, 22nd International Conference Nuclear Energy for New Europe - NENE 2013, Bled, September 9-12. Ljubljana: Nuclear Society of Slovenia, 2013, pp. 1313.1-1313.9.

MONITORING THE EFFECTIVENESS OF THE TRAINING PROGRAM IN RADIATION PROTECTION, SAFETY, SECURITY AND ENVIRONMENT AT THE BELGIAN NUCLEAR RESEARCH CENTRE SCK•CEN

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ABSTRACT

The Belgian Nuclear Research Centre SCK•CEN is one of the largest research centres in Belgium with more than 60 years of experience in nuclear science and technology. Continuous Professional Development activities are offered to SCK•CEN employees with the objective to maintain and increase the competences of the employee in order to optimize the output and wellbeing on the workfloor.
Given the nature of the SCK•CEN activities, a compulsory training program in radiation protection, safety, security and environment is organized for all employees. The training program consists of a mixture of On the Job Training, face-to-face training and e-learning. The content of the training program is adapted to the type of activities of the employee. Lecturers of the SCK•CEN Academy develop the training material and teach the face-to-face training sessions.
In order to evaluate this training program, information is gathered on two levels. On the one side the reaction of the participants to the training is monitored through their feedback shortly after the training course. On the other side the degree to which the participants have acquired new knowledge is measured.

1. Introduction

SCK•CEN performs research on themes that are important for the society of both today and tomorrow and delivers services to industry, healthcare, government and other third parties. Through the SCK•CEN Academy for Nuclear Science and Technology education and training activities are provided at national and international level, covering all topics that are part of the R&D portfolio of SCK•CEN. For all employees and PhD students a program for continuous professional development (CPD) is foreseen. This is centrally organized by a unit called the "SCK•CEN Learning Centre". The Learning Centre is responsible for the development and implementation of the policy on CPD actions, as well as the management and practical organization of the associated training activities.

The SCK•CEN Learning Centre works on all aspects of corporate training activities: from collecting and analyzing training needs, determining the offer of training activities, contacts and negotiations with suppliers, towards registrations and practical organization of events, until the monitoring of attendance, analysis of the feedback and verifying the efficiency and effectiveness of the training activities.
Safety is a key priority at SCK•CEN, next to values like responsibility, excellence, innovation, integrity and sustainability. All training activities of the Learning Centre are organized in four categories:

- Safety, security, environment, health, quality
- Scientific and technical competences
- Personal and management competences
- Your professional environment

Each of them pay attention to topics that reflect the main activities of SCK•CEN and cover all needs of the SCK•CEN personnel in order to maintain and extend their competences. Specifically towards safety, security and environment, a dedicated introduction session was introduced and CPD activities are organized on a regular basis. The aim is to increase safety on the work floor and embed our employees in the company safety culture.
This article focuses on the learning pathway in the framework of radiation protection, safety, security and environment for new employees at SCK•CEN.

2. Training program in radiation protection, safety, security and environment

2.1 Target public

All persons requiring access to the technical domain for work purposes (excluding visitors) follow an on-line information session on general safety procedures, complemented by specific modules relevant to the work the person will be carrying out at the technical domain. This is also mandatory for new (temporary) employees or external persons spending at least six months at SCK•CEN. In addition to the information session, the personal supervision plan describes other training courses and information sessions to be followed within a certain time frame. These are tailored to the tasks and responsibilities and the specific risks the person is exposed to during his/her job. Typical industrial hazards associated with the working environment at SCK•CEN are, among others: fire, mechanical, heavy loads, chemical, electrical, mining,… Due to its nuclear activities, radiation hazards are also part of the working
environment at SCK•CEN.

The staff at SCK•CEN consists of researchers, engineers, technical staff and administrative staff. About half of the personnel holds an academic degree, but a large part of the personnel does not have a specific nuclear background. This has implications on the type and level of training courses that are organized. A distinction can be made between personnel that is professionally exposed to ionizing radiation due to their daily activities (access to controlled areas), and members of the personnel that are not exposed professionally. The professionally exposed personnel is treated as a special target group in the E&T strategy of SCK•CEN.

2.2 Description of the training program

2.2.1 Training program for new employees

The compulsory training program for all new employees with a contract of 6 months or more consists of four parts, which are described below:

1. On-line information sessions to obtain access to the technical domain
2. On-the-job training for professionally exposed personnel
3. Introduction session
4. Dedicated training courses on radiation protection, safety, security and environment

On-line information sessions to obtain access to the technical domain
SCK•CEN organizes on-line information sessions on safety that are compulsory to every member of the personnel and persons who regularly enter the technical domain. The purpose of these information sessions is to familiarize the target audience with the general safety procedures at SCK•CEN, and to promote safety culture in the daily work of each individual. The content of these information sessions consists of a specific combination of modules depending on the work to be carried out. Ten separate modules are available: emergency situations, environment, security, radiation protection, fire hazards, personal protection means, dangerous goods, signalization, electricity and working at heights.

A combination of learning methods is offered in these information sessions. The information is distributed through e-learning modules that are available on the public SCK•CEN website. Complementary to that, the information is also available by means of a brochure. In order to assess whether the individual has grasped all information, an obligatory test is performed at the main entrance of SCK•CEN prior to access being granted. The test consists of a number of multiple-choice questions about the safety modules. In order to get access to the technical domain, the individual has to obtain a minimal score of 70%. In order to refresh the knowledge, skills and attitudes related to the safety topics mentioned above, the on-line information sessions and the test with randomized questions have to be repeated on a yearly basis by every member of the personnel of SCK•CEN and the external workers.

On-the-job training for professionally exposed personnel

There is an inevitable delay between the first day of being exposed to ionizing radiation and the associated risks, and attending a training course in radiation protection. Therefore, newcomers who are classified as professionally exposed personnel have to report themselves to the radiation protection officer responsible for the controlled area where they will work in the first work week. This radiation protection officer provides a guided tour in the installation and associated controlled area(s), focusing on the principles of good conduct in a controlled area. This involves actions to prevent contamination and irradiation, use of PPMs, use of personal dosimeters, measurements and decontamination, management of radioactive waste and transport, local contact persons, and specific emergency alarms and procedures. The personal contact with the local radiation protection officer facilitates getting acquainted with the local safety culture. Individual access to the controlled area is coupled to the successful completion of this on-the-job training.

Introduction session

New employees are invited to an introduction session covering different aspects about their new working environment. During a two-hour information session, the employees receive a general introduction to the mission, research tracks, technical installations and safety management of SCK•CEN. In a second part the supporting services at SCK•CEN are introduced from a practical point of view. This introduction session needs to be attended during the first months of employment. Attendance is registered by the Learning Centre and reported to the management.

Dedicated training courses on radiation protection, safety, security and environment

In addition to the entrance procedure and the introduction session, and within the first six months of employment, the new employees attend a face-to-face training course on radiation protection, safety, security and environment. As mentioned before, a distinction is made between personnel that is professionally exposed to ionizing radiation due to their daily activities, and members of the personnel that are not exposed professionally.

For the latter a training module of 3 hours is provided covering radiation protection and safety culture at SCK•CEN. This module aims at providing a low-level insight into ionizing radiation and its applications, the general framework of radiation protection and the safety culture at SCK•CEN. An 8 hour training module on radiation protection is offered to the professionally exposed persons, providing basic knowledge, skills and attitudes on ionizing radiation and its applications, detection and dosimetry, biological effects of ionizing radiation, and regulation on radiation protection and safety. This course module includes a 1,5 hour practical session on how to work with ionizing radiation.

Training modules on industrial safety, nuclear security and environment, each 1,5 hours, are generic for all new employees.

2.2.2. Refresher training

As mentioned before, each employee at SCK•CEN is obliged to take the randomized safety test each year. The content of the test is linked to the safety animations available online.

Next to this test, each employee will be asked to renew their knowledge, skills and attitudes on radiation protection, safety, security and environment by following a face-to-face refresher course on these aspects. The radiation protection module of this training course is reduced to 1 to 1,5 hour and covers a summary of radiation protection fundamentals, safety, safety culture and risk management. The other training modules on industrial safety, nuclear security and environment are identical to the initial ones.

2.3 Learning Management System

In order to register and monitor all CPD activities of the personnel, the SCK•CEN Learning Centre has developed a customized database. This tool allows the management of the practical organization of the training sessions, the registration of participants and the use of various reporting services. To increase awareness of the importance of training courses and its impact on safety, each member of staff has access to a personal webpage, showing the training courses they have attended in the past, including the validity of relevant certificates or qualifications. In close collaboration with the Internal Service for Prevention and Protection at Work (ISPPW), the Learning Centre coordinates the organization of training courses related to the risks in the working environment. Many of these courses have to be followed in the framework of qualifications, meaning that certificates have to be acquired before certain tasks can be executed. The certificates, including the respective deadlines, are also managed by the Learning Centre.

2.4 Lecturers

For customized training courses aiming at improving competences of SCK•CEN personnel working with radioactive materials or managing nuclear activities, the Learning Centre collaborates with the SCK•CEN Academy for Nuclear Science and Technology [1]. Founded in 2012, the Academy coordinates and strengthens all education and training activities of SCK•CEN, collecting more than 60 years of expertise and experience gained from different research projects. Among the SCK•CEN Academy lecturers, about 150 SCK•CEN staff members in total, are physicists, biologists, medical doctors, engineers, technicians and social scientists who all bring insights and ideas from their specific background into the course programs.

2.5 Evaluation of the training program

In order to determine the efficiency and effectiveness of training courses, an evaluation is performed using the Kirkpatrick training evaluation model [2]. This evaluation model contains four levels of evaluation and can be used to evaluate any kind of training. The first level, reaction, evaluates the degree to which participants find the training favorable, engaging and relevant to their jobs. Level 2, learning, measures the changes in knowledge, skills and attitudes with respect to the training objectives. The third level, behavior, evaluates the degree to which participants apply what they learned during training to their jobs. The fourth level, results, evaluates the degree to which the targeted outcomes occur as a result of the training. The training program in radiation protection, safety, security and environment is evaluated according to level 1, level 2 and to a small extent level 3 of the Kirkpatrick model.

Shortly after the end of each training course that is organized by the Learning Centre, participants receive a link to an online feedback form. This survey mainly assesses the reaction of the participants to the training and contains some questions that are related to level 2 (learning) and 3 (behavior). Participants are asked to evaluate, amongst other things, the content, trainer, course material and organization. Specifically for the radiation protection course for professionally exposed personnel (8 hours), a pre-post test was designed to assess the learning of the participants. At the start of the course, the participants receive a multiple-choice test (pre-test) with 12 questions that reflect the learning objectives. At the end of the course, the participants get a similar multiple-choice test, containing some questions that are repeated from the pre-test and some additional questions. The learning gain is determined through a comparison of the scores on the pre-test to the scores on the post-test, with special attention for the repeated questions.

2.6 Online learning

With the objective to increase the flexibility for the participants and to increase the effectiveness of the training, a significant amount of online learning will be introduced in the training program. The online course will consist of a combination of instructor-led videos, interactive content, multiple-choice questions and small exercises. The learning management system will be used to offer the online courses and to analyze the training course. Information will be stored on the progress of the participants, the score on the tests and the time it took to finish the course. In order to maximize the impact on the skills and attitudes of the participants, a face-to-face closing session will be organized for all participants that have completed the online course. The degree of effectiveness of the face-to-face training will be compared with the effectiveness of the e-learning training, by applying the same methodology as is applied currently.

3. Conclusion

The new learning pathway for new SCK•CEN employees, with course modules on radiation protection, industrial safety, security and environment, was launched in September 2015. Feedback related to efficiency and effectivity was requested to all participants. Overall, the training courses were perceived positively by the participants, mentioning good applicability to the daily work environment and clear and up-to-date information. Learning was quantified in the difference between the score on the pre-test to the score on the post-test.

The organization and follow-up of CPD in general and specifically on radiation and industrial safety, customized to the needs of every member of the personnel at a large nuclear research centre like SCK•CEN remains challenging. Being a national research centre in Belgium, the sessions have to be offered in three different languages with a limited pool of lecturers. Furthermore, the heterogeneity of the workforce of SCK•CEN requires the content of training courses to be adapted to a mixed audience. The training course content was setup to begin with the basic fundamentals of radiation and industrial safety. Specialized training courses can be followed optionally or mandatory according to the local or regulatory requirements, or depending on the job description and associated competences needed.

4. References

[1] http://academy.sckcen.be/
[2] Kirkpatrick. D.L. (1959). Techniques for Evaluating Training Programs. Journal of the American Society of Training Directors, 13, 3–26.

Certified Training for Radioactive Source Security Management

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ABSTRACT

In countries with mature regulatory structures, the use of radioactive sources is highly regulated from a safety perspective. Licensees readily accept such regulations because they are well aware of the potential consequences should a safety incident compromise the health, safety and environment of their employees and surrounding communities. In contrast, a comparable security culture has been much later to evolve, largely because many States, regulatory authorities and licensees have still to appreciate how radioactive sources could be used by people with malevolent intentions. In reality, security incidents involving radioactive sources occur quite frequently. According to the Center for Nonproliferation Studies (CNS) Global Incidents and Trafficking Database, from 2013-2014 there were over 325 incidents of theft or loss involving nuclear and other radioactive material: the vast majority of these incidents involve radioactive sources used in industrial and medical applications.

Radiation Safety Officers (or similar professionals) have historically inherited the responsibility of overseeing the implementation of security policies and procedures for radioactive sources. However, senior and line managers are also responsible for the security of radioactive sources, as well as regulatory personnel (particularly inspectors and license reviewers). The number of accountable staff may number in the dozens at larger corporations with extensive commercial or other business interests and staffing resources to match. These individuals often have substantial knowledge of radiation protection and safety practices, but they may lack formal security education and training which has developed their competency in this area. To address this gap, the World Institute for Nuclear Security (WINS) has launched the WINS Academy, an initiative to provide practitioners with opportunities to earn certification in nuclear and radioactive source security management. The training programme has been designed to be completed online, supplemented by in-person courses, and candidates can sit for certification exams at test centres through the Pearson VUE network, which has 5100 accredited test centres in 180 countries.

Leaders of industry who participated in the Nuclear Industry Summit in 2014 supported this approach when they committed to "ensuring that all personnel with accountabilities for security are demonstrably competent by establishing appropriate standards for the selection, training, and certification of staff." Similar statements were made at the 2016 Nuclear Security Summit in Washington, DC, including a joint statement by 12 States (published as IAEA INFIRC/901) to WINS support certified training.

1. Introduction

Radioactive sources are used routinely by hospitals, research facilities and industry for such purposes as diagnosing and treating illnesses, sterilising equipment and inspecting welds. In countries with mature regulatory structures, the use of radioactive sources is highly regulated from a safety perspective. Licensees readily accept such regulations because they are well aware of the potential consequences should a safety incident compromise the health, safety and environment of their employees and surrounding communities. In contrast, a comparable security culture has been much later to evolve, largely because many States, regulatory authorities and licensees have still to appreciate how radioactive sources could be used by people with malevolent intentions.

This is concerning because we know that terrorists have considered or attempted to use radioactive sources as weapons. As reported by the Associated Press in 2015, Moldovan authorities have interrupted four attempts by gangs to sell radioactive material to extremists in the last five years. The latest known case took place in February 2015, when a smuggler specifically sought a buyer from the Islamic State group for a huge cache of allegedly radioactive caesium that was enough to contaminate several city blocks [1].

In the effort to ensure the security of nuclear and other radioactive materials, facilities and personnel, many States have incorporated requirements in their regulatory framework that include a variety of consequences should organisations fail to carry out their security responsibilities adequately. This could include regulatory orders for corrective actions, restrictions on an organisation's business activities, revocation of the license to operate, and imposition of civil fines and penalties. If an incident occurs and it is found that an organisation, or individuals within an organisation, were wilfully negligent in implementing required security measures, it is also possible that criminal prosecution could result.

Effectively managing the security of high activity radioactive sources therefore requires that organisations understand and comply with their national regulatory requirements. Yet such requirements vary from state to state (where they exist). Where minimal regulatory requirements exist, an organisation will need to decide if it should do more than required, using a cost-benefit analysis taking into consideration the damage to the reputation of the organisation and possible clean-up or other liabilities if there is an incident.

2. Developing Competency Frameworks

Radiation Protection Officers (RPO), who are also known as Radiation Safety Officers, have historically inherited the responsibility of overseeing the implementation of security policies and procedures because some basic measures, such as material accounting and control of access to radioactive materials, were already part of their safety responsibilities. However, senior and line managers are also responsible for the use of radioactive sources, as well as regulatory personnel (particularly inspectors and license reviewers).

The number of accountable staff may number in the dozens at larger corporations with extensive commercial or other business interests and staffing resources to match. But many users of radioactive sources are small or even very small organisations. In these cases, security is likely to be a responsibility of just one or a few staff. Figure 1 provides an example organisational chart and some of the key roles that might be primarily accountable for security of a site's radioactive sources.

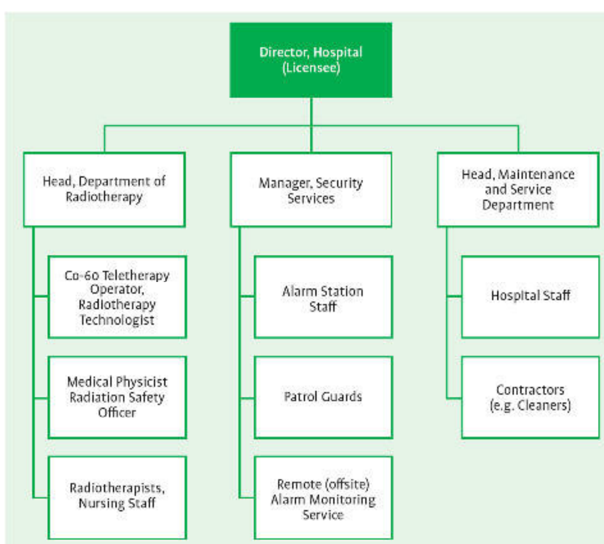

Fig 1: Key roles with accountability for security

These individuals often have substantial knowledge of radiation protection and safety practices, but they may lack formal security education and training which has developed their competency in this area. The word *competency* can be defined as the "qualities an individual needs to have in order to perform the duties of a particular role successfully." The concept is often broken down into three elements: *Knowledge, Attributes* and *Skills* [2]. For example, RPOs might need to have the following security competencies to carry out their job responsibilities effectively:

Security Knowledge

- Possesses accurate, current information regarding threats and risks from the malicious use of sources.
- Understands protection fundamentals (deterrence, detection, delay and response) and management practices.
- Understands the legal obligations and potential liabilities surrounding security matters.
- Is aware of industry regulations as they apply to security issues.
- Understand their role in security incident management, including reporting mechanisms and the chain of command.
- Understands the direct and indirect costs associated with delivering security.
- Understands the range of stakeholders with interest in efficient security practices at the facility.

Security Skills

- Can write security plans and procedures.
- Can help coordinate a security exercise.
- Manages equipment maintenance programmes.
- Conducts internal training and performance testing.
- Develops budgets to sustain enhanced security for radioactive sources.
- Can advocate for options to reduce the security risk associated with sources (e.g. alternative technologies).

Security Attributes/Behaviours

- Promotes security awareness to other staff (prudent security management practices, understanding potential threats and consequences, reporting of incidents, etc.).
- Communicates proactively with other stakeholders on security matters.
- Promotes the need for information protection as appropriate.
- Advocates for an improved security culture.
- Utilises key performance indicators for security.

Once the required competencies are agreed, then an organisation can develop an impactful training programme. The type and amount of training that each employee receives should be based on a systematic job task analysis that identifies individual security responsibilities along with the competences required to carry out each responsibility. The training programme should specify how staff with direct responsibility for the equipment are trained and the procedures they must follow to ensure that the equipment is properly operated and maintained. (Individuals may need to receive certifications in some areas to ensure this.)

3. Implementing Security Training

Security training starts immediately when employees are recruited and receive their first security induction. It continues as they regularly receive refresher training on the basics and specialised training to meet the needs of changing job titles and growing responsibilities. The objective is to establish a competency-based structure throughout the organisation that defines the knowledge, skills and behaviours employees need to have in order to carry out their security accountabilities and proactively minimise the potential of outsiders or insiders to operate unseen. Senior managers require different competences from frontline operational staff, so the training programme must accommodate different audiences and needs.

International recognition of the need for specialised security training for staff has increased substantially in the last decade and led to a rapid rise in training programmes. In 2012, representatives from 30 International Atomic Energy Agency (IAEA) Member States gathered in Vienna to establish the International Network for Nuclear Security Training and Support Centres (NSSC Network). The Network's vision is to provide excellence in nuclear and radioactive source security worldwide, and its mission is to contribute to the global efforts to enhance capacity building through a worldwide, collaborative network of nuclear security training and support centres. By April 2017, the Network consisted of 64 institutions registered in 58 countries [3]. In addition, the IAEA holds approximately 60 international nuclear and radioactive source security training events annually.

Coincident with and aligned with the development of the NSSC Network, WINS has launched the WINS Academy, an initiative to provide practitioners with opportunities to earn certification in nuclear and radioactive source security management. The target audience is a multi-disciplinary group including board members, executive managers, security directors, scientists and engineers, offsite incident responders, regulators, and other professionals with management responsibilities for nuclear and radioactive source security. All participants begin with a core Foundation Module that sets out security as a fundamental aspect of risk management and corporate reputation, as well as a strategic, operational activity that needs to be implemented organisation-wide. Participants then choose one elective module according to their interests, needs, and background. After completing both modules, they have the opportunity to take proctored exams; if they pass, they are certified by WINS as a *Certified Nuclear Security Professional (CNSP).*

In 2016, WINS released its Academy elective course specifically designed for professionals with direct accountability for the security of radioactive sources used at medical, industrial and research facilities. This course targets RPOs and other managers who are responsible for the use of radioactive sources; it also supports the professional development of regulatory oversight personnel, particularly inspectors and license reviewers. Such individuals often have substantial knowledge of radiation protection and safety practices, but they may lack formal security education and training. The course is intended to be useful to any organisation that needs to secure its radioactive sources, ranging from larger corporations with extensive commercial or other business interests and staffing resources to match, to very small organisations.

The training programme has been designed to be completed online, supplemented by in-person courses, and candidates can sit for certification exams at test centres through the Pearson VUE network, which has 5,100 accredited test centres in 180 countries. Graduates join an elite, and growing, professional network. As of today, approximately 900 participants from 80+ countries have enrolled in the Academy programmes and more than 225 individuals have become CNSPs.

4. Next Steps

In cooperation with its sponsors and selected partners, WINS is producing blended in-person learning materials sensitive to various cultural norms and expectations to complement the online WINS Academy certification courses. These in-person training sessions can be delivered at selected training centres to serve both domestic and regional needs. WINS will be piloting the first in-person training courses for radioactive source security management with the Instituto Nacional de Investigaciones Nucleares in Mexico.

In conjunction with the development of training materials, WINS is also able to provide assistance for identifying and training national specialists capable to independently deliver the training, and for assisting training centres willing to become certified against international standards such as ISO 29990. This international standard has been developed to improve and standardise the quality of education and training in non-university settings, including industry-training programmes. Achieving ISO 29990 certification offers an internationally recognised external benchmark of quality; demonstrates credibility of the training centre, their competence and professionalism; and gives potential employers and others in the community an objective measurement of participants' knowledge.

These efforts are underpinned by State commitments to support the WINS Academy. During the 2016 Nuclear Security Summit, 12 countries came together and signed a Gift Basket in support of the WINS Academy. Titled a *Joint Statement on Certified Training for Nuclear Security Management*, the effort was led jointly by Canada and the United Kingdom and signed by Finland, Hungary, Indonesia, Kazakhstan, Mexico, the Netherlands, New Zealand, Norway, Thailand and the United States. On 6 December 2016, the Joint Statement was published as IAEA Information Circular 901 (INFCIRC/901) [4]. INFCIRC/901 commits signatory States to support the WINS Academy in its efforts to expand its international certification programme, including through the provision of advocacy, peer review support, contributions, or by other means as necessary.

5. References

[1] Butler, D. and Ghirda, V. AP INVESTIGATION: Nuclear smugglers sought extremist buyers. Associated Press (2015). Retrieved from: http://bigstory.ap.org/article/688d82738c6f4e89b9636edfbc868de6/ap-investigation-nuclear-smugglers-sought-terrorist-buyers.

[2] Johnson, D. and Howsley, R. Why Regulators Must Be Competent. Radiation Regulator 1/3, 105 (2013).

[3] NSSC Network. International Atomic Energy Agency (2016). Retrieved from: http://www-ns.iaea.org/security/nssc-network.asp?s=9&l=76.

[4] IAEA Information Circular 901 (2016). Joint Statement on Certified Training for Nuclear Security Management. Retrieved from: https://www.iaea.org/sites/default/files/publications/documents/infcircs/2016/infcirc901.pdf.

ENETRAP III TOOL FOR CAPACITY BUILDING IN RADIATION PROTECTION.

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ABSTRACT

In the FP7 ENETRAP III (nr. 605159 Fission-2012-5.1.1), thirteen European institutions are working over seven working packages with a common objective: to enhance the education and training in radiation protection at European and national level, taking into account the needs in different sectors such as nuclear industry, healthcare, research centres or governmental institutions.

This presentation focuses on the achievements of Work Package 5. WP5 has designed a Capacity Building (CB) tool that encompasses a big amount of information around 3 target audiences, namely the professionals in radiation protection, the people in training and the RP community. The CB tool serves as a unique source of information on education and training in radiation protection, such as training references, professional workshops and an Education and Training (E&T) database. Next to specific information about E&T events, also general information about European projects and networks is available, as well as relevant legislation and the related qualification framework. With the development of this CB tool, supported by the EUTERP foundation, WP5 aims to contribute in transferring knowledge and developing skills and competences at individual and collective level in order to protect workers, the public and the environment from the potential risks of ionizing radiation today and in the future.

Collaboration with the IAEA was set up and the actions taken consolidates with the relevant actions of the NKM Group of IAEA. This allows information about European radiation protection E&T initiatives to become known and consulted at global level.

1. Introduction

The ENETRAP project series were founded in the sixth and the seventh European Framework Programs, with the aim of maintaining a high level competence in radiation protection (RP). The ENETRAP III project started in June 2014 and ends in May 2018. There are thirteen European institutions working over seven working packages and the main objective is to enhance the education and training in radiation protection, at European and national level, taking into account the different sectors such as industrial, medical, research or nuclear field.

The ENETRAP project was created with the aim of assuring the continued development of suitable well trained personnel and an adequate knowledge management (KM) to guarantee future safe use of ionizing radiation (IR) as well as the development of new technologies in a safe way, in line with EU policies on Education & Capacity Building. Innovating and modernizing education and training are key priorities in several initiatives of the Europe 2020 strategy, which aims to improve Member States capabilities by providing hands-on RP training using different tools.

All ENETRAP III activities are carried out in work packages (WP), described as coordination activities, except WP1 which is management activity, with one of the Consortium partners taking the lead and with collaboration from appropriate partners of the Consortium and external advisors. One of the most important results of the ENETRAP III project is the development of a tool for CB and transfer of know-how in RP (WP5) in order to contribute to the main objective of ENETRAP. The Capacity Building (CB) tool developed encompasses a big amount of information around three target audiences, namely the professionals in radiation protection, the people in training and the RP community.

The CB tool serves as a unique source of information on education and training in radiation protection, such as training references, professional workshops and one of the most important resources for the radiation protection community: an E&T database focussed on the radiation protection expert, the radiation protection officer and the exposed workers. Next to specific information about E&T events, also general information about European projects and networks is available, as well as relevant legislation and the related qualification framework. With the development of this CB tool, supported by the EUTERP foundation, WP5 aims to contribute in transferring knowledge and developing skills and competencies at individual and collective level in order to protect workers, the public and the environment from the potential risks of ionizing radiation today and in the future. This tool is also offered to all the European projects and Platforms to present all opportunities in radiation protection in order to build a common CB strategy based on a consensus on common needs, vision and instruments related to:

- **research: knowledge creation**
- **innovation: technological applications**
- **education and training: knowledge transfer and competence building**

This paper aims to present and share the experience of establishing platforms and networks in RP items in the context of the EU framework as well as their achievement and challenges for future development of a RP culture. The importance of networking is regarded as a tool for promoting E&T in radiation protection. In this context, the aim of this WP5 is to contribute and to improve the EUTERP portal. This includes information on European and national regulations and legislation, recognition procedures, training providers, courses, assessment tools, useful contacts, links to relevant organisations in the field, etc.

2. Materials and Methods

The RP E&T activities are embedded in the European legal framework through the EURATOM Basic Safety Standards (BSS) [1] published on January of 2014 where the new definitions for the Radiation Protection Expert (RPE), Radiation Protection Officer (RPO) and Medical Physics Expert (MPE) are used. These definitions are the basis for the transposition of the legislation in the European countries and enable a harmonization of the RP actors across the European Union.

For the purpose of ENETRAP III project, capacity building is understood as a strategy, based on a consensus on common needs, the vision and the means for transferring knowledge and developing skills and competences, both individually and collectively, in Radiation Protection matters to protect workers, the public and the environment from the potential risks of ionising radiation today and in the future. Capacity building considers different aspects to produce the expected change in the RP community: education & training, knowledge management, knowledge networks and human resource mobility.

The main objective of WP5 deals with the dissemination of the ENETRAP and ENETRAP II&III projects activities and results through a website.

The specific objectives are to improve the EUTERP CB portal in order to:

- provide an electronic platform where all relevant information about E&T in radiation protection can be found
- increase awareness and visibility of existing E&T resources on RP, thereby also providing a better understanding on where and which education and training actions are currently missing;
- develop an **E&T database** containing information about E&T events and providers specific designed to RPE, RPO and workers
- enable access to learning materials and useful information around E&T in radiation protection, providing support to E&T providers and enabling them to improve the quality and increase the availability of training courses;
- combine all relevant available information regarding E&T in RP, currently spread over different carriers, and offer them to the stakeholders in one coherent way.

These specific objectives have been implemented at the EUTERP portal as a management system in radiation protection. The key challenge for this tool is to make sure that the full potential of digital technologies is used for learning. And at the same time preserve the results from the ENETRAP I-II-III projects and bring together the information that is currently spread over several websites and other carriers (databases, CDROMs, papers, documents, etc.), including the promotion of the EUTERP community.

The Working Package 5 (WP5) was in charge of developing these objectives to improve the EUTERP website to become a capacity building tool and transfer of know-how in RP. This movement will increase the efficiency of the RP initiatives and will provide access to a vast amount of knowledge and thereby opening the door for new opportunities.

In order to design the structure of the Capacity Building tool, several analyses were done. This included an overview of the ENETRAP projects results (including the expected results of ENETRAP III) and an analysis of the structure of different and well recognized web portals with a capacity building strategy in different activity fields.

3. Results and Discussion

One of the most important results of the ENETRAP III project is the development of a tool for Capacity Building (CB) and transfer of know-how in Radiation Protection (WP5) in order to contribute the main objective of ENETRAP: to maintain a high level of competence in RP, assuring the continued development of suitable well trained personnel and adequate knowledge management.

CB considers different aspects to produce the expected change in the RP community: education & training, knowledge management, knowledge networks and human resource mobility [2, 3].

Education and training (E&T): is the critical element to create capacities and prevent the decline in expertise and to meet the future demands. This is the main pillar of ENETRAP-projects.

Knowledge management: deals with the process of creation, organization, storage, preservation, transference and utilization of knowledge.

Knowledge networks: are related with the social interaction between the actors involved in the RP Knowledge (experts, regulators, E&T providers, students, young professionals, senior professionals, other stakeholders,..) in order to have communication, ask questions, share ideas, participate in constructive debates to have better understanding on where and which education and training actions are currently missing. One of the main aspects is to offer a coherent overview to the research EU projects and platforms related to RP.

Human resource mobility: easiness of the exchange of workers across the national borders, developing a common high-level safety & RP culture, supported by the EU training policy. The instruments for borderless mobility are the lifelong learning strategy and the mutual recognition of the RPE status between Member States.

As we have mentioned before, this approach is in line with the Europe 2020 strategy of the European Commission [4]. This strategy focussed on education and training, can be summarized as follows:

- Needs analysis (results of the training, knowledge, skills and competences ...)
- The convergence towards a common vision
- The development of common instruments to meet the above needs and vision (EQFs, ECVET, and continuous professional development.)
- Lifelong learning and mobility without borders

The Capacity Building Tool

To make efficient use of resources and to reach an optimal result, assuring the continuity in time, ENETRAP III collaborates with the EUTERP Foundation that already had an operational website in E&T in RP. This website served as a basis for the electronic platform to become a knowledge and a document management system. This portal also increase the transparency in capacity building on RP, facilitate the access to available E&T material and foreseen course events, and improve the coordination between the different institutions involved in capacity building. The aims of the EUTERP foundation are in line with the objectives of the CB tool. The use of this portal as basis provides the advantages of a solid community to support the CB tool.

Taking in consideration that CB requires influencing multiple entry points to produce the expected change in the RP community (education & training, knowledge management, knowledge networks and human resource mobility), the portal structure has organized the information around three target audiences, namely the professionals in radiation protection, the people in training and the RP community. The **education and training centre** is designed to cover all the information related to the students at all stages and young professionals in training (E&T). This block includes different utilities as an "E&T Database", "Resources for educators (TTT)", "Training guides and manuals" and a "Library". The CB tool serves as a unique source of information on education and training in radiation protection, such as training references, professional workshops.

The most important result of WP5 is the E&T database and the overview of valuable information that is spread in different places forming a multidimensional system of knowledge management in RP.

What can you find on EUTERP database?

The EUTERP database is the place to search when you are looking for:

(Training) Courses
Academic Education
Internships, PhD and Postdoc opportunities
On-the-job training
Job opportunities
Workshops, conferences, symposia
Organizations
All in the field of **Radiation Protection** in Europe.

The development of the database is still ongoing but is close to be finished. The "E&T database", contains information about E&T events, opportunities and providers. This application includes the information organized by

- the nature of event: E&T courses, Degrees, PhD topics and Masters;
- the target audience: E&T: RPE, RPO, Exposed Workers
- the kind of the event: initial, retraining and specialization in any type of areas of the radiation protection.

On-the-Job-Training (OJT) is included, as well as an overview of institutes hosting on-the-job-training possibilities, conforming to the agreed standard identified in the project.

This tool can be available at the EUTERP Foundation CB Platform:

http://www.euterp.eu/

Further this EU database is being connected with the IAEA new development database "Integrated database for nuclear education and training" in order to promote the CB in RP not only at the European context, but at the international level minimizing the efforts and being part of the pan-database devoted to the specialized E&T.

One of the key factors ensuring qualitative high-level training is the suitability of trainers. The trainers not only need to have a high-level understanding of the scientific and technical basis they are training, but also an insight in the context and a sense for the social and philosophical aspects of the situation, and appropriate didactic skills. At the current scenario, an understanding of the existing credit and qualification systems is also very relevant. Providers and trainers must be able to develop "learning outcomes" for all new topics they will teach. In this sense we have implemented the “Resources for educators” area, devoted to the train the trainer (TTT) strategy, developed as part of the objectives of ENETRAP III (WP5) to facilitate good practices in training course development and implementation adapted to different teaching modalities (from face-to-face to b-learning).

With the aim of encouraging the knowledge management addressed to the people in training and trainers, two blocks have been developed: “Training guides and manuals” is the section containing information and documentation related with syllabus, recommendations, as well as teaching material usable by students, teachers, and general public. A library section is also added where it is possible find many references that are useful for E&T in radiation protection, some of which are free to download. The list is divided into several domains. In addition to the detailed listing, further publications and teaching materials are available from the following websites: ICRP publications, ICRU reports, IAEA scientific and technical publications, UNSCEAR reports, EC radiation protection series and an overview of EC radiation protection legislation.

This Education and Training tool in RP promotes the creation of an active knowledge networking in RP and also will promote the use of the data base with the established European platforms/projects MELODI, EURADOS, NERIS, ALLIANCE, ENEN, etc.

Table 1 Summary of the related projects and networks included in “Radiation Protection Community”

Projects:	Related Networks:
	IRPA
	ENEN Association
EUTEMPE-RX	MELODI
TRASNUSAFE	NERIS
NUSHARE	ALLIANCE
PETRUS	EURADOS
GENTLE	EAN
CINCH	EMAN
MEDRAPET	EFOMP
	HERCA

4. CONCLUSIONS

WP5 has designed a CB tool around three groups of professionals, the people in training & the RP community. With the development of this CB tool, supported by the EUTERP foundation, the WP5 aims to contribute in transferring of knowledge and developing skills and competencies, at individual and collective level, in RP matters to protect workers, the public and the environment from the potential risks of ionizing radiation today and in the future.

The design of this tool has been done to integrate, in a coherent way, all the information of the EUTERP foundation as well as all the structure to include, given the interest of students, professionals, and the RP community. The portal offers a complete collection of information of E&T in RP: legal requirements, national approaches, European E&T standards and requirements, course material, course organizations, etc.

This tool includes support to the RPE and RPO job profiles, in terms of education and training qualification, and also in the credit systems such as ECVET and raises the profiles of the RPE and RPO as an attractive career option promoting their mobility around the European Union.

Finally, as a main part of this CB tool, ENETRAP III has developed a database of E&T events and providers, which increases awareness of, and accessibility of E&T, opportunities and resources and promote networking which brings a positive effect to the whole Community. The events included in the DB are focused on RPE, RPO and EW, belonging to different kind of training programmes as initial, refresher, specialization, on-the-job training (OJT), and others. By having the E&T information of other EU projects it is possible build up a cooperative system based on a RP community.

5. References

[1] EURATOM. 2013/59/EURATOM. Council Directive of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation.

[2] European Training and Education in Radiation Protection Foundation - EUTERP. http://www.euterp.eu/

[3] United Nations. 2006. Compendium of basic terminology in governance and public administration. http://unpan1.un.org/intradoc/groups/public/documents/un/unpan022332.pdf

[4] European Commission. Joint Research Centre. 2014. Strategic Energy Technology (SET) Plan Roadmap on Education and Training. https://setis.ec.europa.eu/system/files/SET%20Plan%20Roadmap%20on%20Education%20and%20Training.pdf

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THE DEVELOPMENT OF EDUCATION AND TRAINING IN RADIOLOGICAL PROTECTION IN ARGENTINA

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1- Introduction

One striking fact in the field of radiological protection is the contrast between the important trajectory of this discipline, which through great material, intellectual and scientific efforts has collaborated in the formation of a nuclear activity with high safety standards, and the limited development of historical studies on this field from which important conclusions can be drawn.
Among the most relevant are the writings of J. Samuel Walker[1]. They were designed primarily to study the history of activity within the US which also has some fragments dedicated to the comparison with international regulations. The History of the International Atomic Energy Agency[2], published in commemoration of the 40th anniversary of the institution, also provides relevant data even though its main theme is to show the complex evolution of this international body. Also noteworthy are the contributions of Jacques Lochard and Olivier Godard, who work on the subject from the particular link with the precautionary principle[3]. Similarly, the works of Lindell[4], Clarke and Valentin[5], and that of Ortiz López[6] together constitute an excellent systematic scheme of important events brought from within the discipline itself.
Undoubtedly these are works whose importance is not under discussion. However, all of them have the peculiarity of not exceeding the perspective of a chronological account of events linked to the decision of setting regulatory regulations. Most important facts, of course, and which account for the great scientific effort made by physicists, chemists, engineers and biologists, of a very high level and academic formation.
But a work based on historical science that aims at the reconstruction of this fruitful activity suggests a critical use of documentation and sources, a contextualization of the different historical moments in which radiological protection is developed; a perspective that correlates the paths taken by the profession with the general development of nuclear activity, as well as with the political and economic life in which it is deployed.
In the following paragraphs, some theoretical elements will be presented for the understanding of the history of the development of nuclear activity in Argentina in connection with a contextualization of Argentine scientific and technological policy. Elements that may contain a contribution to a holistic understanding of the central theme of the work: education and training

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[1] WALKER, J. Samuel; *A short history of nuclear regulation. 1946 – 2009*, USNRC, 2010; "The Atomic Energy Commission and the Politics of Radiation Protection, 1967-1971", in *Isis*, Vol. 85, No. 1 (March, 1994), pp. 57-78; and *Permissible Dose. A History of Radiation Protection in the Twentieth Century*, University of California Press; 1st edition (November 6, 2000)
[2] FISCHER, David; History of the International Atomic Energy Agency. The First Forty Years, IAEA, Viena 1997.
[3] GODARD, Olivier and LOCHARD, Jacques; "L'histoire de la radioprotection. Un antécédent du príncipe de précaution". CECO-995. 2005. <hal-00243007>
[4] LINDELL, Bo, DUNSTER, H. J. & VALENTIN, Jack; "International Commission on Radiological Protection History, policies, procedures", *Seguridad Radiologica,* (18), 2000, p. 4-12.
[5] CLARKE, Roger and VALENTIN, Jack; "The History of ICRP and the evolution of its policies", *Annals of the ICRP*, ICRP Publication 109, 2009.
[6] ORTIZ LOPEZ, Pedro; "Eight decades of ICRP recommendations in medicine: a perspective", in *Annals of the ICRP 45*, Marzo 2016.

in radiological protection, as a relevant element in the construction of a more general "nuclear culture".

2 - Historical context and technological exception

There are different interpretations about the history of nuclear activity in the Argentine Republic. In this paper, it is argued that the development of the sector presents a particular evolution: on the one hand, it has an exceptional character, and on the other hand, its own development has been generated in a certain "relative autonomy" with respect to the more general paths of the country's politics and economy. One factor that has contributed to this characteristic has been the generation of a "nuclear culture"; and scientific-technical training has been an important element in this regard.

As a starting point it will be considered a traditional classification that raises a duality between the different economic-political systems, establishing the differentiation between central countries and peripheral countries[7]. This distinction is closely linked to the criterion of an international division of labor between basically industrial countries, and agricultural and countries. This implies particularly highlight the social and economic inequalities that are evident in each category, as well as the geographical distribution (North-South) which resulted from this classification. However, as with all forms of conceptualization, the application to particular cases admits gray or intermediate areas.

Taking the above idea, it could be considered the setting of nuclear energy in Argentina as a case of development of a technology that involves a strong capital investment in a peripheral country.

The initial forecast for these countries is the import of capital-intensive technology, mainly because they have not developed an industry of their own that allows such concretions. Nevertheless, the economic-political dynamics of Argentina reached a certain autonomous industrial capacity.

In the early days of the nuclear plan, our country was in the beginning of the economic stage called "industrialization by import substitution": Both the difficulties in attracting industrialized products from Europe due to the consequences of World War II and the placing of commodities in the main selling area in a cost-effective manner pose a deterioration in the results of the exchange. This situation generated the stimulus towards a policy of diversification of the productive matrix, with the objective of meeting with domestic production the need for consumer, and capital goods. This decision was accompanied by a process of public investment (increasing public debt), plus technological transformation.

Although Argentina showed a slightly stronger structure compared to the countries of the region, it was also marked by similar tendencies: social and political instability; trajectories marked by persistent ups and downs in economic directions; military coups that constantly threaten democratic freedoms and legal institutionality; and also the economic and political pressure from central countries exerting their capacity to influence the internal decisions of peripheral countries in favor of their particular interests.

To carry out the aforementioned policies, the state played a key role. In this process of public investment and productive and technological transformation, it is important to note particularly the drive for a strong institutionalization strategy. This included not only the unprecedented development of highly complex technology but also a unique policy of building technological linkages with ties to other areas of the public sector, together with the decision to deepen the training of human resources.

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[7] This conceptualization was developed mainly by economists linked to the Economic Commission for Latin America and the Caribbean (known by its Spanish acronym CEPAL). Similar theoretical categories were after developed by Immanuel Wallerstein in his theory of the *world-system model*, and by the theory of economic cycles proposed by Giovanni Arrighi.

Autonomous nuclear power production has not been the only project presented at that stage in the history of Argentina. However, as Diego Hurtado points out:

> It is a process that began in the middle of SXX and not foundered in the eddies of a military coup or economic crisis, as was the case with other local technology start-ups. Notwithstanding tenacious international pressures and periods of proverbial social and political instability, the development of nuclear technology has a clear enough trajectory to merit the category of exception.[8]

To summarize: the peripheral country's conditions did not allow to glimpse the certain possibility of an industrial and technological undertaking of the magnitude of a nuclear system. The emergence of a particular ideological and political-economic scheme posed a scenario in which a country like Argentina could consider installing a complex technology such as nuclear.
While there were other projects of similar importance, their fate was not identical. Nuclear activity was able to make its own way despite all the constraints raised, confirming the character we pointed out at the beginning: its exceptionality
This exceptional situation therefore is expressed both in relation to the peripheral status of Argentina as well as in relation to other industrial technology initiatives that were projected at a similar time in a country with clear profiles of political and economic instability

3- Techno-politics, relative autonomy and "nuclear culture".

By the '70s, Argentina appeared behind India as the second most advanced country in the nuclear field among developing countries. However, the basic treatment that the world gave to this project did not seem to have the purpose of explaining or understanding it
A considerable number of international writings about nuclear programs in non-central countries insisted on the idea that these projects had a non-peaceful destination. That is, according to this particular configuration, Argentina appeared as a destabilizing element for the global system. Contrary to this guideline, the nuclear initiative of Argentina will be characterized as a form of techno-politics of peaceful option.
Gabrielle Hecht states with great clarity that this term refers to

> (…) the strategic practice of designing or using technology to constitute, embody, or enact political goals. Here I define technology broadly to include artifacts as well as non-physical, systematic methods of making or doing things.[9]

This idea involves at least two relevant aspects: on the one hand, the materiality of technology as a component of political processes, or as a vehicle for political objectives; and on the other hand, the competence of the technologist, his knowledge applied in various processes as a form of political participation. That is to say, both "the technological thing" and the knowledge that manages it exceed its singularity, possess an extra meaning: the former constitutes an element that embodies a policy, and the latter are active subjects of a more general or state policy.
Applying this categorization to the Argentine nuclear development, Hurtado explains that

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[8] HURTADO, Diego; *El sueño de la Argentina Atómica*, Edhasa, Buenos Aires, 2014, p.15. Translation from spanish: Alejandro Margetic.
[9] HECHT, Gabrielle; *The Radiance of France. Nuclear Power and National Identity after World War II*, Cambridge, The MIT Press, 1998, p. 15.

> The decision to acquire a natural uranium power reactor in the late ‘60s for the purpose of using Argentine uranium and minimizing dependence on the US - then the only supplier of enriched uranium - is not understandable without the testing of engineers, technologists, and scientists Which made this decision economically and technically feasible and which, in turn, guided successive political decisions, such as the place of nuclear energy in the national electricity system or the choice of technology for the second power plant[10]

Based on this idea, two other concepts emerge that will clarify a viewpoint that will then be considered in relation to training in radiation protection: "nuclear culture" and relative autonomy. To speak of *relative* autonomy involves determining the particular logic of a singular practice, composed of an object with its particular characteristics, and by the treatment of the social groups that are constituted around it. Thus, for example, nuclear activity can be distinguished from any other productive practice because of its specificity and the unique knowledge that puts it at stake.

Although all forms of human activity develop in a particular historical context that affects them, each one will assume a specific dynamic determined by its own forms of production. To figure out this kind of "autonomy" for the development of Argentine nuclear activity does not mean that this sector has been shaped and developed by the only intervention of men and women linked to that activity; But rather that it is necessary to understand that these men and women developed a unique activity, different from other productive practices influenced by political and economic conditions, national and international, as well as other local and supranational institutions. And this is what marks the "relative" of autonomy: a particularity - the nuclear - inserts in a more complex and extensive system that influences it; But that does not repeat its dynamics, nor that of other practices of similar level of aggregation. That is, it is relative, since its forms are not absolute in the sense that it is completely self-determined.

In this way, each sphere of activity generates a specific, autonomous "culture" that is differentiated from others by the link that establishes a group with its object - and the relation with its context – as well as by the subjective modes of action - ideological and practical- that are expressed in this complex relationship.

* * *

The understanding of the historical context and, within it, the expression of a specific techno-politics that develops in a "relatively autonomous" way and that generates a particular culture leads, in this case, to the idea of "nuclear culture".

The development of a "nuclear culture" is perhaps one of the keys to the success of this form of techno-politics. This culture allowed it to resist in the moments of greater financial weakness, to the changes of political direction that our country has suffered, to the attacks of the international pressures, but also to the internal debates.

Nuclear culture is mainly built from the appropriation by a social group - which could be called "nuclear community" - of a very specific scientific-technical knowledge that involves the handling of an object that appears to the layperson as inaccessible and ominous.

This specific culture is embodied in an institutional and symbolic system that includes a network of organizations, knowledge, regulations and resources that operate together, and around which are formed identities, values, beliefs and modes of action that make possible a practice that tries to establish roots in other sectors of society and state.[11] This "cultural knowledge" with strong

[10] HURTADO, Diego; op.cit. p. 24. Translated from Spanish by Alejandro Margetic

[11] Cfr. HUGHES, Thomas; “The evolution of large technological systems” en BIJKER, W.; HUGHES, Th., PINCH, T.; *The social construction of Technological systems*, Cambridge, The MIT PRESS, 1989.

scientific connotations becomes an ideological armor of defense and power at the same time for the group that is constituted around it.

* * *

From both the historical context and the idea of techno-politics, on the one hand, and from the category of relative autonomy and the formation of a nuclear culture on the other, It follows that the training and the knowledge of the specialists form a key to the understanding of the nuclear activity as a whole.

The generation, deepening and profusion of knowledge, that is to say, the decision of a policy of training and training in our country, both at the university level and in the scientific-technological field, have been inescapable factors in the process of forming a broader national policy. At the same time, the knowledge acquired collaborated in the creation of a specific culture, in this case a "nuclear culture". Transitively, this "nuclear culture" is an elementary factor in the evolution of this particular activity, as a techno-political one. In short, not only the nuclear activity in our country will be incomprehensible without analyzing the link with the scientific-technical sector; nor will the development of science, and scientific formation, without the political historical correlate in which it is developed.

In short, the nuclear activity in our country assumes an exceptional character due to the conditions of the country in which it is developed, and in relation to other undertakings of similar size that have not achieved similar progress. Secondly, this exceptionality is expressed in its materialization as techno-politics. This techno-politics has a relatively autonomous development -which further characterizes the exception nature of the activity- and, at the same time is cause and consequence of the formation of a strong specific culture, based on the scientific management of the technological object, which has allowed the progress mentioned.

2- Radiological Protection Education & Training in Argentina.

It is understandable now that the training and training policies of the subjects involved in nuclear activity have played a role on a scale that includes but also exceeds what is strictly linked to the scientific knowledge of its object.

Training in radiation protection, of course, has not been the only aspect of this complex knowledge. But without a doubt, it has been an element of paramount importanceUp to this point, an attempt has been made to draw up some historical and theoretical guidelines without which a complete understanding of the evolution of radiological protection training could not be undertaken. From here on, it will show some singular elements of that trajectory of scientific-technical education & training.

It has been said that the scientific-technical formation has had an imprint in the formation of a nuclear culture, on the one hand, and in the generation of knowledge that convey the possibility of concretizing a techno-politics, on the other. Along the same lines, a nuclear culture involves a social group that assumes a series of values, identities, forms of organization, and action all of them in the treatment of a specific subject based on a scientific-technical knowledge developed. This knowledge then constitutes a binding element of that culture.

It is important to consider in these paragraphs some elements that cross the history of the training in Radiological Protection in Argentina. In this sense, the future of this educational policy will be seen as a form of broader development of a techno-politics in the sense that the generation and strengthening of a nuclear culture, around which a social group is established and acts with defined identity and values.

These educational practices have the destiny to become an element of production of some subjects of a specific community. That is, it is not enough to point out the characteristics of the singular knowledge, but also this knowledge embodied in some subjects will form the active component in a particular techno-politics. It is understood therefore that without the specific actions carried out by this group, that project cannot be carried out properly, and therefore without them there is no success of a more general public policy.

* * *

The series of events that will be described below constitute relevant moments -material and symbolically- in the path of consolidation of the educational practice of radiation protection. In addition, this organizational consolidation constitutes a link certainly not weak in the chain of practices typical of a techno-politics. The criteria that are proposed as a guide for interpretation for this series of events are at the same time traits of the importance that this discipline has achieved in the entire nuclear activity.

The elements that mark a route in the historical summary that follows are: a strong institutionalization, a constitutive specificity, and the constant linkage with different scientific / educational sectors as well as political. It can be deduced that each of the traits we have just mentioned is interwoven in a network of practical actions that crystallize in organizational achievements. Thus, a strong institutionalization implies the specificity of a practice that is linked, in this case, to anchoring in the higher education system, and to the link with international organizations. Only in analytical rather than empirical terms can an element be isolated from another.

It is inevitable to emphasize that the installation of a nuclear power reactor, as with all nuclear technological applications, becomes feasible only with a radiological safety system that adequately goes along these advances. That is, a robust radiological protection system that records high levels of security makes the technological developments viable. It is unthinkable, or at least was not for our country, a project of nuclear technology without accompaniment according to the radiation protection point of view. To such an extent, this characteristic assumed a central role that from the outset, both radiological protection and its teaching constituted inescapable requirements, specifically sanctioned by a legal framework of the highest level.

From its origins in Argentina, the nuclear activity was legitimized by a corresponding legislation that sustained its development. Significantly, this same legal framework has considered as an essential element the presence of specific measures of radiation protection as well as the training of people linked to the use of ionizing radiation. One thing worth remembering is its anticipatory nature: this legislation is established in early 1958. Compared with other equally important milestones at the international level, we could note that this is a precursor decision: Five months before UNSCEAR approved its first report (13/6/1958), almost one year before Publication 1 of the International Commission on Radiological Protection (ICPR) (late 1958), and in conjunction with the beginnings of the organization of the International Atomic Energy Agency, Argentina already had a regulation issued by a competent authority that exhaustively established the requirements for the use of radioisotopes and ionizing radiation, implying at the same time a radiation protection training. The "Regulations for the Use of Radioisotopes and Ionizing Radiations" approved by the board of the National Atomic Energy Commission (known by its Spanish initials CNEA) and put into effect on January 24, 1958 by Decree 842/58 of the National Executive Power, ruled in article 19 that any person interested in the use of radioisotopes should:

> (...) have acquired in a specialized center of the country or abroad the knowledge and experience properly documented to enable it for the use of the radioisotopes that it wishes to apply with a dedication not less than one year or in its defect
>
> a- To have attended in the country or abroad a practical-theoretical course on the use of radioisotopes sufficient to be trained in the specific use of the radioisotopes and to have passed corresponding examinations. This course

should obtain the knowledge directly linked to radiation physics, radioactivity, radiochemistry, measurement instruments, radiological health physics and protection. Its duration will not be less than 50 hours theoretical and practical classes, or

b- have performed professional practice in a center authorized for the use of radioisotopes that the applicant wishes to apply according to set by the CNEA.[12]

Moreover, an aspect of vital importance to note is the creation of a single public institution that centralized all nuclear activities in the country. The CNEA would concentrate R & D tasks necessary for the development of Argentine nuclear plan. In this way the only nuclear organism of the country had among its main objectives the scientific-technological planning of the sector.

But it should also be added that since the beginning of this public body was also present the Management of Radiological Protection, an area that was led by Dr. Dan Beninson[13], one of the world's leading figures in this discipline. Just as a comment, those who remember the past of this organism refer to the Management of Radiological Protection and Security of the CNEA as "The Management"- “La Gerencia”. These elements clearly point out the importance that has been given in Argentina, and is given, to the control of radiological risks for the worker, the public, and the environment. It is a clear expression of an organization that tends to the institutional strengthening and the building of institutional networks.
Another significant element of the importance of the principles of radiological protection is its influence on the whole of nuclear activity. Abel Gonzalez, clearly states that in Argentina,

> The basic principles for radiation safety are based on the ICRP recommendations and are fully tailored to the fundamentals of the international safety regime being built under the aegis of the IAEA. The current Argentine basic radiation safety standards declare as its objective “achieving an appropriate level of protection of individuals against the harmful effect of ionizing radiation and safety of radiation sources” and fully follow the ICRP principles. However, Argentine regulations are unique in that these basic principles have been extended to the so-called “nuclear safety” standards, which are based on the same principles than those of radiation safety standards.[14]

These ties of practical integration of the whole system, decisively suppose a policy of formation that accompanies all the national effort placed in the development of nuclear activity.
Some other important milestones will then be considered in the measures taken on training in radiological protection in Argentina.
The formalization of the training in Radiological Protection, assuming a university education profile, was carried out towards the end of the '70s. Between 1977 and 1979, the Radiation Protection and Security Management of the CNEA gave the first courses on Radiological Protection and Nuclear Safety for the training of its own personnel.
Soon, in 1980, the CNEA and the Faculty of Engineering of the University of Buenos Aires (FIUBA, initials in spanish), the most prestigious university in Argentina, celebrate an agreement whose main objective is to fit into the national university system the "Postgraduate Course in

[12] Cfr. http://www.radioproteccionsar.org.ar/online/doc/publicaciones/reglamento-decreto.pdf
[13] Dan Beninson was chairman of CNEA; chairman of UNSCEAR (1974 a 1979), and for many years a member of the ICRP, which he chaired from 1985 to 1993.
[14] GONZALEZ, Abel; “The Argentine Approach to Radiation Safety: its ethical basis”, Hindawi Publishing Corporation, Science and Technology of Nuclear Installations, Volume 2011, Article ID 910718.

Radiological Protection and Nuclear Safety". The curriculum had a total of 1100 class hours, and the corresponding academic recognition (diploma awarded by FIUBA and CNEA)[15].

It was not more than a year (1981) that the IAEA began to sponsor this course by providing financial support for the participation of foreign students, particularly from Latin America and the Caribbean, making it the first recognized Post Graduate Educational Course (PGEC) partially funded by that international body.

The fact that this career assumed a university institutional profile and a scope beyond the borders of their country of residence was not enough to exhaust the different education and training needs in this discipline. Nuclear activity in general also required that all of its workers had adequate knowledge to develop their practices, and at the same time constituted an element of strengthening a nuclear culture. A minority but important sector of nuclear workers, with sufficient competence and experience to properly attend to their tasks, did not necessarily meet the formal requirements of a postgraduate university degree. Therefore, in 1983, the Radiological Protection Course - Technical Level, for postulants without a degree began to work. This course has a curriculum with a duration that currently reaches 360 hours of class.

The decades of the '80s and' 90s were particularly difficult for nuclear activity in Argentina: the whole sector had to deal with a process of de-financing, among other political decisions that hit it. It was this culture once again, these symbolic ties in a social group, which prompted that despite the vicissitudes there was not a year in which training in radiological protection stopped.

Between the years 1994-1997 a process of reorganization of the nuclear activity took place. Law number 24,804/97, also called "nuclear law", made regulatory activity independent (previously exercised by the CNEA through its Radiological Protection Management) by creating the Nuclear Regulatory Authority (ARN, initials in spanish). These changes resulted in the renewal of the agreement for the delivery of the Postgraduate Course, which was thus in charge of FIUBA and the newly formed ARN. The "institutional transfer", as will be seen, did not produce a loss in its organizational framework, since the ARN became the "heir" institution of the trajectory in the training in radiological protection.

In 1997, the postgraduate course in "Radiological Protection and Security of Radiation Sources" conceived in our country and with an experience of more than 17 years is replicated in the Syrian Arab Republic dictated with a program and characteristics similar to the one Argentinian. Years later another seven international centers will be added, proposing a structure equivalent to that developed by Argentina.

In 2003 a restructuring of the original course was proposed. In response to IAEA suggestions for the unequal development of Latin American countries in the nuclear area, the nearly one-year course was divided into two specific postgraduate courses: "Postgraduate Course in Radiation Protection and Security of Radiation Sources" (650 hours) and "Postgraduate Course in Nuclear Safety" (350 hours), being the second correlative of the first. This shows that the ARN-IAEA relationship is not marked by a purely financial linkage. The two organizations are in constant dialogue in the perspective of the development of a policy of continuous improvement regarding training in radiological protection. The synergy put into play, undoubtedly, has been a central element in the development of this training policy and shows the character of strong institutionalization and links with supranational organizations.

Following the same line, in 2006 the first IAEA Education and Training Appraisal (EduTA, English acronym) mission was carried out in a Latin American country: a general evaluation performed by international peers on the national educational infrastructure on radiological safety issues. The mission concluded with very positive results for Argentina. The specificity of educational practice is reinforced in its own development.

[15] Although the CNEA is not properly an educational institution capable of developing university degree plans on its own, its academic and scientific prestige positions it as an institution sought by universities to develop projects or programs together.

On the one hand, these achievements contributed to the fact that the following year, both the Postgraduate courses, the Technicians course, and the ARN facilities used to teach these courses were certified under ISO 9000: 2000 norms,[16] And on the other hand, also as a sequel to the EduTA mission, in 2008 the Argentine Republic signed a Long Term Agreement (LTA) with the IAEA. Through this agreement Argentina assumed the responsibility of becoming a Regional Training Center (RTC) in Latin America and the Caribbean for Nuclear, Radiological, Transportation and Waste Safety. The ARN will be in charge of carrying out the management of the RTC, through its Education and Training Unit (UCE, Spanish acronym).
The creation of the UCE raised once again a work of institutionalization and centralization of the policies of education and training, which allowed an action with greater emphasis on academic subjects. Since the implementation of this Unit, the ARN has been able to work in a more focused way with the UBA through its Faculty of Engineering. In this way, a series of updates, administrative and academic improvements were addressed, as well as the formalization of a series of practices, such as those listed below:

- In order to adapt to the new forms of organization of higher education in our country, the Postgraduate Courses have been transformed into "Specialization Degree in Radiological Protection and Security of Radiation Sources", and "Specialization Degree in Nuclear Safety ". Also, an update of the programs and their schedules was carried out.
- From the previous modifications, the titles are granted by the University of Buenos Aires (UBA) with recognition of the Ministry of Education. Until that time, the titles were issued by the Faculty of Engineering.
- The synergy of the administrative systems of both institutions (ARN and UBA) was improved, obtaining improvements in monitoring and registration systems, among others.
- - At the same time, improvements were made in the use of didactic and pedagogical resources such as the various forms of distance education platform, educational networks, among others.
- The academic recognition of the teachers from the nuclear activity has been achieved, since they must be formally appointed by the UBA as their own teachers.
- At present the process of assimilation of the diplomas of the graduates of previous editions of the postgraduates to the condition of "Specialists" according to the current regulations is very advanced, also permitting the homologation in universities of other countries.[17]

A special mention deserves the obtaining of National University Accreditation by the "Specialization Degree in Radiological Protection and Security of Radiation Sources". The Argentine higher education system establishes standards of educational quality that include a detailed evaluation of aspects that go beyond the program of academic contents: Administrative and infrastructure issues, updating libraries, teacher training and education, cost planning, improvement planning and self-assessment processes, among others. In 2013, this Degree was presented to the National Commission for Evaluation and University Accreditation (CONEAU), a competent national body that ensures that university programs meet a high standard of educational quality (in addition to the ISO certification already obtained). After an arduous work of the Unit that involved a detailed task of technical, academic, formalization and information gathering of support, the CONEAU began a systematic process of evaluation that culminated in a favorable verdict, granting the accreditation to the Specialization Course. On the other hand, the next challenges that the ARN arises are linked to a process of deepening and continuous

[16] In 2010 and 2014, they were recertified under ISO: 9001: 2008, and this certification continues to be valid
[17] LARCHER, Ana; NICOLAS, Rubén y HURTADO, Diego; “Revalorización de la tradición educativa de la ARN y búsqueda de la excelencia académica”, Paper presented at the 10th Latin American Regional Congress on Security and Radiological Protection- IRPA. “Radioprotección: nuevos desafíos para un mundo en evolución” april 2015, Buenos Aires.

improvement in their training and training tasks, in their academic aspects as well as infrastructure and administrative processes. In this regard, the following are indicated:

- Update and provide new teaching equipment to the headquarters of the CRC in the CAE (in progress)
- Provide a new approach to the traditional Radiological Protection Course - Technical level, based on the needs from the reactivation of the Argentine nuclear plan. (in progress)
- Design courses with new formats and specific contents facing new regulatory challenges. (in progress)
- Design mechanisms for monitoring and impact of the training activities developed (in progress)
- Review the Specialization Course in Nuclear Safety, according to the new IAEA Syllabus (in progress)
- Introduce new IT elements for improving teaching performances (in progress)
- Contributing to the IAEA's Global Training and Strategy 2011-2020, collaborating in the consolidation of national E & T programs in the region.
- Receive a follow-up EduTA mission (in progress)

These challenges that have just been listed are accompanied by the strengthening of the area of Knowledge and Academic Management within the UCE. The area aims to centralize general training information and focus on developing solutions to some of the challenges posed. On the other hand, this area is working on a Diagnostic Process of regulatory knowledge throughout the institution. As a result of this process, an update of the ARN Training Plan is expected.

* * *

The scientific-technical training developed by ARN is a central axis of both its institutional trajectory and its projections. On the other hand, the character of a strong institutionality, with the development of a specificity, coupled with the connection with other scientific-educational sectors as well as political, both national and international in each one of the mentioned milestones. It is the realization of the "acquisition" by a social group of scientific and technical knowledge that is constituted as a binding element of a specific culture.
The education and training in radiological protection is a decision that, over time, has collaborated in the generation of a "nuclear culture" with all the ramifications that have been considered in this work, and which, as has been pointed out, is one of the factors Which affect the particular development of nuclear activity as a whole.

BIBLOGRAPHY

- CLARKE, Roger & VALENTIN, Jack; “The History of ICRP and the evolution of its policies”, *Annals of the ICRP*, ICRP Publication 109, 2009.
- FISCHER, David; *History of the International Atomic Energy Agency. The First Forty Years*, IAEA, Viena 1997.
- GODARD, Olivier and LOCHARD, Jacques; “L'histoire de la radioprotection. Un antécédent du príncipe de précaution”. CECO-995. 2005. <hal-00243007>
- GONZALEZ, Abel; “The Argentine Approach to Radiation Safety: its ethical basis”, Hindawi Publishing Corporation, Science and Technology of Nuclear Installations, Volume 2011, Article ID 910718.
- HECHT, Gabrielle; *The Radiance of France. Nuclear Power and National Identity after World War II*, Cambridge, The MIT Press, 1998.
- HUGHES, Thomas; “The evolution of large technological systems” in BIJKER, W.; HUGHES, Thomas., PINCH, T.; *The social construction of Technological systems*, Cambridge, The MIT PRESS, 1989.

- HURTADO, Diego; *El sueño de la Argentina Atómica*, Edhasa, Buenos Aires, 2014.
- LARCHER, Ana; NICOLAS, Rubén y HURTADO, Diego; "Revalorización de la tradición educativa de la ARN y búsqueda de la excelencia académica", Paper presented at the 10th Latin American Regional Congress on Security and Radiological Protection- IRPA. "Radioprotección: nuevos desafíos para un mundo en evolución" april 2015, Buenos Aires.
- LINDELL, Bo, DUNSTER, H. J. & VALENTIN, Jack; "International Commission on Radiological Protection History, policies, procedures", *Seguridad Radiologica,* (18), 2000.
- - ORTIZ LOPEZ, Pedro; "Eight decades of ICRP recommendations in medicine: a perspective", *Annals of the ICRP 45*, Marzo 2016.
- - WALKER, J. Samuel; "The Atomic Energy Commission and the Politics of Radiation Protection, 1967-1971", *Isis*, Vol. 85, No. 1 (March, 1994)

  Permissible Dose. A History of Radiation Protection in the Twentieth Century, University of California Press; 1st edition (November 6, 2000)

  A short history of nuclear regulation. 1946 – 2009, USNRC, 2010;

EMERGENCY RESPONSE TRAINING AT THE INTERNATIONAL ATOMIC ENERGY AGENCY

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ABSTRACT

The International Atomic Energy Agency's (IAEA) Incident and Emergency Centre (IEC) is the global focal point for emergency preparedness and response (EPR) to nuclear and radiological incidents or emergencies, regardless of whether they arise from accidents, natural disasters, negligence or deliberate acts; however, the responsibility for EPR for nuclear or radiological emergencies ultimately rests with the State, as does the protection of human life, health, property and the environment. The IEC maintains the Incident and Emergency System (IES) to ensure that the Agency is prepared to respond in a timely, appropriate and efficient manner to any event that may have actual, potential or perceived radiological consequences to health, property or the environment. The IES is comprised of IAEA Secretariat staff members that are trained to perform specific functions within the IES which is operational 24 hours a day, 7 days a week.

IAEA staff members undergoing certification in the IES must complete three levels of training: General orientation, team or position-specific training, and a demonstration of proficiency. Annual refresher training requirements include classroom training, hands-on practice and full-scale exercises that simulate nuclear and radiological incidents or emergencies. However, there are unique challenges to maintain the IES and implement the training programme. Some of these challenges include the Agency's rotation policy that states most professional staff members can only work at the IAEA for a limited number of years; the need to respond to situations around the world in different time zones and potentially in different languages; and managing the wide range of expertise available throughout the Agency.

To overcome these challenges, the IEC developed strategies to make the training programme simple, flexible, and effective. In order to make the most efficient use of resources, response staff training is focused on one or more functions every month during the year. In addition, staff members are encouraged to participate in training activities that involve multiple positions, such as combined activation drills for Emergency Response Manager and Logistics Support Officer roles. Lastly, the IEC conducts exercises to engage staff and Agency management, including participation with Member State national-level exercises that may be conducted outside of normal business hours. This paper summarizes the experience gained in providing this training, describes how the IEC manages the training programme, and shares lessons learned from developing and implementing training for international organization emergency responders.

1. Introduction

Nuclear and radiological incidents and emergencies do occur and we must be prepared to respond. The International Atomic Energy Agency's (IAEA) fulfils its roles in response to nuclear and radiological incidents and emergencies through the Agency's Incident and Emergency System (IES) and the Incident and Emergency Centre (IEC). The IEC also acts as custodian of the IAEA's Incident and Emergency System to ensure that the IAEA is prepared to respond to any event that may have actual, potential or perceived radiological consequences to health, property or the environment. EPR arrangements for nuclear and radiological incidents or emergencies are based on the international EPR framework.

The international EPR framework facilitates development and maintenance of capabilities and arrangements for preparedness and response to nuclear and radiological incidents or emergencies. The framework is based on three elements: Legal instruments, IAEA safety standards, and international operational arrangements. The Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency are the main legal instruments on EPR which form the legal basis for the international EPR framework. They place specific obligations on the States Parties and the IAEA. The IAEA safety standards on EPR along with a range of technical guidance, tools and training materials provide a robust framework of fundamental principles, requirements and guidance for building sound emergency preparedness and effective emergency response. International operational arrangements are the practical means by which the IAEA, its Member States and the relevant international organizations maintain preparedness and effectively respond to any nuclear and radiological incident or emergency.

In 2005, the IAEA announced the establishment of the IEC to serve as a global focal point for preparedness, event reporting, information sharing, and response to nuclear and radiological incidents and emergencies irrespective of their cause. While emergency response capabilities have existed within the IAEA since the conclusion of the Emergency Conventions in 1980, such as the establishment of the original IAEA Emergency Assistance Services and Emergency Response System, the decision to create an integrated Centre within the IAEA became more pressing with the anticipated increase in the use of nuclear applications as well as heightened concern over the malicious use of nuclear or radioactive materials.

The IEC maintains the Incident and Emergency System (IES) to ensure that the Agency is prepared to respond in a timely, appropriate and efficient manner to any event that may have actual, potential or perceived radiological consequences to health, property or the environment. The IES comprises of staff of the IAEA Secretariat who are trained to perform specific functions, and is operational 24 hours a day, 7 days a week.

2. IAEA's Incident and Emergency System

2.1 Overview

The IAEA's emergency response role comprises of: Notification and official information exchange; Assessment of potential emergency consequences and prognosis of possible emergency progression; Provision of public information; Provision of assistance on request; and Coordination of inter-agency response. The IAEA discharges these roles through the IES, which consists of a warning point, an on-call system, an on-duty system, and a Steering Group.

The warning point is a 24 hour communication centre through which incoming messages are received and acted on. Since the IEC is not normally continuously staffed, the Security Control Centre of the United Nations Security and Safety Service in Vienna serves as a warning point. The on-call system ensures that the initial response to any incoming message is timely and adequate. The following on-call officers are available to facilitate and coordinate the initial response: an Emergency Response Manager (ERM); a nuclear installation specialist; a radiation safety specialist; a nuclear security specialist; an external event specialist; a logistics support officer; and a public information officer. The on-duty system ensures that the IAEA response is effective and commensurate with the nature and magnitude of the event/situation. It consists of three modes of operation (Normal/Ready, Basic, and Full Response Modes), a set of response functions and a roster of trained staff members. The IES Steering Group oversees the response of the IAEA and guides the response on matters of policy.

2.2 IES Responders

During the Basic or Full Response Modes, the IEC operational area may be staffed with as many as 20-30 IES responders during a given shift. The Basic Response Mode operates only during business hours, while a response that requires 24/7 shift staffing is considered the Full Response Mode. Within the IEC operational area, responders work in one of five primary teams or groups: Response Management Team; Technical Team; Liaison Officers; Public Information Officers; and Logistics Team. These teams work together within the IEC, as well as externally with counterpart organizations in the Member States and International Organization, in order to fulfill the Agency's five emergency response roles. At the end of 2016, approximately 200 IAEA staff members were qualified for one or more response position in the IES, and approximately 50 more staff members were pursuing their Initial Certification in the IES.

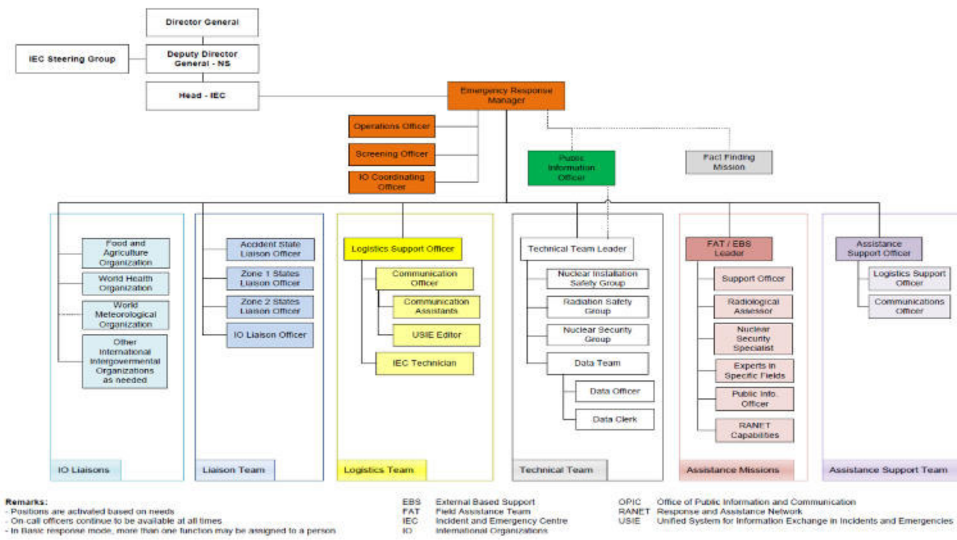

Figure 1: Full Response Mode Staffing Chart

3. Emergency Response Training

3.1 Overview

IAEA staff members engaged in the IES come from every department within the Agency, and no scientific or technical background is required to participate. Staff are considered to be in one of three categories: Pursuing Initial Certification; Expanding Certification; or Maintaining Certification in the IES. Pursuing Initial Certification means that the individual is certifying for a response position in the IES for the first time. Expanding Certification means that the individual has completed Initial Certification in the IES and is certifying for a new response position. Maintaining Certification means that the individual has completed Initial Certification in the IES and is maintaining his or her certification for one or more IES response positions.

Staff members undergoing Initial Certification must complete: (1) General Orientation Training, (2) all training classes for the intended IES response position, and (3) a demonstration of proficiency. IES General Orientation Training is the first step staff must take towards their Initial Certification in the IES. This training introduces the IEC roles and responsibilities, equipment used in the IEC's operational area, and an overview of responses to past nuclear and radiological incidents and emergencies. General orientation training is a half-day training class and is offered at least four times per calendar year.

Annual training requirements for certified IES responders include classroom training, hands-on practice and full-scale exercises that simulate nuclear and radiological incidents or emergencies. In order to make the most efficient use of resources and allow staff members the greatest flexibility in choosing options for training classes, each month the training is structured to concentrate on one or more focus area. Every month, the IEC offers training that encompasses one or more of the response position areas: Response Management Team; Technical Team (including technical On-Call Officers); Liaison Officers; Public Information Officers; and Logistics Team.

Each focus area is covered three months during the year. For example, three months each year the focus covers training and development for the Technical Team. During these months the IEC staff offers: Technical Team classroom training; hands-on training opportunities for Nuclear Installation Specialists, Radiation Safety Specialists, Nuclear Security Specialists, and Data Officers/Clerks; short Technical Team drills via e-mail; Practical Sessions; and other activities or special topics that are intended for members of the Technical Team.

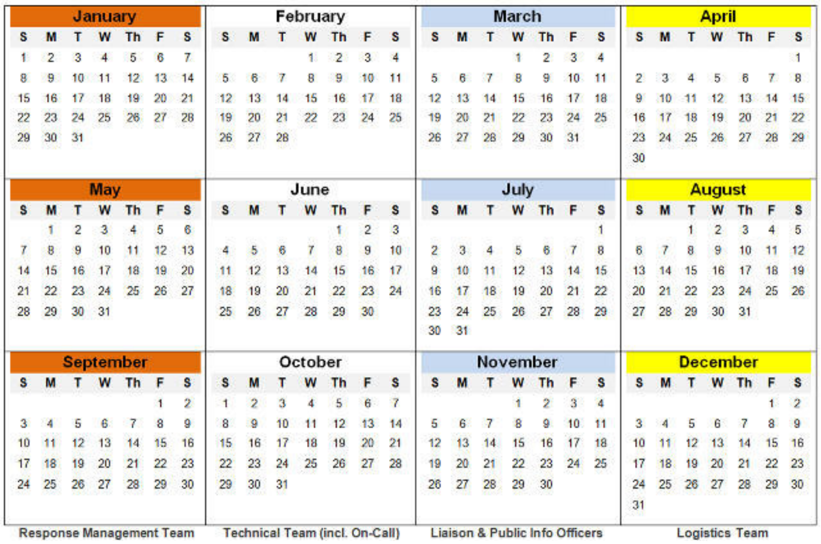

Figure 2: 2017 Monthly Training Focus Areas

3.2 Practical Sessions

Reviewing procedures or checklists is helpful before responding to an incident or emergency; but, there is no substitute for hands-on practice in an operational area. To help support classroom training, the IEC hosts up to two hours of Practical Sessions each month related to the monthly training focus areas. Practical Sessions are not required for IES certification; instead, they are optional, “drop-in,” hands-on practice opportunities. These represent additional opportunities to practice skills learned in training classes. Sample scenarios may be used during these sessions, and the trainers address specific questions from the participants.

3.3 Exercises and Drills

As mentioned, there is no substitute for hands-on work in an operational environment. Staff members who are pursuing or have completed their Initial Certification in the IES must be able to locate references, be familiar with their response checklists, use tools, and excel at selected activities in the IEC prior to a potential event response. Exercises are important opportunities for staff members to practice these and demonstrate proficiency in the IEC operational area. Staff members must complete one exercise or training drill as part of their certification in the IES. IES responders must also complete at least one exercise or event response every 12 months to maintain their certification(s) in the IES. Staff expanding their certification to selected positions (such as the Emergency Response Manager and the Logistics Support Officer) may also need to complete a Task Performance Evaluation: An individual examination of the staff member’s ability to conduct required On-Call response actions, within a time limit, and that is evaluated by two-to-four members of the IEC staff.

The IEC staff conducts three to five real-time Full Response Exercises (FRE) per year. These exercises are internal to the IAEA and do not involve the participation of Member

States or other international organizations; however, some FREs may be in conjunction with an exercise being conducted by a Member States or International Organization. In such a case, the overall activity is used to test the operational arrangements under the Emergency Conventions, and is treated as a real-time Convention Exercise (ConvEx). A primary purpose of exercises is to evaluate IEC internal processes and procedures, as well as the effectiveness of the training program. To keep activities in the IEC operational area as realistic as possible, the IAEA uses names and locations of real nuclear installations – with permission from the responsible Member State. During these exercises, all communication between IES responders and any country or organization outside of the IAEA Secretariat goes to a Simulation Cell. Internal FREs are usually conducted during business hours of a single day, and often involve two shifts of responders serving for three-to-four hours per shift.

In addition, starting in 2017 the IEC began issuing short web-based drills to IES responders in the Technical Team. These drills are comprised of scenarios at nuclear installations or involving radioactive materials. When issued, responders have one-to-two weeks to review the included information, use the data as inputs to the IAEA's web-based incident and emergency assessment tools, and generate a short status report with the responders' own findings on that report. These drills allow responders to utilize the web-based assessment tools and think critically about emergency situations several times per year, instead of solely during annual refresher training. The IEC plans to continue developing and expanding the concept of web-based drills going forward.

4. Training Programme Lessons Learned

4.1 Challenges

As personnel are the most important part of any emergency response organization, it should come as no surprise that staffing issues comprise several challenges to the training programme at the Agency.

Firstly, as stated on the IAEA's website: "For Professional positions, the IAEA follows a policy of rotation out of the Organization. This policy allows Member States to benefit from the return of their nationals after gaining expertise at the IAEA, and it allows the IAEA to have a continuous influx of fresh knowledge and experience at all levels. This increase in international capacity is also of benefit to staff members, who get an opportunity to be part of a dynamic team facing the IAEA's challenges." While a rotation policy has benefits, the regular attrition of trained and certified IES responders creates a challenge that must be met; otherwise, there is a risk of inadequate staffing in response to an incident or emergency.

Secondly, the international nature of the IAEA's contacts means that staff must be prepared to respond to situations around the world, day or night, and not simply within working office hours for Vienna, Austria. In addition, responding to inquiries from Member States, International Organizations, and even the media may potentially require authenticating and verifying information in languages other than English.

In addition, the broad scope of the Agency's work – beyond simply its geographic reach – means that staff members employed at the IAEA span a wide range of expertise. While the IAEA has significant staff resources focused on nuclear power and radioactive materials development, safety, and security, the Agency is also engaged in various projects for nuclear applications, safeguards, and programme management. Identifying, recruiting, and retaining staff members across this spectrum of disciplines presents yet another challenge.

Lastly, participation in the Agency's IES is identified as an important activity by the highest levels of management; but, it is not a required activity for most staff. Unlike a national regulatory agency or government office, Agency staff members are not required to complete a certification in the IES or serve on-call or on-duty roles.

4.2 Solutions

To address these challenges, starting in 2015 the IEC revised the training programme from a whole-year schedule to a monthly focus approach. The IEC currently dedicates entire months to training one specific set of IES responders (Response Management Team, Technical Team, etc.). Previously, training was announced for the entire year at fixed, recurring intervals; however, these dates frequently had to change based on other Agency activities and actual event responses. In addition, it was not always clear to responders when they had to enroll for training classes.

Two hours Regular Training sessions:

ERM - Initial Information Exchange/USIE:	2^{nd} Wednesday of the 1^{st} month of the quarter
ERM /Ops Officer- Full Response Operations:	4^{th} Tuesday of the 3^{rd} month of the quarter
LSO Activation/Emergency Travel Training:	2^{nd} Wednesday of the 2^{nd} month of the quarter
NIS Assessment and Tools Training:	2^{nd} Wednesday of the 3^{nd} month of the quarter
NSS Assessment and Tools Training:	2^{nd} Thursday of the 1^{st} month of the quarter
RSS Assessment and Tools Training:	2^{nd} Thursday of the 2^{nd} month of the quarter
EES Assessment and Tools Training:	2^{nd} Thursday of the 3^{rd} month of the quarter
Tech Team Leader Assessment Training:	3^{rd} Thursday of the 3^{rd} month of the quarter

Figure 3: Sample Schedule from 2014 Training Plan

The change from whole-year scheduling to monthly focus areas actually allowed IAEA staff members to better plan their year for IES training. Within each month the IEC can dedicate time and resources to a single focus; therefore, where an individual class used to be offered four times per year, that class might now be offered two or three times per month in each of three focus months. As the staff has adjusted to this scheduling method, they are more willing to look ahead and determine in which month or months they will best be able to complete required training activities.

Scheduling training activities by set, previously-announced months has enabled the IEC to create easier tools for staff to enroll in training. Instead of trusting that staff members will proactively enter specific training dates into their calendars for the entire year ahead, or needing to send e-mails to individual IES responders the week of select training activities, the IEC now sends a single e-mail with the upcoming monthly schedule. Staff members can enroll in the training class on the date of their choice by clicking on embedded “one-click registration” links in each monthly e-mail. In addition, the IEC also created a one-question survey on the IES Home Page – an internal IAEA Microsoft SharePoint website – to enable staff members to provide their availability for exercises. Lastly, all staff members can see what training is required for their IES response position(s) by going to their personal home page in the IAEA’s Human Resources webpage, AIPS. In 2015 the IEC assigned each staff member in the IES a Learning Certification, which clearly states what response position the individual is qualified for; what training class(es) or activity is required to maintain the certification in that position; and if or when the staff member completed each activity in the previous 12 months. By making the training programme more predictable and easier to enroll in activities, the IEC has enabled more staff members to participate in a greater number of training classes and exercises.

As previously stressed, hands-on work in the operational area is one of the most important elements of the IES training programme. Therefore, the IEC conducts exercises to engage staff and Agency management, including participation with Member State national-level exercises. These exercises are sometimes intentionally scheduled outside of normal business hours in Vienna, Austria, in order to give staff members a sense of working in the operational area during evenings. In addition, these exercises usually involve receiving information in languages other than English, which is the official working language of the IAEA. Sometimes these are intentional “injects” into the scenario; but, sometimes this occurs naturally as a result of participation from a Member State requesting information about the simulated emergency. Besides these full-scale exercises, the IEC also conducts smaller exercises with mixed groups of IES responders. One such example is an “Activation Drill,” which requires select On-Call Officers to work together in groups of two or three to activate the IEC into the Full Response Mode and send out initial information on a simulated emergency. This is another method to give staff members a more practical feel for responding to a nuclear or radiological incident or emergency, and encourage them to learn by doing.

4.3 Future Developments

The next element that must be developed in the IES training programme is eLearning. The demands on IAEA staff members continue to increase, and the rotation policy means that qualified IES responders may leave the Agency after a few years. Successful implementation of online learning activities will achieve significant, valuable outcomes such as: Streamlining the process for new responders wishing to complete their Initial Certification in the IES; Reducing the amount of time IAEA staff spend in classroom training; Enabling IES responders to review or refresh material at any time from the convenience of their PC; Strengthening the long-term response activities of the IES, by making available materials that can be viewed prior to responding to the IEC (if needed); and documenting a consistent, provable basis for additional online learning courses to be created in the future.

4.4 Results

Since adopting the new training structure, there has been very positive feedback from IAEA management and staff. The number of IES training classes offered per year increased from approximately 50 classes in 2014 to 75 classes in 2015 and 84 classes in 2016. In 2016, the IEC made available almost 150 hours of training class time to IAEA staff members (excluding participation in exercises). Lastly, the number of qualified IES responders increased from 185 at year-end 2015 to 191 at year-end 2016, despite the attrition mentioned above.

In addition to more quantitative results, the qualitative outcomes from the IES training programme have also improved. For 2015, 11% of IES responders’ performance in the training programme was rated as “Exceeded Expectations,” meaning that they completed all required training classes for their position(s) and participated in multiple exercises during the year. For 2016, 19% of IES responders’ performance in the training programme was rated as “Exceeded Expectations,” an increase of 8%. Overall, IES responders whose participation in the training programme “Met or Exceeded Expectations” increased from 78% in 2015 to 81% in 2016. As existing IES responders have become more comfortable with the revised training programme and new responders are only exposed to the current schema, it is expected that these results will continue to improve while being balanced against the regular loss of qualified responders stemming from the Agency’s rotation policy.

THE CHALLENGES IN RADIATION PROTECTION EDUCATION AND TRAINING IN LITHUANIA

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ABSTRACT

Training of radiation protection is one of the basic instruments to form responsible public position of safe behaviour with sources of ionizing radiation. 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.

Lithuania has a comprehensive and structured programme of radiation protection training, supported and maintained by detailed legislative requirements. All persons who work in activities with sources of ionising radiation, or may be required to do so during emergency response activities, are required to be trained before commencing the work and must attend retraining at regular intervals. The Technical Support Organizations, the teaching staff and the course content are also assessed, approved, and reassessed at periodic intervals. A register of trained persons is held and maintained by the Radiation Protection Centre (RPC). The quality management system of RPC conforming to ISO 9001 standard was implemented in 2009 and covers all activities of RPC, including radiation protection education and training.

On the request of RPC, an EduTA mission was agreed and conducted on 9-13 November 2015 under the Technical Cooperation national project RER9109 “Strengthening Education and Training Infrastructures and Building Competence in Radiation Safety”. At the end of the mission, the EduTA team identified certain issues warranting attention or in need of improvement and believes that consideration of these would enhance the overall national capabilities and performances for education and training in radiation protection. According to EduTA recommendations and suggestions it was prepared the actions plan for 2016-2018 which was approved by RPC director.

As a the Member State of European Union Lithuania has to transpose and implement provisions of Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation. One of the main challenges of this process is the recognition of Radiation Protection Experts (RPE) in compliance with Directive. Although the national legislation defines the role of the RPE, no recognition system is in place and no persons are designated as RPEs so far. The Radiation Protection Officers (RPO) in Lithuania actually carries out the duties expected of the RPE, and the high level of training required for RPOs is equivalent to that required for the RPE.

Introduction

Radiation Protection Centre (RPC) is a regulatory body and according the Law on Radiation Protection has the function to coordinate and supervise compulsory radiation protection training and play sufficient role in the development, implementation and improvement of radiation protection education and training infrastructure in Lithuania. RPC together with Ministry of Health draft the legislations related to radiation protection education and training. In scope of transposition of new Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation RPC will have big challenge to review and improve the radiation protection education and training system.

Radiation Protection Education and Training System

The radiation protection training in Lithuania starts in the end of 90ties when Law on Radiation Protection was approved and include article on compulsory radiation protection training which oblige all workers using ionizing radiation, radiation protection officers, first responders and individuals involved in emergency preparedness and response, as well as individuals who most likely could meet the orphan sources to be trained in radiation protection. Responsibility for organization of such training lies on undertakings and employers. For implementation of requirements of Law on Radiation Protection Minister of Health approved Order on Issue of compulsory training in radiation protection prepared taking to account best practice of other countries as well as recommendations and guidance issued by IAEA. This document describe syllabus for compulsory radiation protection training taking to account field of use sources of ionizing radiation and radiation risk and also covers requirements for lecturers and technical support organizations (TSO) providing radiation protection training. The infrastructure of the compulsory radiation protection training was build step by step. The training programmes were prepared by TSO and were approved by Radiation Protection Centre as regulatory body. In few years, almost all individuals who are obliged by Law on Radiation Protection to be trained have been trained.

The technical support of IAEA via regional technical cooperation projects was very valuable for further development of Lithuanian radiation protection training infrastructure. Participation in the workshops and training courses, trainings for trainees and guidance provided by IAEA helps to improve the compulsory radiation protection training. Taking to account IAEA guidance in 2012 was drafted and approved by Minister of Health a new order on Compulsory Radiation Protection Training and Instruction Procedure. This documents change view to the existing syllabus described in previous document and now programs for different users of sources of ionizing radiation, taking to account the radiation risk developed using IAEA suggested model system. Also new document more precisely describe the groups of individuals who need to pass radiation protection training as well as topics of lectures.

Since the 2012 there are the main following groups, who have to be trained in radiation protection in Lithuania:

- Workers, dealing with ionizing radiation sources and radiation protection officers;
- Government officials (Customs officers, State Border Guard Service officers, Police officers and fire fighters) and other employees and persons (as workers of metal scrap yards) whose work (activities) is associated with orphan sources of ionizing radiation and detection of materials contaminated with radionuclides;
- Staff responding to emergencies (firemen's, police officers, workers of medical emergency service).

The 14 modules of radiation protection training are drawn, which are a guide for developing radiation protection training programmes for various groups of specialists (RPOs, workers dealing with ionizing radiation sources, government officials, etc.). Each group of such specialists works with ionizing radiation sources of different risk categories (I to V), and programmes are also developed taking into account the risk category of ionizing radiation sources. For more effective training, there are determined the minimum requirements of education levels for persons, dealing with ionizing radiation sources on their work:

- for RPOs in medical area (Tab 1),
- for RPOs in industrial area (Tab 2),
- for workers in medical area (Tab 3),
- for workers in industrial area (Tab 4).

RS risk category	Minimum education	Initial training duration	Refresher training (every 5 years)
I	University degree in biomedicine, physics sciences or technological sciences	270 hours	20 hours
II, III	University degree in biomedicine, physics sciences or technological sciences	270 hours	20 hours
IV, V	University degree in biomedicine, physics sciences or technological sciences	60 hours	20 hours
Dental X-ray machines	University degree in biomedicine, physics sciences or technological sciences	20 hours	8 hours

Tab 1: The minimum requirements for level of education and training duration for RPOs in medical area

RS risk category	Minimum education	Initial training duration	Refresher training (every 5 years)
I	University degree in biomedicine, physics sciences or technological sciences	270 hours	20 hours
II, III	General education in biomedicine, technological or physics sciences, or specialized secondary school education for graduates up to 1995	270 hours	20 hours
IV, V	High school education, or specialized secondary school education for graduates up to 1995, and acquired professional qualifications equivalent to the type of work	60 hours	20 hours

Tab 2: The minimum requirements for level of education and training duration for RPOs in industrial area

RS risk category	Minimum education	Initial training duration	Refresher training (every 5 years)
I - V	General education in biomedicine, physics sciences or technological sciences, or specialized secondary school education for graduates up to 1995, and acquired professional qualifications equivalent to the type of work with ionizing radiation sources	30 hours	20 hours

Dental X-ray machines	General education in biomedicine, physical sciences or technological sciences, or specialized secondary school education for graduates up to 1995, and acquired professional qualifications equivalent to the type of work with ionizing radiation sources	14 hours	8 hours

Tab 3: The minimum requirements for level of education and training duration for workers dealing with ionizing radiation sources in medical area

RS risk category	Minimum education	Initial training duration	Refresher training (every 5 years)
I - V	Secondary school education and acquired professional qualifications equivalent to the type of work with ionizing radiation sources	30 hours	20 hours

Tab 4: The minimum requirements for level of education and training duration for workers dealing with ionizing radiation sources in industrial area

To ensure the effective compulsory training process, there are the requirements for TSOs. The TSOs:

- Have to have programmes approved by the regulatory authority - RPC. It is also possible to use the foreign training programmes, only they must be registered in Lithuania;
- Have to have classrooms including necessary equipment for RPT courses;
- Have to enable course participants to use legislation necessary for the courses;
- Have to enable course participants to use all equipment (dosimeter, etc.) for practical course exercises;
- Have to ensure that lecturers of the RPT courses are qualified and have valid attestation certificates listing topics the lecturer is entitled to deliver;
- Etc.

Knowledge of course participants is evaluated after every RPT course. There are some requirements for their effective knowledge assessment:

- An Evaluation Commission should be established to assess knowledge of course participants;
- 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. Examination is divided into two parts - theory and practice. A certified person must have a university degree in technology or physics, or biomedical sciences. A person wishing to be certificated and be a lecturer can select a number of topics to be certificated for and the main topics are:

- Fundamentals of radiation physics;
- Fundamentals of radiobiology;
- Types of ionizing radiation doses, units of measurements and values, dosimetric equipment and methods;
- Radiation protection fundamentals. Radiation protection system and legal regulation in Lithuania. State radiation protection supervision system in Lithuania;
- Requirements for licensing of practices with sources of ionizing radiation. The state register of sources of ionizing radiation and occupational exposure;
- Radiation protection in industry and science: types of exposure, justification, restrictions, optimization, quality assurance and control system;
- Radiation protection in medicine: types of exposure, justification, restrictions, optimization, quality assurance and control system;
- Public exposure: types of exposure, monitoring and requirements for limited exposure;
- Radioactive waste classification, management and storage;
- Transportation of radioactive materials;
- Preparedness and response to radiological emergencies;
- Radiometric and dosimetry.

RPC is interested in effective implementation of radiation protection training, so once per year (or if it is necessary – more than once) is organizing the verification of institutions (TSO), providing radiation protection training.

Created compulsory radiation protection training system ensure that every year more than 1000 individuals are trained or retrained in radiation protection. In 2008, the Programme (Strategy) on Radiation Protection Training was drafted and approved by director RPC. In 2014, the Strategy was reviewed.

Education and training appraisal mission

Lithuania during the 20 years has already developed the radiation protection education, training and retraining infrastructure. It was sufficient to evaluate how created infrastructure comply with the international standards on radiation protection education and training. One of the tools for evaluation of such compliance is IAEA provided Education and Training Appraisal Mission (EduTA). On the request of the RPC, sent to the IAEA Secretariat on February 2015, an EduTA mission was agreed to be conducted on 9-13 November 2015 under the Technical Cooperation national project RER9109 “Strengthening Education and Training Infrastructures and Building Competence in Radiation Safety”.

The general objectives of the EduTA mission were following:

- To carry out a detailed appraisal of the status of the provisions for education and training in radiation protection and the safety of radiation sources in Lithuania;
- To identify areas in education and training, where the provisions should be improved to meet the IAEA safety standards, the national education and training needs and best practices;
- To provide the Lithuania with recommendations and suggestions for improvement;
- To provide key staff in the Lithuania with an opportunity to discuss the legislative framework and the national policy and strategy in the field, with the EduTA team members who have experience in the issues at stake;
- To promote the IAEA Standards and Guidelines relevant to the scope of the appraisal.

The EduTA team evaluate Lithuanian legislations on radiation protection training, has interviews with the staff of RPC as well as visited TSOs providing the compulsory radiation protection training and retraining and discussed with the TSOs staff.

EduTA team summarise that Lithuania has a very comprehensive and structured programme of radiation protection training, supported and maintained by detailed legislative requirements. All persons who work in activities with sources of ionising radiation, or may be required to do so during emergency response activities, are required to be trained before commencing the work and must attend retraining at regular intervals. The TSOs, the teaching staff and the course content are also assessed, approved, and reassessed at periodic intervals. A register of trained persons is held and maintained by the RPC. The quality management system of RPC conforming to ISO 9001 standard was implemented in 2009 and covers all activities of RPC, including radiation protection education and training.

EduTA mission identified certain issues warranting attention or in need of improvement and believes that consideration of these would enhance the overall national capabilities and performances for education and training in radiation protection. The EduTA team recommended that:

- A recognition system should be developed for the Qualified Experts (QE) and sufficient QEs must be recognised to provide expert advice to the licensees in Lithuania.
- In parallel to the establishment and implementation of QE recognition system, a separation of the functions and duties between QE and RPO should be arranged.
- The training program should be enhanced towards establishing and promoting a National Strategy on education and training in radiation, transport and waste safety.

Conclusions and recommendations of EduTA mission are sufficient for further development and improvement of Lithuanian radiation protection education and training infrastructure.

Challenges in radiation protection education and training

The existing radiation protection education and training infrastructure taking to account EduTA mission recommendations need to be improved. Lithuania is a member of European Union and is required to transpose the requirements of the Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (Council Directive) into the legislation of Lithuania by 6 February 2018. It requires Lithuania to incorporate the role of the Radiation Protection Expert (RPE) into the national legislation. The provisions of Council Directive state that Member States shall ensure that arrangements are made for the establishment of education, training and retraining to allow the recognition of radiation protection experts as well as may make arrangements for the establishment of education, training and retraining to allow the recognition of radiation protection officers, if such recognition is provided for in national legislation. The Council Directive also give provisions for the undertakings to consult with RPE and on an advice shall be covered by the RPE as well as duties of RPO.

The Radiation Protection Officers (RPO) in Lithuania actually carries out the duties expected of the RPE, and the high level of training required for RPOs is equivalent to that required for the RPE. Although the national legislation defines the role of the RPE, no recognition system is in place and no persons are designated as RPEs so far. In any case Lithuania shall review the existing legislation and taking to account the EduTA mission recommendations and requirements of Council Directive to arrange it.

One of the challenges of this process will be the recognition of (RPE) in compliance with Council Directive.

Conclusion

Lithuania has created system of radiation protection training based on Lithuanian legislation and EU and IAEA recommendations. Legal requirements for radiation protection training are developed and met in practice. The created system ensures that persons, who work and deal with ionizing radiation sources or are responsible for radiation protection at working objects, get the main information and skills, required for their effective work and safety.

As a the Member State of European Union Lithuania has to transpose and implement provisions of Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation. One of the main challenges of this process is the recognition of Radiation Protection Experts (RPE) in compliance with Council Directive.

References

- Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards. General Safety Requirements No. GSR Part 3.
- Building Competence in Radiation Protection and the Safe Use of Radiation Sources. Safety Standards Series No.RS-G-1.4.
- Training in Radiation Protection and the Safe Use of Radiation sources. Safety Reports Series No.20
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.
- Law on Radiation Protection.
- Order of the Minister of Health On the Approval of Compulsory Radiation Protection Training and Instruction Procedure.

RADIATION PROTECTION COMMUNICATION STRATEGY FOR PUPILS, STUDENTS AND THE PUBLIC

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Abstract. The importance of the communication with the public in radiation protection is playing the role not only in emergencies but also in daily life. The problems which are important for professionals as radon, medical exposure, consumer products, emergency management and other problems related to radiation protection are also essential for the public. The communication strategy is based on radiation protection information dissemination for pupils, students and the public.

Very often there is a lack of understanding, that radioactivity is the part of our environment, and the use of ionizing radiation is very various and wide – not only for atomic energy, but also in X-ray diagnostics, nuclear medicine, brachytherapy, industry, science etc. For the purpose that pupils would gain the knowledge of safe use of ionizing radiation, by the initiative of European Commission, it was prepared the methodological publication "Radiation and Radiation Protection" (a course for Primary and Secondary Schools, where the radiation protection topics are included in adequate educational programs (like civil protection etc.). Radiation Protection Centre had translated the above mentioned methodological publication into Lithuanian language and had adapted it for the high schools in Lithuania. The Ministry of Education and Science of the Republic of Lithuania had approved this methodological publication as a suitable informative publication for teaching the different age pupils of radiation protection topics.

The students from the various universities and high schools, who are not directly related to radiation protection (physics, public health, kinesitherapy, ergotherapy students), also students from foreign countries who are studying in Lithuania by the ERASMUS program, are familiarized with the functions of Radiation Protection Centre. Some of the students according to a bilateral cooperation contracts between Radiation Protection Centre and universities or high schools have possibilities to make a practice in different field, related to public exposure (such as threat of radon gasses to public health, measurements of building materials etc.).

In order to actively and successfully spread the knowledge of radiation protection and to promote development of radiation

protection culture in Lithuania, the specialists of Radiation Protection Centre collaborate with specialists from the Public Health Bureaus and organize meetings with the public. The people' communities of different regions of Lithuania are attending the meetings where presentations on popular topics in radiation protection are discussed. The cooperation between Radiation Protection Centre and the National Public Health Bureaus is strengthening by the annual radiation protection informative workshops for bureaus specialists, who are as the main players in dissemination of knowledge for public in field of dangerous factors to the human health and healthy life style.

This strategic approach of communication between regulatory authority and public help to improve the better understanding that every member of the public is able to take the responsibility of communities' radiation protection.

Introduction

Radiation protection is a very specific topic for communication with the public. Although there is a relation between the public age, profession, educational level, working area and experience, but the most important task in communication with public in general is how to present this topic in easy understanding way for everyone. The other very important aspect is the presenter – on his preparedness, experience, finally personal characteristics depends how well the public will understand the radiation topics. Communication with the public on the topics related to radiation protection could be divided to communication in daily circumstances and communication in a nuclear or radiological emergency. Although there is a lot of information, which is good material for preparing the communication material with the public, but it would be difficult to say the same about the methodology of public communication with the public. The International Atomic Energy Agency has officially published the publications[1,2] for communication with the public in a nuclear or radiological emergency, which are very useful for preparing the specialists to be ready to communicate with the public during the real emergencies. However, we should agree that there is still a lack of professional literature or training material, which could serve as a methodological material to prepare the specialists for communication with the public in daily circumstances.

Radiation Protection Communication with the Pupils

The communication strategy is based on radiation protection information dissemination for pupils, students and the public. There is not approved a separate legal act as official strategy of radiation protection communication with the public in Lithuania, but the strategic statements of communication are clearly determined in differenet legislations. There was approved the Radiation Protection Training Development Programme

(Strategy) by the Radiation Protection Center Director's Order in 2008 (the document was reviewed and renewed in 2014), where is clearly stated: "In order to provide the necessary knowledge on radiation protection, there are events organized for various public groups – pupils, students, journalists, students <…> – during the seminars, lectures and conferences. Information regarding the radiation protection and the latest developments in the field of radiation protection is also published on the Radiation Protection Centre's official website and regularly disseminating through national media channels."[3] The European Commission took into account the importance of public knowledge of ionizing radiation, and initiated the release of methodological publication (a course for Primary and Secondary Schools)[4] for teachers on the relevant issues of ionizing radiation and radiation protection. In 2000 with professional support of Swedish Radiation Protection Institute, this publication was translated into Lithuanian language and has reached the teachers, students and other public groups, which are interested in ionizing radiation and radiation protection issues in Lithuania. The pupils for whom this coursebook is intended constitute a remarkably heterogeneous group in which cognitive abilities may vary considerably, because of this the items recur in a gradually more complex form. The selected material is divided into five age levels. The first three levels are designed for use in primary education while the last two levels are aimed at secondary education. Each level can be taught as a self-contained unit, although the teacher is free to use material from previous or subsequent levels. The course may therefore be regarded as a source of reference material with which the teacher can construct his own lessons. In the first three levels emphasis is put on relating radiation to pupils' personal and everyday experiences and observations. Pupils are made aware of the risks and benefits of ionizing and non-ionizing radiation. In the final two levels, a more detailed examination is made of the subject from both the technical and social points of view, the aim being to enable pupils to develop an informed and balanced view of radiation. The Ministry of Education and Science of the Republic of Lithuania had officially approved the mentioned methodological publication "Radiation and Radiation Protection" as a suitable informative publication for teaching the different age pupils of radiation protection topics. As it was mentioned already, many copies of this methodological publication in Lithuanian language were provided for schools and gymasiums in Lithuania. For the effective learning and to improve the teachers skilss, competence and knowledge in radiation protection, Radiation Protection Centre at least once per year is organizing the meetings with the teachers from different areas of a country. During that meetings Radiation Protection Centre's specialists sharing their experience on how to provide the difficult radiation protection topics for different age of pupils in understandable way. This kind of meetings between the professional radiation protection specialists and the teachers are bringing the best possibilities for the teachers to receive the alive answers and professional cosultations from the radiation protection specialists. Also the radiation protection specialists, participating at these meetings, are gaining the useful advices from the teachers how to commincate with the different age auditorium, what should be the main points of this communication. Also radiation protection communication with pupils and their teachers as well time to time is strengthening by the common projects, mostly initiated by the schools. In these projects Radiation Protection Centre is participating as Technical Support Organization, which provides the necessary equipment, consulations, meetings with the radiation protection specialists and simmilar issues. The often the results of the common projects are presented in the conferences, organized by the schools, which initiating the projects. At these conferences the results of the projects are presented by the pupils and also by the specialists from Radiation Protection Centre. It should be mentioned that the Government of the Republic of Lithuania more than ten years initiated the national project “Pupils – to Government” (picture No 1). During this project, the selected pupils from different schools of Lithunia have a chance one week to “work” in the Government of the Republic of Lithuania in a role of the ministers. The pupils, who are selected by their grades and invited to participate at this project, have the right to choose at which Ministry he or she will spend a week in a role of the minister. According to this project Radiation Protection Centre every year accept the pupils – ministers from the Ministry of Health of The Republic of Lithuania. During the visit at Radiation Protection Centre these pupils have a chance to watch the work at laboratories, to discuss with the specialists on various radiation protection topics, to try to use the equipment for the detection of orphan ionizing radiation sources and to be involved in other activities, during which thet receive all the necessary information of radiation protection.

Picture No 1. *The moment of the project “Pupils – to Government” pupils visit at Radiation Protection Centre*

Radiation Protection Communication with the Students

In Lithuania there is no separately taught in such specialty as radiation protection, however, the specific topics are included in several other specialties (radioecology, medical physics, public health, etc.). The basic knowledge in radiation protection is received by students of other specialties as well – radiologists (physicians), dentists, radiology technologists, veterinary physicians and others. The students from the various universities and high schools, who are not directly related to radiation protection (compared to the students mentioned above), also students from foreign countries who are studying in Lithuania by the ERASMUS program, are familiarized with the functions of Radiation Protection Centre. During this kind of the meeting Radiation Protection Centre's specialists are presenting the radiation protection infrastructure in Lithuania, the State Register of Sources of Ionizing Radiation and Occupational Exposure, authorization of activities with ionizing radiation sources, radiation protection supervision and control, preparedness for radiological and nuclear emergencies, monitoring system of population, occupational and patient radiation exposure, organization of high-level activity regulatory and orphan sources detection. Radiation Protection Centre is signed several bilateral agreements with different universities of a country. According to these cooperation contracts Radiation Protection Centre creates the conditions for the students to performe their scientific practice there and also support the students Final Thesis (for Bachelor or Master degree) projects (the students are available to use the laboratories or the necessary equipment or data for preparing their Final Thesis). For example, according to the cooperation contract with the Utena University of Applied Sciences, Radiation Protection Centre provided an opportunity for Environmental Protection Engineering student to make a practice on threat of radon gasses to public health.

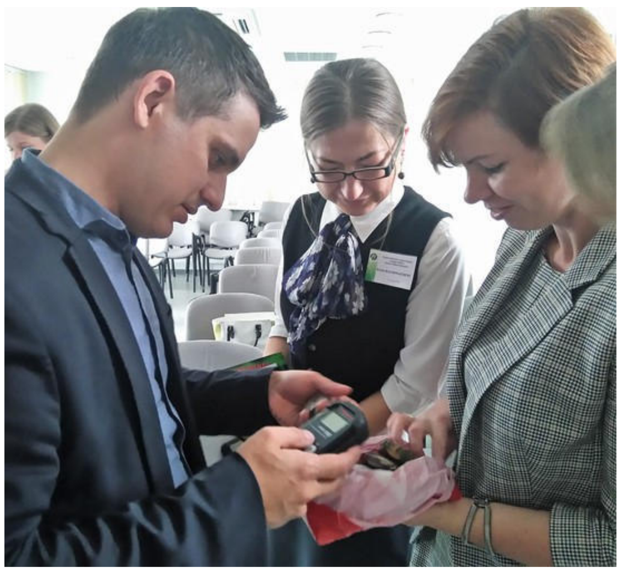
Radiation Protection Communication with the Public

In order to spread the knowledge of radiation protection actively and successfully and to develop the radiation protection culture in Lithuania, Radiation Protection Centre's specialists collaborate with the specialists from the Public Health Bureaus and time to time organize meetings with the public (picture No 2). At these meetings radiation protection specialsts are presenting the popular topics of radiation protection like:

- ✓ what is ionizing radiation and why it can be dangerous?
- ✓ how to identify the source of ionizing radiation?
- ✓ is there any exposure in our dwellings?
- ✓ can daily used food or water be contaminated with radionuclides?
- ✓ what is the radiological emergency and how to act during it?

Participants of these meetings are wondering if household appliances can emit ionizing radiation, what radiation effects on humans and plants are, what actions were taken during radiological accidents in Ukraine (Chernobyl) and Japan (Fukushima). Participants also are bringing their old watches or other things which according to their understanding might be radioactive. The radiation protection specialists are measuring the radioactivity of these items and informing the people about the results.

At the recent time, the public is more interested in radiation protection and its importance in our daily life. Although the accident at the Fukushima Daiichi nuclear power plant did not affect Lithuania directly, but the publications on newspapers and the readers' comments on them, also the questions, which were received by the radiation protection specialists after the Fukushima accident, just proved that the communication with the public on radiation protection topics should be permanent.



Picture No 2. *The moment of the meeting with the public*

Radiation Protection Centre is always seeking for more successful and fruitful collaboration with the Public Health Bureaus and annually is organizes the seminars for the Public Health Bureaus specialists (picutre No 3). During these seminars radiation protection specialists are presenting the topics like:

- ✓ radon problems in the home,
- ✓ radiation protection of patients (special attention to the children and pregnant women),
- ✓ nuclear emergency preparedness and response,
- ✓ Chernobyl accident and its consequences for Lithuanians,
- ✓ the areas and possibilities of collaboration between the Radiation Protection Centre and the Public Health Bureaus.

Radiation Protection Centre, as the partners, is also particiating at the public events, organized by the Public Health Bureaus (as an example: "October – the Month of Health Improvement in Panevėžys"). During these events the people can have the direct communication with rdiation protection specialists, to ask the actual questions and to receive the professional answers.

Picture No 3. *The moment of the meeting with the Public Health Bureaus specialists at the Radiation Protection Centre*

Conclusions

1. There is still a lack of professional methodological information how to communicate with the public (taking into account the differences of the age, status, working experience, educational level etc.) in a daily circumstances, because the for nowadays still more attention is paid for the risk communication with the public during nuclear or radiological emergency.
2. Bilateral friendly collaboration between teachers and radiation protection speciliasts are useful for both sides – in a way by teaching each other the teachers are gaing the specific information of radiation protection and the radiation protection specialists are gaining the experience on how to communicate witht the public.
3. Radiation protection communication with the pupils, students and the public is helping to form the right understanding of the the safe use and dangers of ionizing radiation. Also radiation protection communication is improving the public skills to choose the trustable information (social media, newspapers, journals, scientific and popular lietarure etc.).
4. Seeking to educate Lithuanians on radiation protection topics, the Radiation Protection Centre started the successful cooperation with the Public Health Bureaus since 2013. Although the period of this fruitful collaboration is still very short, but during the meetings with the public it is already possible to notice the positive changes in understanding of radiation protection.

References

1. Communication with the Public in a Nuclear or Radiological Emergency; Emergency Preparedness and Response; EPR-Public Communications 2012; Date Published: 2012.
2. Method for Developing a Communication Strategy and Plan for a Nuclear or Radiological Emergency; Emergency Preparedness and Response; EPR Public Communication Plan 2015; Publication Date: July 2015.
3. Radiation Protection Training Development Programme (Strategy); approved by Radiation Protection Center Director‘s 2008 April 18th Order No. 21.
4. Radiation and Radiation Protection - A course for primary and secondary schools, Jos Draijer and John Lakey; Commission of the European Communities; Office for Official Publications of the European Communities.

TEN YEARS OF EXPERIENCE FEEDBACK IN DISSEMINATION OF RADIATION PROTECTION CULTURE: 1,500 HIGH SCHOOL STUDENTS INVOLVED IN RADIATION PROTECTION ACTIONS

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For the tenth consecutive year, IRSN, CEPN, the scientific culture center of Franche Comté, INSTN and ASN offer to French and foreign high school students (approx. 16 to 18 year old) to participate in international workshops named "Radiation Protection Workshop". More than 1,500 students have participated and contributed to the spread of radiation protection culture.

These workshops, led by professors in partnership with radiation protection experts, academics and researchers in scientific disciplines are intended to engage students, on a voluntary basis, in multidisciplinary activities related to radiation protection practice.

International meetings are organized at the end of the second quarter of the school year to allow students who participated in the workshops to present their work and interact with other students and with radiation protection professionals.

During the 2015-2016 school year, more than 140 students were involved in this action coming from 16 high schools: France, Germany, Belarus, Ukraine, Morocco, Moldavia and recently involved, a high school from Fukushima (Japan) in close partnership with about thirty radiation protection experts.

For the tenth edition to be held at the INSTN in Saclay from 20th to 22th March, in addition to the countries historically involved, Colombia joins the workshop.

Throughout the academic year, students under the guidance of their teachers and with the assistance of radiation protection experts carry out work on various topics concerning the practical implementation of radiation protection. These annual international meetings are organized to enable everyone - student, teacher and expert to present their work and exchange information and opinions with other students and professionals in radiation protection.

This type of action allows young people to become informed citizens being able to make their own judgement about key issues related to radiation protection, such as:

- What are the different types and levels of exposure?
- What are the living conditions in the contaminated territories (Belarus, Ukraine, Japan)?
- Where is the radioactivity and how to measure it?
- What are the health effects of ionizing radiation and how to assess risks at low doses?
- What are the means of protection against exposure?

Depending on local interest, some schools have decided to study the natural radioactivity, radiation protection in the medical field, monitoring around nuclear power plants or living condition in contaminated territories due to an accident (Chernobyl and Fukushima), favoring a multi-disciplinary approach.

In addition to oral presentations in French during the plenary sessions, one afternoon is devoted to presenting the work carried out throughout the year, by means of workshops and posters.

Another afternoon is dedicated for visiting scientific installations related to radiation protection, energy or scientific research.

The growing success of this action to spread the radiation protection culture, forces the organizers to consider all arrangements to ensure the sustainability of the "Radiation Protection Workshop".

www.lesateliersdelaradioprotection.com

Introduction

CEPN, ASN, IRSN, CEA / INSTN, the Science Pavilion (CCSTI) and SFRP offer to French and foreign high schools to be mobilized for the "International High school meeting on Radiation Protection" also called "Radiation Protection workshops", as every year since 2008.

For the tenth consecutive year, the radiation protection workshops allow high-school students around the world to share their work and to visit research facilities related to radiation protection.

This year, this event were organized at INSTN in Saclay

Since the beginning of the adventure, 1,500 high school students were involved in this educational activity and acquired the elements of radiation protection culture.

For several years, students from France, Germany, Belarus, Moldova and Ukraine were involved. This year, thanks to the support of the Franco-Japanese Sasakawa Foundation, a delegation of high school students in Fukushima participated and worked on the issue of evacuation of people and their return to the territories in Fukushima.

Finally, a delegation of students from a high school in Bogota, Colombia participated for the first time in this international event.

Workshop Description

The workshops are designed to engage high school students (16 to 18 years old) in activities concerning the practical radiological culture, key element of the radiation protection of workers, public and patients.

The workshops of radiation protection are based on key points that structure and guarantee the quality of this unique educational event in France:

- the importance of a multidisciplinary approach, where topics from engineering domain and health coexist,
- student involvement on a voluntary basis and requiring substantial work from students,
- identifying scientific elements which are discussed in the workshops through the transdisciplinary themes of radiation protection
- the organization of pathway in each school in order to develop a citizen questioning process on concrete issues of radiation protection, expanding the strictly scientific approaches of problems addressed and allowing students to study topics following technical, scientific, ethical, sociological, ecological ... perspectives.

General objectives

Workshops for Radiation Protection are part of a spread out process of the radiation protection culture among young students studying mainly science subjects (but not only).

This initiative aims to bring social awareness through an appropriation of scientific and social elements associated with ionizing radiation in the environment.

Radiation protection workshops also contribute to promote scientific and technical culture in high school which knows disaffection unfortunately.

This educational activity also enables discovery of the professional world through technical visits and discussions with experts from the field.

Methodological approach

To engage high students in activities to develop practical radiation culture at school, a multidisciplinary approach is implemented by the teaching staff of each school. Teachers involved teach physics, chemistry, mathematics, science and life of the earth, letters, philosophy, history, geography, arts, economics and social sciences, and finally foreign language.

Partnerships are established for each school with radiation protection experts (universities, expert bodies, research organizations ...) according to the work program adopted by the students.
Finally, the steering committee of these Radiation Protection workshops, develops and monitors the work of the involved schools throughout the year.
These workshops start at the beginning of the school year and include a theoretical classroom provided by the teacher with additional lectures given by experts combined with a part with practical experiences. Students have the opportunity to handle detection and measuring devices, visit technical facilities and conduct experiments.
In March of each year, international meeting is organized to allow students to present their work in plenary sessions and share with other students and radiation protection professionals. This event represents the apogee of the work done during the school year. During 3 days, nearly 25 themes were presented in French, except for high school students in Fukushima and Bogota, who presented in English.
One afternoon was devoted to technical visits and students discovered some installations at Saclay nuclear site such as DOSEO platform, the EL3 reactor, the virtual room VERT, the laboratory for liquid scintillation and the SOFIA simulator (Fontenay-aux-Roses).

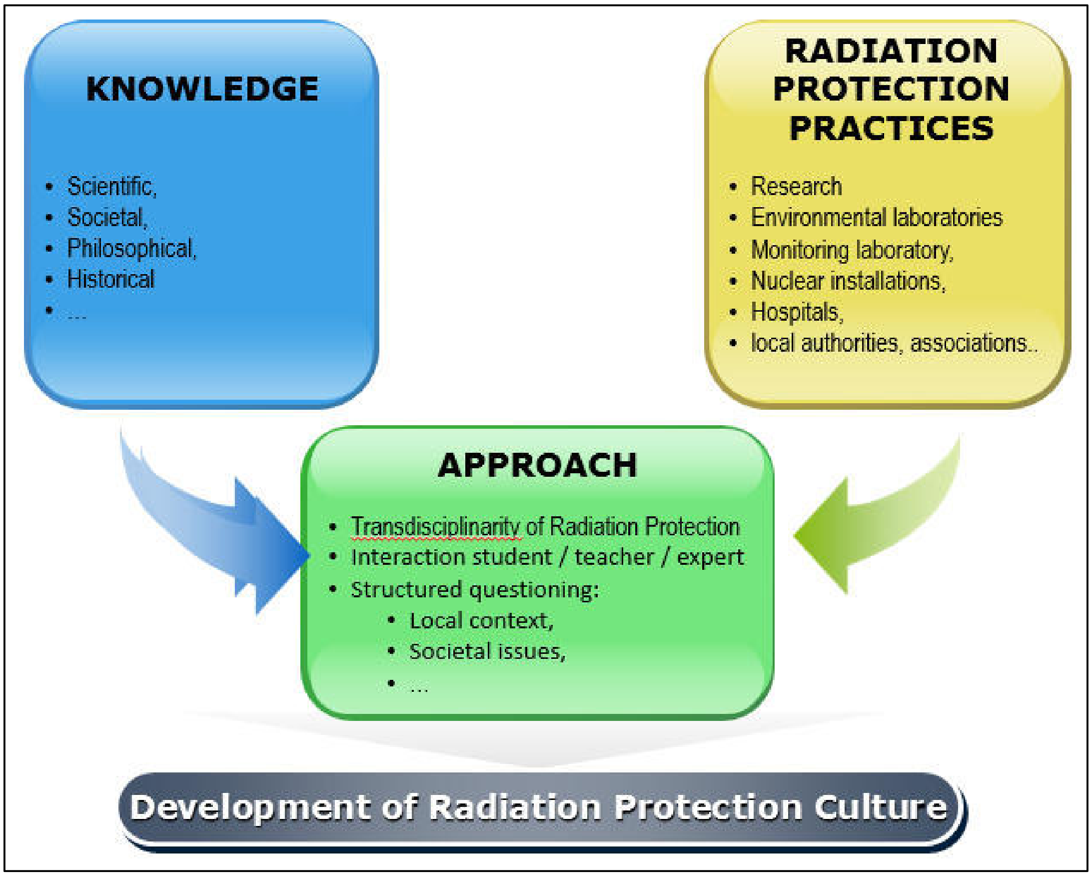

Fig 1. General methodological approach of Radiation Protection Workshops

The topics

Because of transdisciplinary of radiation protection, the choice of topics is vast. For example, this year, the studied topics were:

- The question of the evacuation of people and their return to the territories in Fukushima
- Radiation protection of staff working in nuclear power plant
- Post-accident iodine dosage
- The dismantling of the Fukushima Daiichi plant
- Radioactivity and medical diagnosis
- Highlighting different types of radiation
- Radiation therapy: benefits and risks
- Cell therapy and stem cells
- Radiation protection at the museum
- Radioactivity and risk
- Application for authorization to possess and use radionuclides unsealed sources for medical applications
- The protection of the pregnant woman and fetus during medical examination or treatment
- Radiography and pediatric scanner: harmless examinations for children?
- Radiation protection in the operating room associated with the Marie Curie history of radiography
- Evolution of internal contamination of the people affected by the Chernobyl accident

- Thyroid problems in Fukushima
- The new sarcophagus of Chernobyl
- Uranium: from origine to extraction
- The rehabilitation and monitoring of former uranium mines of Limousin region
- Disposal, nuclear waste management and the scenario of a possible exit from nuclear
- What do we make of our radioactive waste?
- ANDRA storage sites in Aube
- The CIGEO project - CMHM center
- Philosophical sketches
- Radiation protection in Colombia
- Radiation protection for pilots, crew and passengers during air travel

Results

In addition to the work performed during the radiation protection workshops, some students were involved in measurement campaigns in four countries. They contributed to the writing of a scientific article in the Journal of Radiological Protection (J. Radiol. Prot. 36-2016, 49–66). The title is “Measurement and comparison of individual external doses of high-school students living in Japan, France, Poland and Belarus-the 'D-shuttle' project. A total of 215 people from 6 schools inside the Fukushima prefecture, 6 schools in other prefectures in Japan and 12 overseas areas.

The contribution of the students was effective and 130 co-authors signed this article downloaded 88733 times!

Fig 2: article published in Journal of Radiological Protection

Conclusion

This unique action in France is assisted by organizations such as the regulatory body (ASN), the TSO (IRSN), the nuclear Education & Training institute (CEA / INSTN), the center of scientific culture (CSSTI), a protection assessment association in the nuclear field (CEPN) and the French radiation protection society (SFRP).

The radiation protection workshops allowed students to develop a practical culture of radiation protection. Through this experience, they have indeed been able to

• Acquire point of reference with respect to the radioactivity present in the environment and notions of the means of measurement
• Interpret external and internal exposure measurements and acquire key to understanding

• Understand the biological effects that can occur after exposure to ionizing radiation and the risk assessment at low doses
• Acquire notions on the protection of the environment and mankind from radioactivity
• Discuss issues related to protection against ionizing radiation.

The growing success of this work to spread the radiation protection culture, force the organizers to consider all arrangements to ensure the sustainability of the "Radiation Protection Workshop".

Training in Radiation Protection: Developing expertise and culture in radiation protection

(Outputs from a dedicated SFRP symposium organized in 2016 in Paris, France)

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SUMMARY

Organised by the Teaching Commission and the Technical Protection section of the SFRP (Société Française de Radioprotection – French Radiation Protection Society), this symposium was held in Paris on June 14-15, 2016. The objectives of this symposium were to provide the actors of radiation protection with a clear vision on the radiation protection expertise and culture issues.

Three main domains have been addressed, (i) initial and continuous education for radiation protection professionals, (ii) development of a radiation protection culture for professionals, patients and citizens, and (iii) evolution of educational methods.

Balance between professional training in radiation protection and needs of the stakeholders has been discussed.

A radiation protection culture is of prime importance for professionals - not only those directly exposed to ionizing radiation but also their managers, to promote a more efficient radiation protection. Such a culture applied to general public and patients allows them to apprehend more efficiently available information on that matter.

Concerning the evolution of educational methods, emphasis was to reinforce the notion of skills vs. knowledge. Introduction of new educational tools based on recent communication technics, has been discussed.

Finally, the main output of this symposium is: training is a key element to implement radiation protection.

INTRODUCTION

Patient radiation protection is based mainly on the implementation of the justification of examinations and the optimization of delivered doses principles (L 1333-1). It's a duty (safeguarding of care, quality of treatment) and an obligation inscribed in the code of public health. Many elements are involved (intervention of the Medical physicist, quality control of machines, etc.), including the compulsory Radioprotection of patients TRAINING (R 1333-74).

The decree of 18 May 2004 defined compulsory contents of training by profession, and imposed a decennial pace of renewal. The findings (inspections of ASN [Autorité de Sûreté Nucléaire - Nuclear

Safety Authority] and evaluation of the system in 2010) showed that this training with standard contents but non-proportioned to the stakes and imposed by regulation, without advocating the methods or evaluation, little improved the practice or culture of radiation protection.
Starting in 2012 and with the help of experts in training engineering, the ASN tested an experimentation with professionals: appropriating the general training objectives and defining the pedagogical and then operational objectives as close as possible to the stakes and daily practices, reasoning in terms of concretely expected competences, and advocating durations, methods, training materials, and evaluation process.
Given the success of this experimentation, which has won the support of professionals, and the opportunity offered by the transposition of the Euratom Directive 2013/59, the generalization of the experimentation will regulatory take place in 2016.
A technical decision of the ASN currently under consultation will define the general objectives and headings (pedagogical objectives and expected competencies, overall duration of teaching, required skills for training, the pace of training renewal...), that professionals will have to decline themselves and formalize in professional guides. These guides validated by the ASN, will be guidelines to follow in order to provide training, and specifications guaranteeing both the adequacy and the harmonization of training.
A training strategy (expected objectives and competencies) directly linked to the practice and a graduated approach commensurate with the issues, should ensure a better effectiveness of training. Training needs identified by professionals themselves, an appropriate pace, responses to specific needs, should ensure the support of the greatest number.
The involvement of professionals in the definition of their training, in response to specific needs, appears to be a strong additional asset for acquiring skills and change practices.

INITIAL AND CONTINUOUS EDUCATION AND TRAINING FOR RADIATION PROTECTION PROFESSIONALS

Development of a competency framework

The development of a competency framework is at the heart of professional certification. It is a collaborative process that must go beyond the competency framework to an evaluation framework in order to provide proof of professional mastery. It is an indispensable step that helps to improve the professionalization of the training courses developed by teachers and trainers.

During this symposium, the INSTN (Institut National des Sciences et Techniques Nucléaires, National Institute for Nuclear Sciences and Technologies) presented such a development concerning the branch of radiation protection technicians.

The reference to the expected professional skills of the labor market is a pivotal point of the process. Developing a skills repository results from the analysis of a trade, a job, a function. This analysis is valid only if it is a collective and shared analysis. This involves setting up working groups involving the players in this occupation, job or function, with specialists in the analysis of tasks and professional activities and employers directly concerned or potential. This analysis resulted in a document, generally referred to as the "professional activity reference framework", which describes precisely the activities and tasks characteristic of the trade concerned. The description of the tasks, grouped into coherent activities in professional terms, generally specifies what actions are expected, in what context and what results are expected. Then comes the drafting of the competency framework itself.

A competence is a set of knowledge, know-how and behaviors organized in order to appropriately perform an activity.

INSTN has worked out with nuclear safety professionals, four standards in a logic of professionalization as a continuum of training. They each have a skills repository and an evaluation repository based on a precise definition of the professional activities carried out by an operator, a technician, a senior technician and an engineer assistant in radiation protection.

This long-term work with the professionals has highlighted the fast evolutions of the profession in terms of approach to radiation protection in the field (concept of integrated radiation protection).

We are currently considering the establishment of a monitoring mechanism on employment in this sector which would involve the INSTN and the employers concerned.

Companionship as an in-company learning

Another kind of in-company learning is the companionship. Knowledge, know-how and behaviors are transmitted from a senior employee to the newly recruited employee. In that case, a basic training is a prerequisite.
A grip by the field hierarchy is assured. The whole of this grip is formalized and is the subject of a companion booklet whose principle is to list the achievements. They are obtained through personal work on knowledge of work practices and instructions, by a duplicate work with a tutor, by criticizing the practices of a holder to the hierarchy, by carrying out actions monitored by a tutor, and by a final questioning to verify the effectiveness of learning.

Continuous training of PCR

The need to break the loneliness, to maintain a level of competence, to find mutual aid and to share successes and difficulties was the starting point of the creation of PCRs (Personnel Compétent en Radioprotection – Radiation Protection Officers) networks.
Over time, this need has become more prominent with regard to continuing education.
This training need, felt by a large number of PCRs, was largely legitimized by a feeling of "gap" between initial training and the reality of the field. As a result, and in order to meet the expectations of our members, the networks have therefore turned to the setting up of training days to try to optimize the practices and to strengthen the confidence of the field PCRs.
In order to assist networks wishing to enter into a training program, a pedagogical committee was created to propose the necessary tools for the construction of a pedagogical sequence.
Today, these days are a great success with our members so much that it would be necessary to multiply these meetings!
As a general rule, these days are divided between theory and practical workshops, with a part regulatory news and very often, in connection with the current problems. They are often organized in small groups, which allows the interactivity, and always in the conviviality and the mutual aid.
Given this growing success and the very positive feedback on the qualitative aspect, we question the feasibility of having these teaching hours recognized as part of the renewal of the PCR certificate.
The problem is, on the one hand, to integrate the training made within the networks into the certification of the training organization and, on the other hand, to put into practice the dispensations from the last training session.

ENHANCING RADIATION PROTECTION CULTURE AND SKILLS FOR PROFESSIONALS

Evaluating training performance: the EDF experience

Since 2012, EDF has committed to a vast program of renovation of training courses. Among them, two radiation protection training modules, one level 1 module for speakers, and one level 2 module for project managers.

These courses are aimed at a heterogeneous population. They bring together people with different professional and educational backgrounds and are characterized by the diversity of their occupations (electricians, scaffolders, boilermakers, and method engineers), their statutes, their functions and companies.

These courses are thus described as "multi-job" trainings in the company's jargon. They are provided by 250 trainers belonging to a dozen training organizations distributed throughout France.

The "Organizational and Human Factors of SocioTechnical Systems" group (FOHST) of EDF R & D is positioned to design, evaluate these trainings and support the accompaniment of the change with training providers.

The objectives of the evaluation of the training design are to identify areas of progress with respect to three areas of inquiry and reflection:

- Is knowledge the one that will facilitate understanding of the rules and their appropriation?
- Does training provide training in working situations, in particular to reduce the gap between training content and future work?
- Does the training take into account the different learning modalities and lessons learned from adult learning, including experiential learning?

The proposed and designed evaluation methodology is based on a participatory approach Bringing together prescribers, designers, trainers and trainees.

The innovative tool for this evaluation is based on the simulation of intervention scenarios, punctuated by disruption and events, in which the team of trainees must identify the strategy (s) of possible actions to manage these situations of work.

It is therefore clearly distinguished from the practices of assessing the satisfaction of the trainees, the tests of knowledge, or the evaluations of transfer by questionnaire during annual interview with the hierarchical manager.

These results have led to a review of the re-design of some existing training content, the design of new content, while other recommendations have been transformed into a new design criterion for other courses. Some of the recommendations have thus become design requirements.

The ANCCLI experience: Developing Radiation Protection Skills and Culture to promote citizen expertise.

The ANCCLI (Association Nationale des Comités et Commissions Locales d'Information - National Association of Local Information Commissions and Committees) main objective is to develop radiation protection skills and culture to promote citizen expertise.

The ANCCLI promotes the rise in competence and culture of radioprotection of CLIs (Commissions Locales d’Information – Local Information Commissions) in providing information on major nuclear issues. To do so, the ANCCLI builds constructive partnerships. For instance, the ANCCLI and IRSN

(Institut de Radioprotection et de Sûreté Nucléaire – Institute for Radiation Protection and Nuclear safety) jointly organize training seminars for CLI members:

- Waste (HA MAVL - HA MALL)
- Environment and health
- Post-accident
- Dismantling
- Organizational and Human Social Factors
- Transport of radioactive substances

Culture of Radiation Protection: Patients, physicians and nursing personnel are all hospital radiation protection actors.

The culture of radiation protection in the medical field has increased considerably over the last twelve years. There are, however, areas where much remains to be done: in the operating room, where there is little or no training in radiation protection and among doctors who are very unaware of GBU (Guide du bon Usage en radiologie – Good Practice Guide in radiology).
The upcoming revision of radiation protection training for patients, as well as the introduction of radiation protection into the initial training of all doctors, must make it possible to overcome these shortcomings.

In addition, new generation facilities, especially scanners, offer a great potential for optimization that professionals must learn to use to the best advantage.

The increasing number of PSRPMs (Personne spécialisée en radiophysique médicale -Medical Radiophysics Specialist) actually involved in imaging is an asset in this context since optimization is at the heart of their missions. It is therefore necessary to be optimistic, but vigilant. The ASN inspection reports and the IRSN periodic reports concerning the collection of doses under the NRD (Niveaux de Référence Diagnostiques - Diagnostic Reference Levels) and the exposure of the French population related to diagnostic procedures will make it possible to measure and to follow in time the impact of all the measures taken.

INTEGRATION OF NEW EDUCATIONAL TECHNICS AND METHODS

Distance Learning:

Based on the feedback analysis from the creation and functioning of a professional License in Nuclear Techniques and Radiation Protection (TNRP) an experiment done at the University of Strasbourg, Strengths and weaknesses of distance learning were studied.

The TNRP Pro license is a training which aims to give skills to work overall the professions of the nuclear sector and includes 450h excluding tutored project and internship.

Strengths were:

- providing training to those prevented
- Personalized and customized follow-up
- Attractive technological innovation
- Educational inputs
- didactic inputs

Weaknesses were:

- Opening threshold set at 7 registrants
- technical problems
- Presence required for on-site lab and exams
- Risk of isolation and abandonment
- Need for recognition by the institution

The pedagogical team regretted the one-shot operation of this training with regard to the investment of more than five years to carry out this project. However, the majority of the teachers involved recognized that they had been led to reflect on their educational practices. They say they have not really changed their courses in face-to-face at the end of this distance learning experiment.

Computer-assisted training at work in glove box

The alpha risk generated by Plutonium requires the use of this material in a glove box. The interventions require a lot of practice, serenity, reflex during routine manipulations but also in the face of degraded situations. A
Constant and repeated learning is justified by the risk of injury or inhalation during operations in glove boxes.

The training of the participants is essential in these activities where the control of the gesture of the operator must be precise and appropriate. A simulation tool was created to contribute to good practice training. It allows simulating the normal working and degraded situations.

This pedagogical toll is interactive. It allows 3D simulation in real time. To increase its pedagogical effectiveness, it simulates the actual working environment. The operator controls his avatar on a touch screen with a great freedom of action.

The role of SIBAG is also to train oneself to the good reactions in degraded situations. In this type of configuration, perfect knowledge and mastery of procedures are essential for the operator to properly handle an incident and limit the consequences. This knowledge and mastery of all the situations can only be obtained through a very regular training. It does not require the presence of an Instructor.
Automatic reporting allows stakeholders, their hierarchies and trainers to
follow the progress of the learners and to orient the training sessions that complement this self-training on simulator.

Integration of new information and communication technologies into training: Risk and Opportunity.

Initial training (and recycling every 3 years) cannot alone respond to the challenges. Should these actions be integrated into a global approach and change the paradigm between companies and operators?

- The learning enterprise: young generation will have 13 different occupations during its career, what is role of the company in this context and the role of the national education?
- The extended enterprise : To have a shared base of pedagogical modules between the companies and the operators to take into account the specificities

It is a matter of extending the professionalization actions in accessing to a shared and collaborative knowledge base. Such a digital training puts the individual at the center and authorizes the development of a digital culture of actors by the overcoming of barriers.

The reorganization of skills development through the networking effects allows the alliance with the multitude of users and the developers of educational content (increasing yield). For one who knows, it means going from the production of a specification for a production line to the live production of content.
In the end, the increase in the efficiency of training is followed by the increase in the factors of production.

The risk is thinking the digital transition from the trainer's point of view alone, and the opportunity is thinking about the digital transition from the point of view of the learner and the necessary involvement of his / her management.

CONCLUSION

At the end of this symposium, the general point of view was that culture and competency in radiation protection are always in demand. Whatever your field of expertise, whatever your own knowledge, the future of radiation protection resides in training, may it be initial education, continuous training, using either classic or digital tools.

Finally, the main output of this symposium is: training is a key element to implement radiation protection.

TOWARDS A BROADER PERSPECTIVE ON NUCLEAR ACTIVITY

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1- Introduction

For some years the "nuclear community" has been making important efforts to extend the reflection on nuclear activity towards a vision that includes the social sciences and humanities. In this way are the publications of the ICRP's "Task Group 94", as well as the workshops developed under its auspices; there are also relevant contributions from different research centers and universities, such as Science & Technology Studies Unit, SCK • CEN (Belgium); Without forgetting that this Conference includes in its program a space that will specifically deal with Integration of social sciences and humanities in radiation protection education and training. It should also be noted that main protagonists of this discipline have produced different works devoted to thinking about ethical problems related to radiation protection. This is the case of Lauriston S. Taylor[1], Bo Lindell[2], Giovanni Silini[3] and, from my country, Abel González[4], to mention just some of them.
These efforts constitute a very important focus point for further developing an approach to nuclear activity based on a broad vision from social disciplines or ethical reflection.
The complexity of nuclear activity deserves an understanding that exceeds the capacity of so-called "hard sciences". A different view, the assumption that this phenomenon can be exhausted only under the understanding of these disciplines implies what is called "epistemological reductionism". Under its general description, reductionism is an approach to understanding the nature of complex things by reducing them to the interactions of their parts, or to simpler or more fundamental things. Its critics use the term to characterize those theories that try to realize an understanding of the science reducing it only to its gnoseológical traits. Or, they maintain, it is reductionist a theory that understands that science is explained only by its method and that, in addition, the method - unique for any discipline that claims to be scientific - comes from those applied in the physical-natural sciences.
Those who do not share this perspective point out that this perspective does not contemplate a series of factors necessarily involved in what we currently understand by science, the ways in which science works concretely
This implies including the complex relationship between science and technology, or the phenomena of the valuation of theories, as well as the problems related to the validation of the application of knowledge, on the one hand; and on the other hand, the financing of scientific research, the structuring of a scientific technological system, the relationship of science with the market and industry, without which it would be impossible to understand completely.[5]

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[1] TAYLOR, L. S.; "The philosophy underlying radiation protection," American Journal of Roentgenology, vol. 77, no. 5, pp. 914–919, 1957; "Some nonscientific influences on radiation protection standards and practice. The 1980 Sievert lecture," Health Physics, vol. 39, no. 6, pp. 851–874, 1980.
[2] LINDELL, Bo; "Logic and ethics in radiation protection", Journal of Radiological Protection, Volume 21, Number 4, Published 20 November 2001.
[3] SOLINI, G., "Ethical issues in radiation protection—the 1992 Sievert Lecture", Health Physics, vol. 63, no. 2, pp. 139–148, 1992.
[4] GONZALEZ, Abel; "The Argentine Approach to Radiation Safety: its ethical basis", Hindawi Publishing Corporation, Science and Technology of Nuclear Installations, Volume 2011, Article ID 910718.
[5] See relevant works from the argentine philosopher Enrique Marí or Oscar Varsavsky. MARI, E.; *Elementos de Epistemología comparada*, Puntosur, Buenos Aires, 1982. VARSAVSKY, O.; *Ciencia, política y cientificismo*, CEAL, Buenos Aires, 1969. Or, in the French materialist school, authors like

In the line of argument that has just been presented, it is tried to point out that the "nuclear science"[6] that includes radiological protection as applied discipline requires not only the understanding of an interaction between atoms and their "infinite" derivations, causes and consequences, but also the knowledge of an equally complex interaction between human subjects: Men and women who put into play resources - material, intellectual, symbolic - for the production of nuclear energy and the vast technologies that this implies; of men and women who develop regulatory systems in political and legal frameworks that exceed strictly nuclear issues; of men and women who accept or not the location of nuclear installations in all its varieties, Among other forms of human relations that are arranged around the "nuclear thing".
By accepting this perspective, nuclear activity as a whole becomes even more complex and, at the same time, gains in wealth its capacity for understanding. If one accepts this matrix of thought which assumes that "the nuclear" needs to be comprehensively understood, including the modes of social interaction that allow its concretion and development, then the intervention of the social sciences and humanities constitute an unavoidable tool.
These disciplines enable a vision of the nuclear phenomenon in which the current problems facing nuclear activity are incorporated. That is, the phenomena of its acceptance or rejection, for example, are no longer external to it. This kind of "aberration of meaning" that forces the mixture of phenomena of different nature, nevertheless forms the possibility of solving these problems.

2- Epistemic problems

Radiation protection is a constantly developing discipline. From its achievements the whole nuclear activity has reached very important security standards. Paradoxically, it is also true that events, incidents or accidents in any branch of activity are seen as "shifters" to further advance the frontiers of knowledge, as well as in the regulation field that set new standards of safety.
However, it is striking that the levels of fear, rejection or distrust from the citizens on the nuclear technological applications have not diminished, in spite of multiplicity of applications that suppose, as is known, advances in the field of human health, industry, and power.
Faced with this dilemma, it could be easily hypothetized that more knowledge in the field of radiological safety greater distrust by the population on nuclear activity.
However, it is clear that such a hypothesis is at least very weak: ¿what would have happened if there had not been an increase in radiological safety standards? Would the rejection have been reduced? It would also be indispensable to show other variables that could affect the level of distrust of the population. This would quickly lead to the conclusion that the fact that there is greater knowledge, and therefore better controls, does not actually have a direct relation to that negative perception.
Even so, the contrary idea could take place: the fact that there is constant progress in knowledge and that this knowledge promotes higher safety standards does not affect positively the population's perception of nuclear activity as a whole.
This approach has no anti-scientific claim. Rather the complete opposite. The development of radiation protection is possible from a sustained advance of scientific knowledge, although this is not the only element to consider. However, such progress often face social questions to which it’s not so easy to find an answer. This problem is irresolvable if it is addressed only within the frames of disciplines whose object of knowledge revolves around atomic and nuclear phenomena.

Georges Canguilhem or Dominique Lecourt. CANGUILHEM, G., *Le normal et le pathologique*, Paris, PUF, collection «Galien», 1979. LECOURT, D., Pour une critique de l'épistémologie, Paris, Maspero, 1974.

[6] Allow me to use this concept which, although it may seem a neologism, is accepted in a significant number of texts belonging to the field of nuclear activity and institutions such as MIT, which has a specific department with that name: MIT Department of Nuclear Science and Engineering.

It is true that in the nuclear field there is widespread recognition of the existence of problems associated with forms of subjectivity that directly affect the activity, on which have been tried - without much success - solutions. The interest in the area of social communication, institutionalized and perfected in the R & D, regulatory organizations and responsible for the facilities, reflects the genuine concern of scientists, technicians and decision-makers to convey convincing explanations to citizens, without losing scientific rigor.

In short, the idea that a better communication with the population could begin to settle some debates, or at least converge positions, has appeared for some years now. Notwithstanding this effort, the attitude of the population towards the sector has not changed significantly.

The problem that arises once again is that "the social" appears as a phenomenon external to "the nuclear": subjects, institutions, social classes, workers, the public, the environment, stakeholders, maintain a structurally external status to technological applications in the nuclear field. This alienation of subjective, social factors, in relation to the nuclear thing, cannot be overcome from a proposal that does not include as part of its objects of knowledge the decisions, ideologies, fears, values of subjects that in a way or another are linked to nuclear activity.

It is important to raise it without mediations. If the last argument of a nuclear science that wants to explain the phenomena associated with its important activity is based only on the knowledge of its subject – perhaps the most paradigmatic of the history of mankind -, it will face an epistemological problem, that is, the problem of how the production of scientific knowledge is understood, and what is done with it.

Science, understood as a set of methodological procedures that has the destiny to formulate objective knowledge based on a controlled experience and justified by logical and empirical means poses a limitation. It is an instrumental idea of the scientific, in which science is reduced to a cognitive process. In his development he forgets that he cannot get rid of factors that are inescapable.

Science, as a way of giving meaning to the world is a social phenomenon; since signification is a human act, where interactions among rational beings give intelligible form to the world. From this point of view, science is a form of productive work - meaning of the world - that occurs between men and women living in society, regardless the unique knowledge object of each discipline. The particular object to which each discipline is engaged to does not change the characterization of science being a human activity that produces meaning to natural and social world.

Thus, what in general terms can be called "social" is a prerequisite of scientific knowledge and is significantly present in each of its processes; And it is also as decisive for the production of knowledge as the methodological rules of empirical testing or hypothesis formulation[7]. Society is not the depository of a knowledge elaborated by a pre-social science-machine, just as science is not a set of tools isolated from the decisions of men / women.

3 - Science *in* society

For much of the XX° century Western world had greatest hopes in science. The progress of scientific knowledge was not only the bearer of greater wisdom. It was at the same time the driver of material and moral progress for the whole of society. There were those who, moreover, thought that this material wealth could result in a welfare for all humanity. A projection of this approach reaches, in a kind of reincarnation of old platonic political ideas, the fantasies of nations governed by wise / scientists. The magnificent development of scientific knowledge in various disciplines worked with this perspective that sought to extend the success of its activity

[7] Even authors whom the history and philosophy of science classify as “positivist” or “logical empiricists”, recognize the influence of "the social" in strictly scientific activities. Cfr. REICHENBACH, Hans; *Experience and Prediction*, Chicago, University of Chicago Press, 1938.

to the whole society. In fact, there were profound changes in the relationship between men of science and power structures. According to Daniel Bell,

> In the period immediately following World War II°, a new scientific elite was closely involved in issues of national power in a way unknown to the history of science.[8]

A scientific elite had become a major political player, with the possibility to influence the destiny of its country in the immediate term and in the long run. Obviously, Manhattan Project is the paradigmatic case of what has just been sustained.

But this same process is a contradictory process, at least for science. The massive incursion of scientific and technological issues into the highest political decisions produced a change in scale in the organization of scientific research. Both the military camp and the industry formed a chorus of demands for scientific participation: production technology was urgent and researchers were needed. At the "Fordist" moment of economic production, science began to be developed in large productive units of knowledge: R & D units, the setting up of scientific and technological systems of the most developed nations. The so-called big science began to require huge investments that were generally only available to the states. In addition, because of the scope and complexity of its objectives, the working groups were composed of multidisciplinary staffs.

If before this point in history it could be difficult to argue the isolation of science from the set of social practices, from here, with scientists participating in political decisions, and states developing scientific technological systems, it became theoretically impossible to deny this association.

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Even if the basic / applied science old classification were accepted, in the field of pure research, understanding it as an activity that had as its interest the search for knowledge by knowledge itself, it would be imprudent to deny the projections of application that might arise from their results. The fantastic expressions of the English chemist Frederick Soddy in the early twentieth century, when his successes with Ernest Rutherford began to be known, bear witness. Their first joint investigations concluded in the idea that the phenomenon of radioactivity was a sign of changes in matter: "transmutation"! Exclaimed Soddy. The confusion caused by their results did not allow them to see clearly the full meaning of their feat. They had to deepen their studies almost a year to conclude that the key to their findings was elsewhere: energy. Only a few years later, in 1908, a book authored by the English man was published, in which he stated:

> A race which could transmute matter would have little need to earn its bread by the sweat of its brow (…) Such a race could transform a desert continent, thaw the frozen poles, and make the whole world one smiling Garden of Eden.[9]

Even if it were argued that Soddy-Rutherford's research did not have an initial applied fate, his immediate projections led him to ground the idea that matter could store an "inexhaustible" amount of energy, which in turn could generate the possibility of a "white city," resplendent and

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[8] BELL, D.; *El advenimiento de la sociedad industrial*. Alianza, Madrid, 1994.

[9] SODDY, F.; "The interpretation of Radium", London: Murray, 3rd ed., 1912, p. 251, quoted in WEART, S.; *Nuclear Fear,* Cambridge, Harvard University Press, 1988, p. 5. See also, TRENN, T. J., *The Self-Splitting Atom: The History of the Rutherford-Soddy Collaboration,* Taylor & Francis, London, 1977.

brilliant. In short, even when the idea of a basic science is held for no predetermined purpose, society is intrinsically linked to scientific discoveries.

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But, as it is known, this example is incomplete. As recounted in biographies and histories of science, Rutherford's immediate reaction to the cry of "transmutation" was reprobation. But it did not happen the same when Soddy's fantasies projected that white city, even though it was an equally insecure hypothesis. It is not difficult to figure out the causes for the differences in Rutherford's reactions: transmutation refers to a passed form of "science", destined to sorcerers or alchemists; while urban fantasies were the order of the day in a world in frank process of industrial expansion. Electric power is the soul of an industrial society.

Here is something more subtle: society is not only meant to be a recipient of the potential benefits of science, not only has a passive character to scientific activity; It also creates a material and symbolic space for the development of scientific knowledge. Undoubtedly, there was no place for transmutation at the beginning of the twentieth century, but for the improbable fantasies of the white city of Soddy. And this option is possible because energy had become the "soul" of modern industrial societies. Not only would these discoveries have been possible 200 or 300 years earlier because of a lesser development of science, but they would have seemed untimely, incredible, out of place.

Society will use and take advantage from scientific findings. But it is also the space that gives them meaning.

* * *

About 80 years ago the Irish scientist John D. Bernal published a book whose title expressed a very particular concern: "The social function of science". In these pages he tried, among other things, to consolidate some new foundations on the question of the progress of science. He came to wonder about the uneven progress of scientific disciplines. He suspected that it was not just the genius of some thinkers or intellectuals in the ranks of one or another science; or of best application of this or that method, but there could be some other factor that would produce some speed changes in its histories. He was particularly interested in British scientific development, in a period starting at the beginning of the twentieth century and culminating in the publication of his book (1939).[10] There he detected that technological applications in heavy industry had grown markedly, and that strikingly other areas had stopped their glow. He also warned that it could show a correlation between these advances and setbacks, and unequal funding they had received from the British state some areas at the expense of other.

That there were a greater scientific-technological development in the area of heavy industry from the scientific knowledge produced as a consequence of a decision of the British state does not seem to propose greater difficulties of understanding. Technological applications in heavy industry had an obvious explanation: the production of warlike artifacts after the First World War.

But that the progress of knowledge had some relation to political and / or economic decisions was no longer something that could be readily accepted by scientists and philosophers of science. If scientific knowledge was "objective" could only be so because it self-regulates ie, sets its own laws of dynamics; and because it cannot depend on extra-scientific factors (moral, ideological, political or economic). Thus, if science develops, it can only be due to an advance in theories, in the tuning of hypotheses, or in certain uses of more advanced technologies. That is, always internal elements to science.

This particular assessment of scientific development takes on greater strength when analyzing the particular history of physics in the United Kingdom. Two important articles will be taken as an

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[10] BERNAL, John Desmond; *The social function of science*, London, Routledge, 1939.

example in which one tries to characterize the phenomenon of the professionalization of British physics. The following are the main conclusions of these works:

- The development of a career for a physicist became a very difficult task because “many were unable to do so because of a lack of employment opportunities and were obliged to spend an unacceptable length of time as junior university demonstrators, to take up careers in school teaching, or to leave physics”
- The members of The Physical Society, founded in the last quarter of the 19th century, “played an important role in the social organization of physics. But expressed no direct interest in the industrial application of physics”.
- In the same years, the foundation of a number of provincial university colleges provided a widespread interest in promoting higher education in science and technology. It had two related consequences: an increasing number of employment opportunities, and an increasing number of physicists.
- At the beginning of the 20th century the average salary for a physicist as a teacher was 4.5 times lower than that of a physics assistant teacher.
- The contributions made by science to the war effort not only helped change the public perception of the scientist but also stimulated self-awareness among scientists about their role in peace as in war.
- The title of "physicist" did not exist in the registry of public services, (only “chemical”). Only in 1939 does physics arise as a profession.

The symbolic and material recognition of physics as a science, through which a scientist can develop his or her career, that is, being a physicist, does not depend on the physical itself, but on the material conditions for its development. That is, social institutions give a value, again, material and symbolic major or minor to some scientific disciplines depending on a multiplicity of variables that exceed the very dynamics of science. That is why science here is also intrinsically linked to the fate of dynamics and social order.

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4- Towards a broader perspective of science

What is at the basis of this discussion is a critical epistemological statement of the positivist version of science: an "extended" perspective that allows to observe the insufficiencies of a Reichenbachian / Popperian perspective of scientific activity.
To the original idea of these authors of the order of scientific activity in contexts, which presents a context of discovery and another of justification, will propose a series of corrections that enable to think what has been argued previously.

a- For science to be possible, there must be scientists. The "production of scientists" is not the direct result of scientific activity. It is primarily the result of a series of political and economic decision by a state and / or private institutions. That is to say, the transformation of an individual into a scientist is due to the existence of universities, institutes, laboratories, decisions, all of which exceed the framework of scientific activity itself. It is therefore a "social decision" to call it somehow ambiguous and general. This phase can be called "context of education".

b- Techno-scientific innovations have a two-pronged position facing scientific knowledge. Throughout history is recognized countless inventions whose theoretical background is minimal. And at the same time, there are more and more technical innovations that produce theoretical changes, or at least are their facilitators. Biotechnology is a typical case of this. Techno-scientific developments therefore constitute this novelty, that is to say, the generation of new knowledge regardless of its origin.

c- Scientific knowledge is not only justified or validated through logic and scientific methodology. If it is accepted that there are not only processes of discovery, but also innovation processes of innovation, then it should be accepted that the evaluation of discoveries and innovations involve evaluation mechanisms that go beyond the logical-methodological justification. In this way, a new technology is validated or evaluated according to its feasibility, its applicability, its competitiveness in relation to alternative proposals, and in general according to its usefulness. A discovery / innovation, therefore, exceeds the "degree of truth" of its justification. This context can be denominated “valuation context”.

d- The technological application of knowledge, implies criteria that exceed validation through "it Works". Although this criterion can be considered the main criterion, others may be applied: economic profitability, social utility, cultural contextualization, among others. Scientific policy and management are fundamental here, whether public or private. The society itself introduces its criteria of acceptance of the techno-scientific activity, which is now subject to a global judgment, external to the scientific community.[11]

If these critical approaches to the positivist perspective of science are accepted, it is necessary to incorporate the idea that science, as a phenomenon broader than the capacity for correct application of a method, involves social relations, interactions between men and women, that exceed the traditional framework of the strictly scientific.
To think the phenomenon from this point of view promises, at the same time, to think problems not usually considered: What technological developments and for which purposes?; What processes does this decision take?; Who and in what way do they intervene? What kind of professionals are needed for the proper development of a particular nuclear plan?; What is a "worker"? Is a scientist a worker? What is the "environment"? In what way do citizens participate in nuclear activity? What does the population's distrust face the scientific knowledge of those who operate and regulate the different technologies imply? How to reconcile the claims of economic profitability (or sustainability), social benefit and scientific development? Ethical-political controversies that occur daily in the face of scientific and technological developments and which slip from the hands of a traditional perspective in nuclear science.
Just thinking about the idea of "not in my backyard", which can include assumptions like "I understand the arguments, but I do not want anyway" or "I understand the utility, in fact I use it, but I do not want it either" raises the emergence of paradoxes which escape the idea of the exclusivity of the scientific argument.
The Fukushima Daiichi accident called into question practical problems of enforcement of regulatory standards as well as technological problems. But it conclusively hit the treatment of institutional communication; shook the ways in which the Japanese “nuclear village” understood the place occupied by citizens in a city also inhabited by a nuclear facility; highlighted the problems in the link between regulatory entities and companies operating nuclear plants; made clear the problems that arise to the hierarchical structures before an emergency situation; posed the question of the legitimacy of projecting towards the future the continuity of nuclear-based power production; And also the role of social groups such as the so-called Yakuza[12].

[11] Tomo esta original perspectiva de ECHEVERRÍA, J.; *La filosofía de la Ciencia*, Akal, Madrid, 1995.
[12] Crf. KINGSTON, J.; “Japan’s Nuclear Village” in The Asian-Pacific Journal, Volume 10, Issue 37, Number 1, September 9, 2012. National Diet of Japan, The Fukushima Nuclear Accident Independent Investigation Commission, Official Report, 2012. HYMANS, J., “Veto Players, Nuclear Energy and Nonproliferation”, International Security, 36:2 (Fall 2011), pp. 154-189.

5- Conclusions

In short, a number of complex problems that cannot be addressed from the reduced field of some scientific discipline that knows only its object of study.
This series of issues are not specific to emergency situations, or a particular country, but at very different levels of severity, they are expressed through nuclear activity as a whole. Addressing these problems from an broader perspective of science, enables a more complex understanding and at the same time better adapted to the difficulties faced by nuclear activity.
For all these reasons it is proposed to reflect on the possibility of incorporating these epistemological principles of an expanded vision of the process of production of scientific knowledge in training programs in radiological protection, with the aim of training professionals to be increasingly attentive to the multiple challenges facing our societies in the 21st century.

Bibliography

- BELL, Daniel; *El advenimiento de la sociedad industrial*. Alianza, Madrid, 1994.
- BERNAL, John Desmond; *The social function of science*, London, Routledge, 1939.
- ECHEVERRÍA, J.; *La filosofía de la Ciencia*, Akal, Madrid, 1995
- GONZALEZ, Abel; “The Argentine Approach to Radiation Safety: its ethical basis”, Hindawi Publishing Corporation, *Science and Technology of Nuclear Installations*, Volume 2011, Article ID 910718.
- HYMANS, Jacques, “Veto Players, Nuclear Energy and Nonproliferation”, *International Security*, 36:2 (Fall 2011).
- KINGSTON, Jeff.; “Japan’s Nuclear Village”, *The Asian-Pacific Journal*, Vol. 10, Issue 37, Number 1, September 9, 2012.
- LECOURT, D., Pour une critique de l'épistémologie, Paris, Maspero, 1974.
- LINDELL, Bo; “Logic and ethics in radiation protection”, *Journal of Radiological Protection*, Vol 21, Number 4, 20 November 2001.
- MARI, E.; *Elementos de Epistemología comparada*, Puntosur, Buenos Aires, 1982.
- NATIONAL DIET OF JAPAN; *The Fukushima Nuclear Accident Independent Investigation Commission*, Official Report, 2012.
- REICHENBACH, Hans; *Experience and Prediction*, Chicago, University of Chicago Press, 1938.
- SOLINI, Giovanni; “Ethical issues in radiation protection—the 1992 Sievert Lecture”, *Health Physics*, vol. 63, no. 2, 1992.
- TAYLOR, Lauriston S.; “The philosophy underlying radiation protection,” *American Journal of Roentgenology*, vol. 77, no. 5, 1957;
  “Some nonscientific influences on radiation protection standards and practice. The 1980 Sievert lecture,” *Health Physics*, vol. 39, no. 6, 1980.
- TRENN, Thaddeus J., *The Self-Splitting Atom: The History of the Rutherford-Soddy Collaboration,* Taylor & Francis, London, 1977.
- VARSAVSKY, O.; *Ciencia, política y cientificismo*, CEAL, Buenos Aires, 1969.
- WEART, Spencer; *Nuclear Fear,* Cambridge, Harvard University Press, 1988.

ACHIEVEMENTS AND ONGOING ACTIONS RELATED TO THE 7FP ENETRAP III PROJECT

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ABSTRACT

Specifically for technologies that make use of ionising radiation, nuclear safety, assuring the protection of men and environment, is of utmost importance. The perceived growth of the use of radioactivity in different application fields such as medical, industrial, research and other sectors, requires an advanced understanding of radiation protection in order to protect workers, the public and the environment from the potential hazards of ionising radiation.

Within this perspective, maintaining a high level of competence in radiation protection, assuring suitable well-trained personnel and adequate knowledge management is crucial to ensure future safe use of ionising radiation and the development of new technologies in a safe way.

To this end, adequate high-level education and training (E&T) is crucial to prevent the decline in expertise and to ensure the availability of elevated radiation protection knowledge, skills and competences which can meet the future demands. In order to also contribute to a common high-level safety and radiation protection culture, the training policy and its implementation should have an international character, encourage lifelong learning and facilitate exchange of workers across national borders. ENETRAP III aims at developing several elements that contribute to the implementation of this approach, in line with the ECVET principles.

1. Introduction

The ENETRAP III project is designed to build further on the achievements of the previous two sister projects, and finalize the policy and implementation for E&T in radiation protection for RPE's and RPO's, in line with the Euratom Basic Safety Standards. It is the intention that ENETRAP III will develop aids for the implementation of a harmonized E&T structure, which could be especially useful for newcoming countries.

ENETRAP III adds new and innovative topics to existing E&T approaches in RP. It will further develop the European reference training scheme with additional specialized modules for Radiation Protection Experts working in medical, geological disposal and NPP. It will implement the ECVET principles and will establish targeted assistance from regulators that will play a crucial role in the endorsement of the proposed courses and learning objectives.

ENETRAP III will also introduce a train-the-trainer strategy. All organized pilot sessions will be open to young and more experienced students and professionals. In this way, ENETRAP III aims to contribute to increasing the attractiveness of nuclear careers and to lifelong learning activities.

A web-based platform containing all relevant information about E&T in RP will facilitate an efficient knowledge transfer and capacity building in Europe and beyond.

ENETRAP III will also propose guidance for implementing E&T for Radiation Protection Experts and Officers, hereby providing extremely important assistance to all Member States who are expected to transpose the Euratom BSS requirements into their national legislations. Moreover, ENETRAP III will demonstrate the practical feasibility of earlier developed concepts for mutual recognition and thus provide leading examples in Europe demonstrating effective borderless mobility.

For all these activities ENETRAP III will strongly connect with all stakeholders, i.e. end-users, E&T providers, legal authorities, and to other relevant international organizations, groups and networks dealing with E&T in radiation protection.

2. Results and achievements

In this paragraph an overview is given of the status of the work performed in the different Work Packages (WPs) of the project.

WP2 - Establish partnerships ensuring feedback from stakeholders

The objective of WP2 is (i) to closely involve regulatory authorities who are supposed to provide the legal framework for implementing roles and functions of RPE, RPO and MPE as well as the appropriate E&T requirements of the Euratom Basic Safety Standards in the development of the project work and the dissemination of ENETRAP III results, and (ii) to facilitate cooperation and exchange of information with technology and radiation research platforms, such as SNETP (nuclear safety), IGDTP (waste management) and MELODI (low dose research), and other associations and institutes, with respect to E&T. Such cooperation should help to ensure consistent and comparable approaches to radiation protection training activities.

In a first phase, when the project concentrated mainly on conception, close collaboration was set up with HERCA and EC DG ENERGY (specifically in the frame of WP7), EUTERP, EFOMP, the ENEN Association and the international organizations IRPA and IAEA.
In a second phase, which is more focused on implementation, other groups such as Art.31 Group of Experts and the European Platforms will be more involved.

Today, the strong liaison and collaborations with EUTERP, IRPA and IAEA and the involvement in the programme of this ETRAP conference organized by ENS, puts the ENETRAP III project and its result to the eye of the European and international stakeholders.

WP3 - Develop further specialized training modules for RPE and run pilot sessions

The objective of this WP is to further develop the ENETRAP reference training scheme for RPE and expand it with specialized modules that have not yet been developed before (these are modules for the RPE working in the medical area, in NPP and in geological disposal).

For each of the Specialised Module Learning Outcomes based on the Bloom taxonomy and comprising the ECVET approach have been developed. Course requirements and programmes have been defined. Required training materials have been prepared. The results have been reported (D 3.1).

Training venues and dates were fixed. In order to announce the training sessions, leaflets, both electronic and printed, have been distributed among appropriate national organizations and groups. Additionally, the pilot sessions were displayed on relevant internet platforms, including the ENETRAP III project website and the EUTERP website.

Building further on the courses organized in the frame of the prvious ENETRAP II project, following courses were organized in the frame of ENETRAP III:
1. A course designed for Radiation Protection Experts (RPEs) working in the medical field, consisting of an online phase as from September 2015 (using the IAEA CLP4NET Platform) and a face-to-face session July 4-8, 2016 (Budapest, Hungary). This course was very successful and will most likely be ran on a continuous basis beyond the project.
2. A course designed for Radiation Protection Experts (RPEs) working in geological nuclear disposal, consisting of a one week face-to-face session from January 16 until 20, 2017 (Karlsruhe, Germany).
3. A course designed for Radiation Protection Experts (RPEs) working in Nuclear Power Plants & Research reactors, consisting of a one week face-to-face session held in the same period from January 16 until 20, 2017 (Karlsruhe, Germany).

WP4 - Develop a train-the-trainer (TTT) strategy and organize a TTT training event

In addition to the training courses for RPEs and RPOs, it was also intedned to provide a training course for the trainers themselves.
It is the objective of this WP to develop a train-the-trainer strategy that will, along with other aspects, promote the ECVET concept. In this way ENETRAP III aims for a sustainable implementation of the most recent didactic methods in a harmonized way throughout current and future training courses in radiation protection (and other nuclear topics), facilitating good practices in training course development and implementation.

The intension of this TTT event is to increase the didactic skills of the participants (often being themselves RPEs or RPOs in charge of training), inform them about new tools both in the domain of didactics as well as in the domain of E&T policy (like the EC ECVET and EQF frameworks). It is not intended to update the scientific radiation protection competences of the participants. Therefore, this TTT will not only be relevant to trainers in radiation protection, but also to trainers in other nuclear domains such as nuclear engineering or the medical area.

Guest lecturers from outside the ENETRAP III consortium, such as an expert from JRC Petten/the EHRO-N observatory, have accepted to contribute for a practical workshop (specifically dealing with the implementation of the ECVET concept).

This training will alternate theoretical plus methodological contributions and real-life professional situations. This training is intended for professionals already involved in training. Indeed, alongside the technical competences also called "hard skills", human and relational qualities, "soft skills", are increasingly valued. These skills are oriented on the long term and help to predict the participant's ability to effectively integrate all knowledge taught and then, they can teach in return.

In this TTT course, there is the desire of training designers to offer a highly participatory training and thus trainees will be highly attracted and involved in the training process through tailored sequences.
Each sequence is described in a document, incorporating objectives, learning outcomes, descriptors such as knowledge, skills and attitude, and finally assessment methods.

One session of this course, in French, was already organized from February 13 until 17, 2017 at the INSTN in Saclay (France) and an English session is planned June 26 - 30, 2017 on the same venue.

WP5 – Dissemination of project results and contribution to a website for capacity building and transfer of know-how relevant to radiation protection E&T

The WP5 commitment is the dissemination of the activities and results of the series of ENETRAP projects, via project events and a website, in order to bring together the information that is currently spread over several websites and other carriers, and to promote the EUTERP community improving the EUTERP website to become a capacity building and transfer of know-how in radiation protection tool. In addition, a database will be developed, easy to use and with a strong search engine, where all stakeholders can find all relevant information regarding E&T courses and other opportunities in radiation protection in Europe (and beyond).
Capacity building is a strategy based on a consensus on common needs, the vision and instruments for research and training in RP matters to create and transfer knowledge and to develop skills and competencies of the individuals, organizations and countries, to protect workers, the public and the environment from the potential risks of ionizing radiation, today and in the future. It is supported mainly in 4 pillars: Education and training, Knowledge management and preservation, Knowledge networks and Human resources mobility.
Having in mind the above concepts, a detailed study of the results of previous ENETRAP-projects results and an analysis of the structure of different platforms of transparency delivering a CB strategy, has led to a proposal of website structure, requisites and functional analysis as reported in the first WP5 deliverable.
It is envisaged that the implementation of the ENETRAP III database will be performed mid 2017, and be available by the end of 2017 via the EUTERP website to all relevant stakeholders.
The database is is available to other groups for customized use.

WP6 - Testing of methodologies for RPE recognition and mutual recognition in practice

The task in WP 6 is to test the methodologies proposed within the guidance developed under Work Package 7 for the professional development of Radiation Protection Experts and the subsequent recognition of RPEs by the national Competent Authority. The primary objectives with this testing is primarily to refine and validate the proposed methodologies and to promote their acceptance within Member States. A supplementary objective is to demonstrate a European registration system for RPEs.

This work package spans the full duration of the ENETRAP III project and is still in full progress.

WP7 - Writing of guidance to support the implementation of E&T requirements for RPE and RPO as defined in the Euratom BSS

The objective of WP7 activities is to facilitate the implementation of the new requirements for RPE and RPO in EU Member States and to help ensuring a consistent approach throughout the European Union.
The Euratom BSS Directive lays down specific requirements for the Radiation Protection Expert (RPE) and for the Radiation Protection Officer (RPO) which have to be transposed by each Member State into national legislation and implemented in practice. Experience has shown that, even though the specific requirements in a European Directive may be quite clear, there can be widely varying approaches to the interpretation of those requirements and implementation in practice.

It is considered that the availability of clear and substantive guidance on how the new requirements for RPE and RPO would be best implemented in Member States would be of value, not only in facilitating the implementation of the requirements across Europe, but in helping to ensure a consistent approach.

Within the framework of ENETRAP III WP7 a guidance document “European Guidance on the Implementation of the Requirements of the Euratom BSS with respect to the Radiation Protection Expert and the Radiation Protection Officer” has been developed and made availbale on the ENETRAP III and EUTERP website.
In this guidance document all key issues for RPE and RPO are addressed:

- adoption of requirements into legislation;
- intended roles/functions/duties of RPE and RPO;
- required infrastructures and mechanism for recognition (RPE);
- suitability and competence requirements (RPE and RPO);
- appropriate education and training.

The guidance proposed complements the guidance being developed in the medical field by facilitating the implementation of the new requirements for RPE and RPO in Member States and helps to ensure a consistent approach throughout the European Union.

The guidelines were also transferred to the Art.31 Group of Experts for comments (outside of the project objectives). These comments were recently received and integrated in an updated version of the document, which is published on the EUTERP website.

3. Conclusions

The project started in June 2014 and is foreseen to end 31 May 2018. The largest part of the objectives and pre-described actions are already met at this stage. In the coming year the project will concentrate on further developments in the frame of WP6 and on summarizing all results achieved and making them available in a sustainable way (via website and database) to the radiation protection E&T community.
With these achievements, ENETRAP III aims to increase the radiation protection and safety culture at the European level and beyond. It has also put forward the vast amount of advanced expertise available in Europe in the field of radiation protection E&T development and implementation.

THE IRPA GUIDANCE ON CERTIFICATION OF A RADIATION PROTECTION EXPERT

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ABSTRACT

One of the major goals of the International Radiation Protection Association (IRPA) is ‘to promote excellence in radiation protection professionals’. In line with this goal, many of IRPA’s Associate Societies (AS) are actively involved in schemes which assess and certify the competence of individual radiation protection practitioners to undertake safety-related work. There is also a growing pressure, largely from a regulatory perspective, to enhance this approach, and several AS are considering introducing such schemes in the future. The move towards a more formalised approach to the certification of radiation protection expertise is evidenced through the most recent updates of both the IAEA and the European Basic Safety Standards. Both place great emphasis on the appointment of a professional-level person having the knowledge, skills and competences through training and experience needed to give radiation protection advice in order to ensure the effective protection of individuals, and whose competence in this respect is recognised by the competent authority. Sensitive to this need, IRPA created a Working Group to develop a guidance document on the development and implementation of a certification process for a Radiation Protection Expert (RPE), which was finally published in 2016.
Key attributes discussed in the Guidance document are: the certification scheme management and governance; the scope of the role to be certified; the main requirements for certification of an RPE in terms of knowledge and skills, minimum educational and experience requirements, competences to be assessed and assessment methods; renewals of certifications and continued professional development for a period of years; code of conduct consistent with the IRPA Code of Conduct; appeals, disciplinary aspects or withdrawal of certification; insurance cover; accreditation of the program by an appropriate accrediting organization; and reciprocity to RPEs certified in another scheme. The document is complemented by several annexes containing the relevant aspects of the IAEA and EU Basic Safety Standards; the IRPA Definition of RPE; a model of RPE knowledge and skills syllabus; the RPE training scheme from the ENETRAP projects; the IRPA Code of Practice; some accreditation standards for certification boards and several examples of certification schemes from up to ten countries provided by their respective AS.

1. Introduction

One of the major goals of the International Radiation Protection Association (IRPA) is ‘to promote excellence in radiation protection professionals’. It is essential that radiation protection practitioners at all levels are appropriately equipped in terms of knowledge, skills, competences, and experience to discharge their responsibilities and ensure safety.
In line with this goal, in October 2011 IRPA created a Working Group (see table 1) with the objectives of: (1) reviewing the various certification processes being used by the IRPA’s Associate Societies (AS) and their respective countries and (2) developing a draft document of guiding principles for the development and implementation of such a certification process. The guidance document would be applicable internationally and useful to IRPA AS that would like to initiate such a certification process or improve an existing process in their countries.
The work was done mainly by e-mail, with only meeting during the IRPA Regional European Congress in June 2014. After a fist draft document, mainly based on UK, USA and Canadian certification schemes, it was decided to get input from a larger base, and all AS were asked to participate in a survey in 2014, with 36 replies received. After reviewing the survey conclusions, a second draft document was prepared and distributed for comments; it was presented and discussed at the IRPA International Congress in Cape Town (May 2016) and the final IRPA Guidance on Certification of a Radiation Protection Expert [1] (see fig. 1) was released after endorsement by the IRPA Executive Council in November 2016.

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Table 1. Members of the IRPA Working Group on Certification

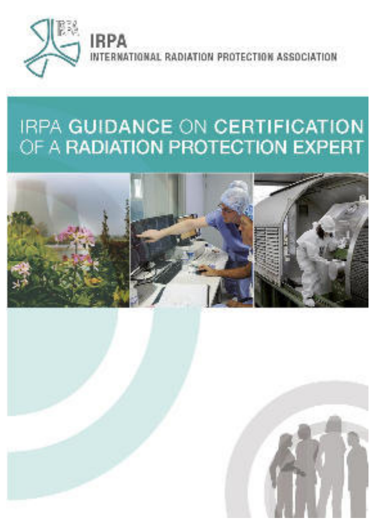

Fig. 1. Cover page of the IRPA Guidance on Certification of a Radiation Protection Expert [1]

Experience has shown that there is no common, unique 'best practice' approach to the certification of expertise. Existing schemes differ in many dimensions –for example in scope of application, knowledge and experience requirements and assessment methods– in part due to the need for alignment with national regulatory requirements and also due to established regional/national practices. The objective of the IRPA Guidance is not to offer a single template of how to establish a certification scheme, but rather to explore and describe the different options and approaches, to identify their respective strengths and weaknesses, and to outline the key considerations which must be taken into account when introducing and establishing such schemes.

In the following sections, an overview of the main aspects of the IRPA Guidance document [1] is included, following the same scheme of the document.

2. Underpinning basis of a certification scheme

Historically, many certification schemes have been established on the responsibility of the profession itself, through an AS acting as a professional body recognising the need to ensure and protect professional standards in radiation protection. This has also served to provide a service to employers to help give them the confidence that key employees have been judged by their peers as having appropriate knowledge, skills, competences and experience to undertake safety-related tasks.

In some cases, such schemes have directly supported a regulatory requirement for employers to have competent employees nominated for specific key roles. This has often involved employers having to provide the regulator with the name of specific employees covering identified roles, following which the regulator has the option of refusing to accept such a nomination if it sees fit. Schemes for the certification of competence operated by AS (and other parties) on a voluntary basis have made a great contribution to giving both employers and regulators confidence in the qualities of individual practitioners.

However, increasingly there is a trend (as outlined in the next section) for a more formal approach to certification, whereby the regulatory body is required to ensure that persons undertaking specific key radiation safety roles have been assessed and certified as competent by an approved scheme. Such an approved scheme could either be directly under the control of the regulatory body, or operated by a non-governmental organization, such as an AS, under an approval from the regulatory body. The advent of this trend and direction is leading to many AS considering the need to develop such a certification scheme, and hence the timeliness of this IRPA Guidance.

3. The international regulatory background

The move towards a more formalised approach to the certification of radiation protection expertise is evidenced through the most recent editions of both the IAEA Basic Safety Standards [2] and the European Basic Safety Standards [3]. Both place great emphasis on the appointment of a professional-level person having the knowledge, skills and competences through training and experience needed to give radiation protection advice in order to ensure the effective protection of individuals, and whose competence in this respect is recognised by the competent authority. Under the IAEA BSS this role is termed a **Qualified Expert** (QE), and the EU BSS uses the term **Radiation Protection Expert** (RPE).

This role has been recognised for many years within the profession as a key role for ensuring radiation safety. In 2008 IRPA proposed to the International Labour Organisation (ILO) that the role of RPE be formally registered under the ILO system for the International Standard Classification of Occupations (ISCO). This was agreed, with the RPE being registered within the group of Environmental and Occupational Health and Hygiene Professionals [4].

Under both the IAEA and the EU BSS there is a requirement for regulatory bodies to have a system for the formal recognition of the competence of the QE/RPE. This is a new requirement for the IAEA BSS, although the previous EU BSS [5] had a similar provision which was newly introduced at that time. In practice, the rigour of application of this requirement by regulatory bodies has increased over time, moving from 'passive acceptance'

of nominations (e.g. refusing appointments by exception) towards the requirement for formal certification schemes.
Both the IAEA BSS [2] and the EU BSS [3] also require the appointment of a **Radiation Protection Officer** (RPO), who is technically competent in radiation protection matters to oversee, supervise or perform the implementation of the radiation protection arrangements. The BSS do not require any formal scheme for the recognition of competence for this role, although of course this is an option for national authorities or indeed for professional bodies such as the AS to pursue if they so choose.
Given the above international background, the prime focus for the formal recognition of competence within radiation protection is the professional role outlined above as QE/RPE. This role is the principal focus of the Guidance Document [1], in **which the term 'Radiation Protection Expert' (RPE) is used with a generic meaning**. Although it is possible, but much less common, to apply certification schemes to the different role of Radiation Protection Officer (RPO), this is not covered in any detail in the Guidance Document.

4. Key attributes of an RPE certification scheme

4.1 Scheme Management and Governance

An RPE Certification Scheme should be established as a specific legal entity. This could be as part of an AS, thereby using the AS as the established parent organisation, or as a separate body. The mechanism of appointing to the controlling Board of the scheme must be clear, as should be the scope of authority of that Board. The scheme must have formally defined procedures for applications, assessment and all related issues, including the appointment of assessors. In most schemes, assessors are volunteers who are themselves certified RPEs whose competence and experience is widely regarded by their peers.
When initially establishing a scheme it will not be possible to appoint persons who are already certified, but the first appointed assessors must be persons who are regarded as leaders in their field and who are widely respected by their peers. The requirement for fees covering application, renewal and annual registration (if appropriate) must be clearly defined.

4.2 Scope of the role to be certified

The first step in developing a scheme is to have a clear understanding and definition of the scope of the role being considered. There is much variation in current certification schemes, and the nature of the scope of the role is one of the key reasons for differences.

4.2.1 Radiation Protection Expert (RPE)

It is essential that the scope of the role to be covered aligns with any regulatory requirements, where they exist. If the scheme requires regulatory approval, it is quite likely that the regulator will have published requirements or guidance which the scheme must take into account. Where the scheme is voluntary, whether or not it indirectly supports a regulatory requirement for competent employees, it is good practice to discuss the development of the scheme with relevant regulatory bodies.
There are many approaches to the certification of RPEs, but in the main they can be considered in two categories as follows.

(a) Generic RPE Certification
(b) RPE Certification differentiated by Field of Application

Several existing certification schemes are based around giving certification limited to specific fields of application, for example: sealed sources, medical applications, nuclear power plants, other nuclear facilities, etc. Most such schemes recognise that there is a common core of knowledge, skills, competences and experience across all fields, but in this approach the assessment can focus on practical application in the specific field. Some schemes acknowledge that some fields are less complex and require less knowledge, skills, competences and experience than others – an example of a proportionate, graded approach to certification. The fields of application can even be grouped together and graded, for example as Level 1 to Level 4 as the complexity of the role increases. The output from such schemes would take the form of a certificate clearly stating the field of application or the level of competence endorsed.

If the generic approach is adopted, there is a need to be able to ensure that a certified RPE is appropriate for a given practical situation. At a first level it seems that the generic scheme is simpler and may be more appropriate for those AS beginning their consideration of certification, especially for smaller societies and for countries with a limited range of applications. However, the importance of ensuring the 'suitability' of RPEs for their specific role must be addressed within the overall national framework.

4.2.2 Certification for other roles

Certification processes can be applied to roles in radiation protection other than that of the RPE. This would depend on the relevant legal requirements and on the perceived demand from professionals within the country. Options could include specialist roles at a professional level which support the work of the RPE, such as shielding assessor, criticality assessor, internal dosimetry specialist, instrumentation specialist, environmental modelling and assessment specialist. These roles could be regarded as 'narrow but deep', in the sense that there is a need for very specific technical knowledge, skills, competences and experience within a well-defined but relatively narrow field.

Certification could also be applied to the role of Radiation Protection Officer (RPO), especially if the regulatory body supports this approach.

The field of non-ionising radiation usually has a completely separate regulatory basis to ionising radiation, and the detailed nature of the hazards and controls is also different. However, the same issues regarding competence in advisers are relevant here, and there is also a growing regulatory interest in this approach. Therefore, schemes can be established on either a voluntary basis or, where there is clear regulatory role, a scheme could operate under regulatory approval.

For any such schemes, it would be necessary to apply the same approach and principles outlined in the Guidance.

4.3 Requirements for certification as an RPE

The objective is to ensure that there is a clear specification of the requirements so that a candidate knows what must be demonstrated to achieve certification, and that assessors have clear guidance on what is the acceptable standard. The requirements must take account of regulatory provisions and guidance, where these exist. Where the scheme is differentiated by field of application, then the requirements must be focused around each specified field, although it is likely that many basic requirements will be common across all fields.

There are four principal components to the requirements for certification – Knowledge, Skills, Competences and Experience.

4.3.1 Knowledge and skills

The first aspect to be considered is educational attainment. The RPE role is regarded as a college graduate-level appointment and profession, and as such a normal requirement would be a college degree, usually in science or engineering, including specialized fields such as radiation protection, medical physics or industrial hygiene. According to national approaches, this would normally be a three or four year degree course. Some current schemes may require a Master's or other postgraduate degree, and some may require specific radiation protection content. However, the intent of these additional requirements may alternatively be met by requirements for demonstrated knowledge and/or experience as below.

Whilst a college degree would be a normal requirement, it is important to consider whether to provide a route for non-graduates to achieve certification. If non-graduates are allowed to achieve certification, there needs to be compensatory measures identified, usually including enhanced experience requirements and demonstrated learning via other routes.

All schemes should have detailed requirements for radiation protection knowledge and skills. These would cover underpinning science, radiation protection philosophy and principles, management, organisation and practical application techniques and knowledge and skills of

applicable legislation and guidance. It can be helpful to specify the level of knowledge required, for example in terms of general awareness, basic understanding and detailed understanding. This allows the assessment process to be prioritised and graded.
One option is to specify specific examinable courses which must be attended and assessed. However, such courses do not always exist, and the approach may be unnecessarily restrictive given the alternative approach of a specified syllabus.

4.3.2 Competence

All certification schemes are ultimately aimed at ensuring that a successful candidate is able to act independently in all relevant practical situations and give authoritative and effective advice. Whilst this clearly requires a necessary level of knowledge and skills, as discussed above, there is also a need to be able to have confidence that the candidate is capable of applying this knowledge, skills and experience in real practical situations, making appropriate judgements, and that he/she can communicate effectively with, and influence, the organisation.
As such, providing evidence of examined courses covering the knowledge and skills requirement, plus evidence of working for a period of time in a relevant facility, is not in itself evidence of the capability to act in an independent and effective manner. This aspect of performance is often termed 'competence to act', or simply 'competence', and implies a step further than just knowledge, skills and experience. Assessment of competence is not straightforward, and is discussed in the next section, but this dimension is increasingly recognised by both regulators and professions as being a fundamental requirement. As an example, it is noted that both sets of BSS [2, 3] refer to 'competence' repeatedly, and the term is becoming increasingly common in national regulations.

4.3.3 Experience

It is self-evident that candidates for certification as an RPE must have relevant practical experience in at least the type of activities relevant to the role. A review of experience requirements within existing schemes shows a range from two to six years, and it is considered here that relevant experience over at least a three to five (3-5) year period would usually be acceptable. There is an interaction between length of experience and the type (or level) of experience. Where a significant part of the experience is of a limited or lower level nature, then longer time periods may be necessary. Because many years of the same experience does not necessarily add significantly to learning and competence, the candidate for certification should show progressively higher levels complexity over the experience period.
It would be possible to specify minimum timescales for experience which would be an absolute requirement for successful certification. Alternatively, the statement of experience requirement could be a guide as to how long it would take a good candidate to assemble the necessary evidence in order to satisfy the assessment regime of the necessary competence across all required areas.

4.4 **Assessment methods**

The certification scheme must define the processes for the assessments of candidates. Firstly, this would require a clear identification of what the candidate must submit, including whether there is a need for the candidate to attend for a written examination or interview. The process would also usually involve the engagement of at least two assessors from its Assessment Panel (or equivalent), chosen to have experience relevant to the candidate's field, who would be responsible for reviewing the candidate's overall submission.
Assessment processes can be considered against each of the four components identified in section 4.3 above.

4.4.1 Assessment of knowledge and skills

Educational attainment can be assessed by the provision of certificated evidence, for example degree certificates. There are several options for assessing radiation protection knowledge and skills:

- The most direct assessment route is a requirement to attend for a specific written examination. This approach results in a clear assessment of the candidate's knowledge and skills, although care must be taken in assembling the question set to ensure that the required range of knowledge and skills are tested, and that the 'pass' level is appropriately set. The approach is potentially quite resource-intensive in terms of examination development and marking.
- Candidates are asked to provide evidence of satisfactory completion of courses, which cumulatively cover the required scope of knowledge and skills. Ideally these courses would be examined, and where this is not the case some additional method of gaining confidence that the candidate has assimilated the knowledge and skills should be considered (see below).
  - Course content should be assessed and the course approved by the certifying organization or other cognizant authority preferably prior to submission as evidence of knowledge and skills.
  - The required scope of knowledge and skills should be defined.
- Candidates are asked to submit transcripts of their college education.

These approaches can be replaced or supplemented by the assessment of competence discussed below.

4.4.2 Assessment of Competence

This is perhaps the most challenging aspect of assessment, and there is a wide variation of approaches in existing certification schemes.

- Written examinations can be designed to make the applicant demonstrate their approach to specific practical situations. This extends the assessment of knowledge and skills towards the notion of competence.
- Testimonials from line managers/supervisors, and/or, certified RPEs familiar with the candidate's work performance can provide a third party view on competence to perform the role in real life situations.
- A requirement to submit a portfolio of evidence, taken from the practical work experience of the candidate, to demonstrate competence against each of the fundamental requirements of the scheme.
- A requirement to undertake an interview with a panel of assessors, who would directly explore the ability of the candidate to apply knowledge, skills and experience to practical situations.

There are clear advantages and disadvantages of each method and a combination of these assessment methods may also be used.

A written examination can be very objective, but it requires significant effort to develop and grade the questions. Testimonials can be very subjective and should not be used alone to determine competence. There is a considerable time commitment for the panellists to conduct thorough reviews of the candidates' background and to conduct in-depth interviews of the candidates. There is the very real possibility to introduce bias (social, political, personal) into the approval process. Traveling to the interview site may be difficult for geographically large countries or where the transportation infrastructure is not well developed.

4.4.3 Assessment of Experience

Every candidate must submit a comprehensive work history detailing relevant experience. The experience statement should be verified by an independent person, for example the employer, line manager of referee.

This should aim to provide a good picture of the length, depth and scope of each period of experience. A more detailed approach would be to require the candidate to provide a link from each section of experience to the detailed scope of requirements.

If the individual's responsibilities (and thus their experience) are specified by regulation based on their title/position (e.g., the RPE in an EU country), then evidence of holding this position could be used to demonstrate relevant experience.

4.5 Renewals

Most Certification Schemes have a renewal system, with a time-limited Certificate. Most re-certification processes are less onerous on the applicant than the original process. Options include:

- Requirement to demonstrate Continuing Professional Development for a period of years, on the order of 5, to show that the certificate holder has kept up-to-date their competence in appropriate legislation and technological advances in Radiation Protection.
- Requirement to state to the Assessing Body that appropriate Continuing Professional Development is being undertaken. A random sample of renewals is then audited.
- Re-assessment of competence – usually applied if the Certificate expires or the certificate holder fails an alternative renewal process.

4.6 Code of Conduct

Certificated RPEs must follow a Code of Conduct, linked to the IRPA Code of Ethics [7]. Particular emphasis should be given to the requirement that RPEs should not undertake professional obligations that they are not qualified, or do not believe themselves to be competent, to carry out (see section 4.2.1 above).

4.7 Appeals, Disciplinary Aspects, Withdrawal of Certification, Insurance Cover

Processes within the certification scheme should define mechanisms for candidates to appeal against decisions made by the scheme.

The possibility of disciplinary proceedings against certificated RPEs, including the withdrawal of a certificate, should be considered in the procedures, for example where there is a *prima facia* case that an RPE has not acted in accordance with the Code of Conduct or has repeatedly given inappropriate advice.

Consideration should also be given to the possibility of arranging insurance cover to protect the scheme from the costs of potential litigation.

4.8 Accreditation

Consideration should be given to review of the scheme by a third party accrediting organization. In an annex, the Guidance provides example accreditation standards in different countries. These standards also provide additional considerations albeit not specific to RPE certification.

4.9 Reciprocity

The scheme should take into consideration the RPE certification attained in another scheme, for example, attained in another nation or AS.

5. Conclusions

As noted above, there is an increasing need for certification schemes to meet both regulatory and professional expectations for the demonstration of expertise in radiation safety. Experience has shown that there is no common, unique 'best practice' approach to such certification. Existing schemes differ in many dimensions, for example in scope of application, knowledge, skills, competences and experience requirements and assessment methods. The objective of this IRPA Guidance Document is not to offer a single template of how to establish a certification scheme, but rather to explore and describe the different options and approaches, to identify their respective strengths and weaknesses, and to outline the key considerations which must be taken into account when introducing and establishing such schemes.

6. References

[1] IRPA Guidance on Certification of a Radiation Protection Expert. November 2016. (Available at the website: www.irpa.net).

[2] International Atomic Energy Agency, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards. IAEA Safety Standards Series GSR Part 3, IAEA, Vienna, 2014.

[3] Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. Official Journal of the European Union L13/1 of 17.01.2104.
[4] International Labour Organisation. International Standard Classification of Occupations (ISCO-08). ILO, Geneva, 2012.
[5] Council Directive 96/29/Euratom of 13 May 1996, laying down basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation. Official Journal of the European Union L/159 of 29.06.1996.
[6] European Commission. Learning Opportunities and Qualifications in Europe. Descriptors defining levels in the European Qualifications Framework (EQF). Available at https://ec.europa.eu/ploteus/content/descriptors-page. (as accessed in May 2017).
[7] IRPA Code of Ethics. Document IRPA11/GA/4. 2004 (Available at the website: www.irpa.net).

IMPLEMENTATION OF THE RADIATION PROTECTION EXPERT AND RADIATION PROTECTION OFFICER FROM THE EUROPEAN BASIC SAFETY STANDARDS IN THE NETHERLANDS

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ABSTRACT

In the new European basic safety standards the roles and responsibilities of the national services and experts involved in radiation protection are clarified. Moreover, a clear distinction has been made between the different roles and responsibilities of these experts and services. The radiation protection expert and the radiation protection officer have been introduced in the European basic safety standards for this purpose. A comparison of the roles and responsibilities of the radiation protection expert and radiation protection officer laid down in the basic safety standards with those laid down in the Dutch Radiation Protection Decree for the Dutch experts reveals that they (partially) overlap. In the Dutch legislation three types of experts are recognized: the “general coordinating expert”, the “coordinating expert” and the “supervisory expert”. The Dutch coordinating expert is highly comparable with the radiation protection expert from the basic safety standards. The general coordinating expert has additional tasks. The implementation of the RPE in the Dutch radiation protection system is well advanced as shown by the learning outcomes and registration requirements for the (general) coordinating expert laid down in Dutch legislation. The Dutch supervisory expert is partially comparable with the radiation protection officer from the basic safety standards. However, the technical competence relevant for a given type of practice that is demanded in the basic safety standards for the radiation protection expert as well as the radiation protection officer is lacking at this moment. To comply herewith, the Dutch system of radiation protection needs to be modified. A first step towards modification is the development of application specific training for the supervisory expert, which will be renamed into supervisory officer radiation protection in our new decree. At this moment the branches are drafting learning outcomes for the new application specific training for the supervisory officer radiation protection in collaboration with the trainers. This is done for nine specific applications namely: 1) medical applications, 2) dentistry, 3) veterinary applications, 4) nuclear fuel cycles, 5) open sources, 6) NORM, 7) accelerators, 8) industrial radiography (including non-destructive testing, NDT and exploration research), 9) gauging techniques.

Introduction

In the new European basic safety standards (2013/59/Euratom; BSS) [EUR14] the roles and responsibilities of the national services and experts involved in radiation protection are clarified. In addition, a clear distinction has been made between the different roles and responsibilities of the services and experts without precluding that national frameworks allow the grouping of responsibilities or allow the assignment of responsibilities for specific technical and practical tasks in radiation protection to specified experts. For this purpose the radiation protection expert (RPE) and the radiation protection officer (RPO) have been introduced in this directive. Thereby implementing the suggestions of European training and education in radiation protection foundation (EUTERP) [EUT08] and of the article 31 Group of Experts to split the radiation protection expertise in an expert that gives competent advice in order to ensure the effective protection of individuals and an expert that supervises the practises and supervises or performs the implementation of the radiation protection arrangements. A comparison of the roles and responsibilities of the radiation protection expert and radiation protection officer laid down in the basic safety standards with those laid down in the Dutch Radiation Protection Decree for the Dutch experts is described in this article.

Radiation Protection Officer (RPO)

The Radiation Protection Officer (RPO) is according to the directive, an individual who is technically competent in radiation protection matters relevant for a given type of practice to supervise or perform the implementation of the radiation protection arrangements. In the Dutch Radiation Protection Decree the “supervisory expert” is described as the expert that carries out a practise, or alternatively that a practise is carried out under supervision of the supervisory expert. A comparison with the tasks and responsibilities of the RPO of the directive reveals that the supervisory expert is partially compliant with the RPO. However, the technical competence relevant for a given type of practice that is demanded in the directive for the RPO is currently lacking in the Dutch legislation.

The role of the RPO is always similar, mainly supervising the work with ionizing radiation. The tasks and the responsibilities of the RPO, on the other hand, are depending on the application and its accompanying risk. The RPO must therefore possess a combination of technical competence and supervisory skills. To comply herewith, the Dutch system of radiation protection experts needs to be modified. A first step towards modification is the development of application specific training for the supervisory expert, which will be renamed into “supervisory officer radiation protection” in our new decree.

Application specific training for the Dutch RPO

At this moment the branches are drafting learning outcomes for the new application specific training for the supervisory officer radiation protection in collaboration with the trainers. This is done for nine specific applications namely: 1) medical applications, 2) dentistry, 3) veterinary applications, 4) nuclear fuel cycles, 5) open sources, 6) NORM, 7) accelerators, 8) industrial radiography (including non-destructive testing, NDT and exploration research), 9) gauging techniques. Each application specific training will consist of a basal module with both technical and supervisory elements followed by an additional module consisting of application-specific technical and supervisory elements as depicted in the Table below.

Table adapted Dutch educational system supervisory officer radiation protection (RPO)

Specialisation	EQF level	Topics basal	Topics additional
		Technical • Radiation physics and interaction with matter, dosimetry and detection, risks and effects **Supervisory** • General role and duties RPO, legislation, dose limits etc.	**Technical** • Technical knowledge, operation and maintenance, specific risks, shielding, measurement, storage, packing and transport, waste and discharges. **Supervisory** • Specific tasks RPO, specific legislation, licenses/reports, incidents,supervising.
medical applications	5/6	B5/6	MA
dentistry	4/5	B5	DE
veterinary applications	4/5	B5	VET
nuclear fuel cycles	6/7	B7	NFC
open sources	6	B6	OS
NORM industry	4/6	B6	NO
accelerators	4	B4	ACC
industrial radiography	5	B5	IR
gauging techniques	4	B4	GT

For each application specific training the learning outcomes will be incorporated in the Dutch Ministerial Rule basic safety standards radiation protection.

Radiation Protection Expert (RPE)

The Radiation Protection Expert (RPE) is according to the BSS directive an individual or, if provided for in the national legislation, a group of individuals having the knowledge, training and experience needed to give radiation protection advice in order to ensure the effective protection of individuals, and whose competence in this respect is recognised by the competent authority. According to article 14 of the directive the training of the RPE needs to be in relation to the type of practice. In the Dutch legislation two types of experts are recognized: the “general coordinating expert” and the “coordinating expert”. According to the Dutch Radiation Protection Decree the coordinating expert ensures that practises with ionising radiation are performed within the legal framework. The coordinating expert must receive a radiation protection training from an accredited institution and must be registered in a special register. The general coordinating expert has additional tasks such as granting internal permission for practises. The Dutch coordinating expert is therefore highly comparable with the radiation protection expert from the basic safety standards. The general coordinating expert has additional tasks. The implementation of the RPE in the Dutch radiation protection system is well advanced as shown by the learning outcomes and registration requirements for the (general) coordinating expert laid down in Dutch legislation. However, the training of the (general) coordinating expert is currently broad and is deemed suitable for all applications. The technical competence relevant for a given type of practice that is demanded in the basic safety standards for the radiation protection expert is currently lacking. The (general) coordinating expert will be renamed radiation protection expert in our new decree. The Dutch education and training program for the radiation protection expert will therefore be adapted in the (near) future to become practise specific. The link with the radiation risk of the practise will also be taken into account to be able to also apply the graded approach in radiation protection knowledge.

Literature

[Eur14]

Euratom. Council directive 2013/59/EURATOM of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation. Published 17 January 2014.

[EUT08]

EUTERP. EUTERP Newsletter no.5, www.EUTERP.eu, December 2008.

VIRTUAL REALTITY EXPERIMENTS (VREs): A NEW APPROACH IN TEACHING RADIATION PROTECTION BASICS

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ABSTRACT

This contribution presents a Virtual Reality Experiment (VRE) to determine the half-life of Ba-137m.

At Johannes Gutenberg University of Mainz, Germany, the concept of Virtual Reality Experiments (VREs) was developed to enhance possibilities for performing experiments in education and training since 2011. The VRE concept enables users to simulate problematic experiments by offering a very realistic look and feel. The software uses potentials of modern teaching media and stimulates their use.

The VRE presented in this contribution simulates the decay of Ba-137m by using a Cs-137 mini-generator. This experiment had been available as a real-life set-up in many German secondary schools before 2001. The VRE enables students to conduct the complete experiment including the handling of the radioactive eluate and the determination of the half-life of Ba-137m by measuring the count rate with a Geiger-Müller tube. Additionally, basic RP-measurements like wearing gloves have to be considered. After performing the experiment, an evaluation gives feedback to the user. The German-Swiss Association for Radiation Protection ("Fachverband für Strahlenschutz") supported the development of this VRE.

1. Introduction on VREs

Performing experiments plays a major role in scientific research as well as in science teaching. Experiments offer the potential to motivate students and enable personal experiences in the process of scientific discoveries. However, numerous experiments, especially in the field of radioactivity, are no longer performed in classes of secondary schools due to restrictions concerning the handling of radioactive sources.

Nowadays, modern media devices, e. g. tablets and smartphones, are regularly used by adults, children and adolescents in everyday life. Apart from that, primary and secondary schools in many countries have recently been provided with modern teaching media such as interactive whiteboards. However, the hardware available is often still not used frequently or in an efficient way because of a lack of convincing software.

With an interactive whiteboard, the VRE software can be used like a demonstration experiment in front of the class. It can be either performed by the teacher himself or by some students. Furthermore, the interactive board allows to perform experiments in group work or learning cycles. Students can even perform experiments individually or in small groups given a sufficient amount of devices to run VREs, e. g. tablets, notebooks or PCs

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in a computer pool. In this case, the number of parallel running Virtual Reality Experiments is only limited by the accessible number of hardware devices. This is a significant improvement in comparison with the real advanced experiments, which most often cannot be performed simultaneously. Moreover, tablets and notebooks enable students to “take their experiment home” or even fully perform it as homework.

2. A VRE to determine the half live of Ba-137m

The definition of the half-life of radioactive material is a very basic concept to describe the radioactive decay and has to be taught in schools according to the curricular guidelines. But only few real experiments to demonstrate the decay of radioactive material are still available in secondary schools in Germany. Therefore, experts at the Johannes Gutenberg University of Mainz, supported by the German-Swiss-Association for Radiation Protection (“Fachverband für Strahlenschutz”), developed a VRE to determine the half-life of Ba-137m. The experiment chosen for the VRE had been available as a real set-up experiment in Germany until 2001. After 2001 the type-approval expired with the consequence that the use of this experiment without a licence according to the Radiation Protection Ordinance [1] was not allowed in secondary schools anymore. Performing this VRE offers the teacher an optimal alternative if the real set-up is not available anymore and gives him much more pedagogical opportunities compared to a lesson without any practical input.

The set-up and procedure of the experiment are in principle easy to understand and to handle. Installation is easy on any device, as only an executable file has to be installed. While all kind of devices are possible to use in principle, best results are obtained on tablets or smart-boards. However, the VRE runs also on common laptops or even personal computers without the possibility of touch-gestures. A tutorial, how to move in the virtual classroom is implemented in the program. However, the VRE can be perfomed very intuitively if common touch-gesture can be used (e. g. on a tablet or Smart-Board). Alternatively the complete VRE can be conducted by using a computer-mouse. Devices can be addressed by clicking on the devices themselves (than a zoom on the device is initiated automatically) or the devices can be operated by a separate tool-box in the upper left corner of the screen.

Concerning the experiment itself, minor mistakes can be made both in reality and in the VRE. Measuring results obtained can be analysed analogous to the results obtained after conducting the real experiment: Depending on the pedagogical aims of the teacher, the half-life of Ba-137m can be determined in an old-fashioned way by using half-logarithmic paper or by using modern software on a computer.

3. The Experiment

In the Cs/Ba-137m isotopic generator, bound, long-lived cesium-137 (Cs-137) decays with a half-life of about 30 years. It decays through β-decay, becoming barium-137 (Ba-137) with approximately 5% of the cesium nuclei decaying directly into the stable state Ba-137 while the other 95% decay into the metastable state of Ba-137m.

Ba-137m is a short-lived nuclide with a half-life of about 2,55 minutes, which is converted to the ground state of Ba-137 by γ-decay with an energy of 662,6 keV. During the elution process the Ba-137 and the Ba-137m is rinsed out of the Cs/Ba-isotopic generator and collected together with the acidified elution solution in a petri dish below the isotopic generator. The Ba-137m in that sample is used to determine the half-life experimentally.

After elution, the isotopic generator requires some time (approximately 20 minutes) to restore the radioactive equilibrium between the mother nuclide (Cs-137) and its daughter nuclide (Ba-137m).

3.1. Performing the VRE

To perform the VRE a Geiger-Müller-Counter tube is installed in the appropriate holder and connected to a digital counter. Furthermore, a stopwatch is required to determine the count rate. A long term measurement (at least 10 minutes) to determine the background-rate should be performed at the beginning. All necessary equipment like the isotopic generator, the elution solution and the syringe are placed on the top of the table in a yellow pan. Figure 1 gives an overview of the set-up before the experiment is started.

Fig. 1 general set-up of the VRE to determine the half-life of Ba-137m

In Principle, the following steps have to be performed:

1. Put on the protective clothing like gloves and the lab-coat.
2. Remove the isotope generator from the box, remove the protective caps and position it in the holder (see figure 2).
3. Put the petri-dish below the isotopic generator.
4. Place the syringe on the tube that is immersed in the elution solution and draw about 2-3 ml of solution into the syringe (see figure 3).
5. Place the syringe on the isotopic generator and press the elution solution through it.
6. Now push the drawer with the petri-dish into the holder below the Geiger-Müller counter tube (figure 4).
7. Start the digital counter and the stopwatch at the same time. The value of the pulse counter is now read off every 30 seconds and the stopwatch and pulse counter are reset to zero. Repeat this for about 15 – 20 minutes (figure 5).
8. Dispose the petri-dish including the content in the box for radioactive waste.
9. Close the filling and discharge opening of the isotopic generator and put it together with the syringe back in the storage box.
10. Create a graph by means of a value table of the measured pulse numbers. Finally, the half-life can be determined both by calculation and by graph.

Fig. 2 isotopic generator unboxed (left) and put in the holder (right)

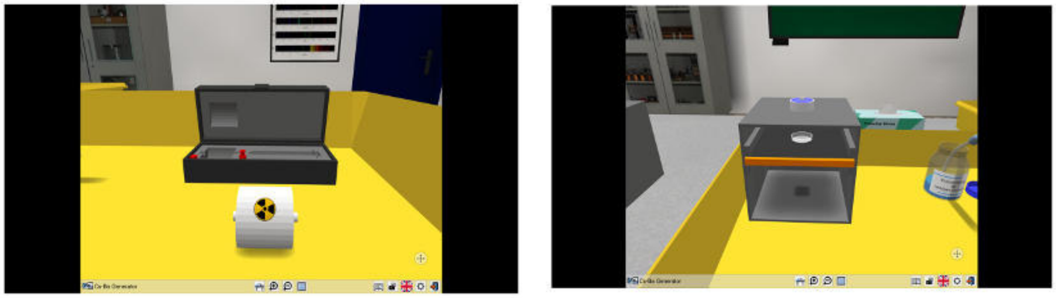


Fig. 3 drawing the elution solution in the syringe

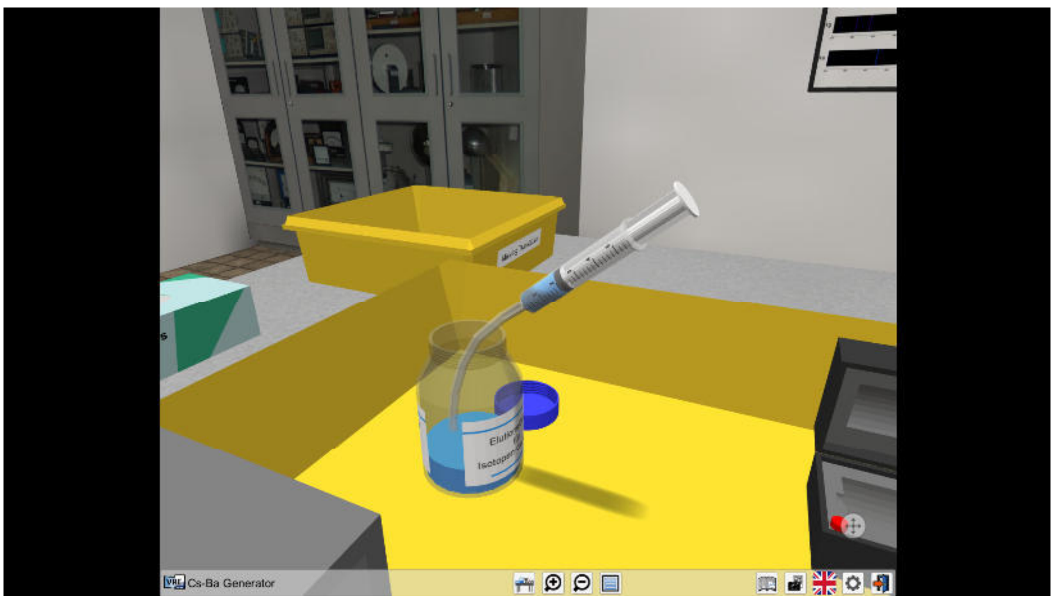


Fig. 4 eluting solution with Ba-137m into the petri-dish (before eluting left figure, after eluting right figure)

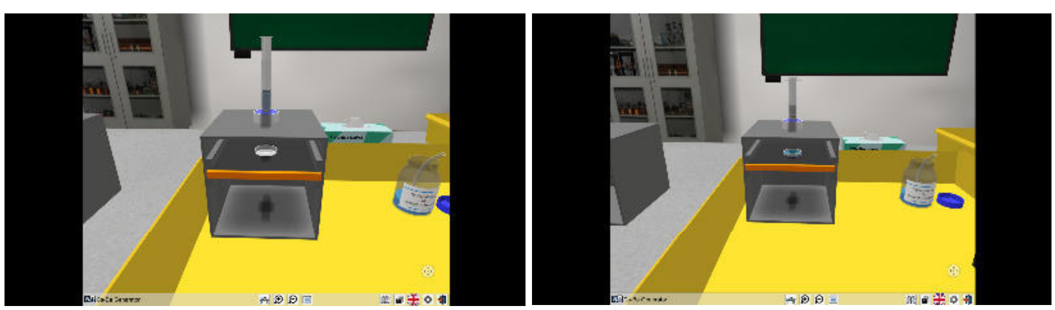
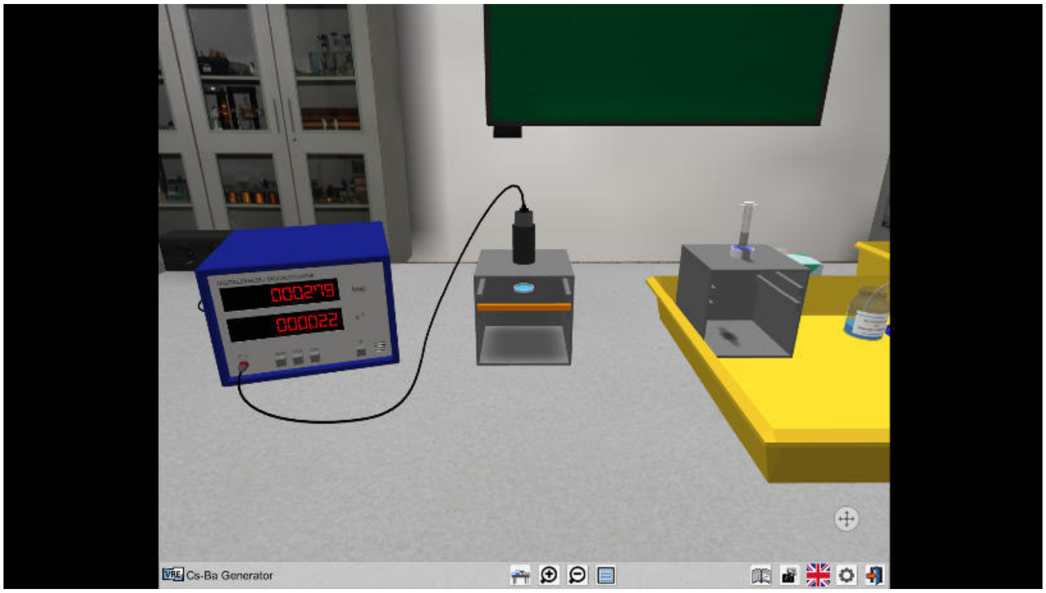


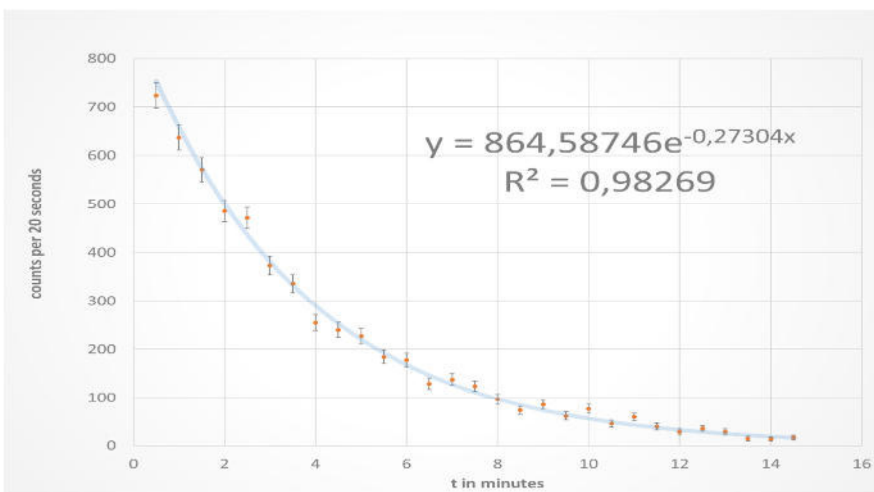
Fig. 5 determination of count-rate with a Geiger-Müller-Tube



3.2. Results

In figure 6 the measured count rate depending on the time is plotted. The calculated half-life after fitting the measuring points with an exponential fit is 2,54 minutes which is in perfect agreement with the literature value of 2,55 minutes.

Fig. 6 Measured decay of Ba-137m by using a Geiger-Müller-Tube



3.3. Radiation Protection Measures

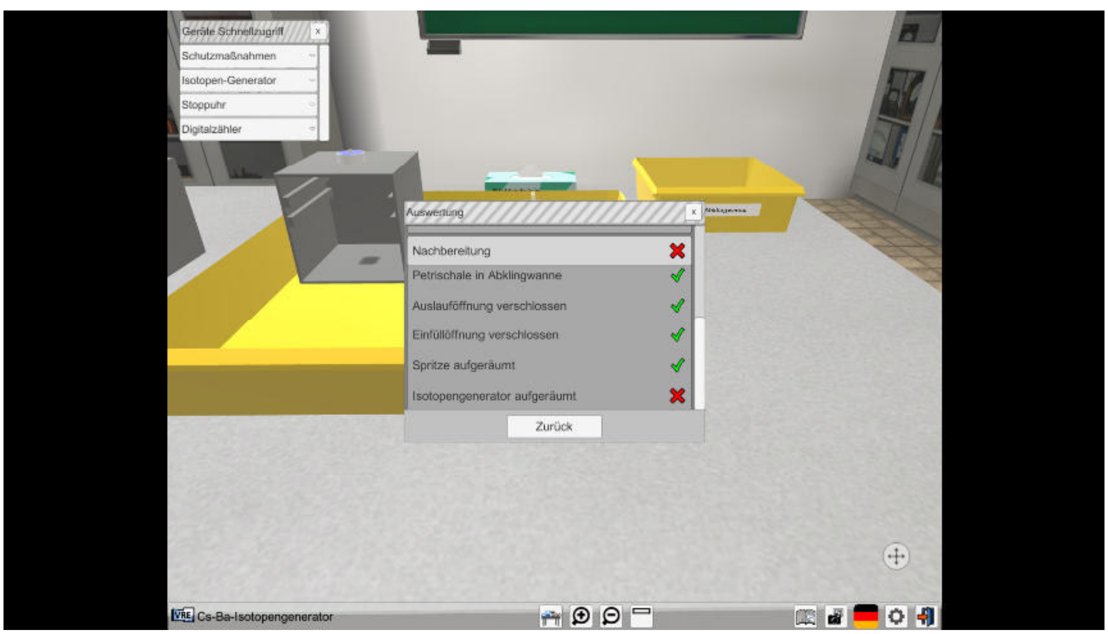
Like in the real classroom, basic radiation safety measures have to be considered. Preparing and performing the experiment including the handling of the generator and the solution are allowed only with protective clothes and a lab coat. Therefore, in a first step the experimenter has to equip himself with the lab coat (at the wall) and the gloves (taken out of the gloves-box), see figure 7.

Fig. 7 Protective clothes in the VRE

After performing the experiment, the petri-dish has to be placed in the box for radioactive waste. The filling and discharge opening of the isotopic generator has to be capped again and the generator must be placed together with the syringe back in the storage box. Used gloves have to be put in the bin and the lab-coat should be placed back at the coat hook at the wall.

At the VRE has been completed, the program provides a feedback on the user to check whether all necessary radiation protection measures have been implemented. Missing or wrong radiation protection actions are marked with a red cross while correctly realized measures are flagged with a green hook (see figure 8).

Fig. 8 Feedback concerning Radiation Protection measures



4. Conclusions

The VRE described in this presentation offers an excellent opportunity to implement an experiment to determine the half-life of Ba-137m in lessons given in high-schools or universities. It offers the teacher an optimal alternative if the real set-up is not available and provides many different pedagogical opportunities compared to a lesson without any practical input. Installation and handling of the experiment is quite simple and can be done without great effort for many different kinds of devices like smart-boards, tablets, laptops or other personal computers. By developing this VRE the Johannes Gutenberg University of Mainz and the German-Swiss Association for Radiation Protection ("Fachverband für Strahlenschutz") hope to present an input to foster and support the implementation of topics like radiation and radiation protection into education of students at secondaries schools or even universities.

5. References

[1] Strahlenschutzverordnung vom 20. Juli 2001 (BGBl. I S. 1714; 2002 I S. 1459), die durch Artikel 6 des Gesetzes vom 27. Januar 2017 (BGBl. I S. 114) geändert worden ist

Posters

Proceedings

5th European IRPA Congress, 4 – 8 June 2018, The Hague

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ABSTRACT

Since 2002, Radiation Protection professionals from all over Europe and beyond have met every four years at regional European IRPA congresses. The Dutch Society for Radiation Protection (NVS) is pleased to host the next congress in this series. The 5th European IRPA Congress is scheduled to take place from 4th to 8th June, 2018 in The Hague, The Netherlands.

With the theme “Encouraging Sustainability in Radiation Protection”, the congress will focus on the various aspects needed to make sure that we have, and will continue to have, adequate equipment, staff and resources to protect human health and our environment against the adverse effects of ionising and non-ionising radiation. Consequently, activities for and by the younger generation of RP professionals are strongly supported and education and training will receive special attention.

In establishing solid sessions on education and training, the organizers will intensively collaborate with the EUropean foundation for Training and Education in Radiation Protection (EUTERP). It is our firm belief that we thus contribute to a closer relationship between the IRPA- and EUTERP-communities. As a consequence we hope to bring the goal of this congress, formulated as its central theme, a little closer.

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In this contribution relevant information concerning this congress and the involvement of EUTERP in this congress will be presented as far as available at the start of ETRAP 2017.

1. Introduction

From 4 to 8 June 2018 the Dutch Society for Radiation Protection (NVS) will be hosting the 5th European IRPA Congress in the World Forum, The Hague, the Netherlands [1].

Since mid-2015 the Scientific Programme Committee (SPC) has met on average every three months to prepare the scientific programme for the congress. The programme format and the key themes have now been decided. In designing the programme, the SPC is working closely with the Local Organising Committee (LOC).

2. Scientific programme

The scientific programme has four components: the regular scientific presentations, refresher courses, poster sessions and the Young Professional Award session.
As usual, the scientific presentations will take place in plenary or parallel sessions. The five key themes include 'medical applications' and 'industrial applications'. The SPC intends to invite a number of prominent speakers for the plenary sessions.

3. Refresher courses

The refresher courses will be very different from what you are used to from previous IRPA congresses: a cluster of refresher courses on Monday morning 4 June and Wednesday 6 June will replace the preliminary hour very early in the day. And we are trying to provide at least two contributions on each topic: a basic lecture and a lecture covering either current developments with regard to a specific subject or a more in-depth examination. We are convinced that this approach will produce more coherent training sessions that meet our participants' needs more effectively. One series of refreshers – on Education & Training, on Wednesday afternoon – is organized in close collaboration with EUTERP.

4. Poster sessions

The traditional poster sessions will also be different. We want to use digital poster boards on which any of the posters can be called up throughout the congress. And via the congress app participants can arrange to meet the creator of the poster. During the breaks special elevator pitches will be held where a small number of poster creators will answer questions about their poster. So no more long queues for partially empty poster boards!

5. Young professionals

All the European associate societies will have the opportunity to nominate a candidate for the Young Professional Award (YPA). On Thursday afternoon, 7 June, all the candidates will present their work. That afternoon as few as possible and preferably no regular scientific presentations will be held, so that everyone is able to see and listen to up-and-coming/young radiation protection experts. And in addition to the YPA, we have well advanced plans to create a public award for the best young professional.

The YPA is not the only activity for young radiation protection experts. We hope to dedicate one of the refresher courses on the Monday morning specifically to young radiation protection experts and the Young Generation chapters of the European IRPA Societies. And there will be a special lunch session for this group. In this way we hope to help stimulate the involvement of the younger generation.

6. Technical visits

As we said above, the Wednesday will be reserved for refresher courses. The SPC and LOC are busy organising a number of technical visits, some combined with a refresher course. Although the locations are not yet definitive, the options being considered are medical, waste and nuclear applications.

7. Conclusions

The congress organisers hope this overview of the programme has fired your enthusiasm and that we will see you at the congress in 2018. Registration has opened in March 2017 and we look forward to receiving your contributions from now on. You will find detailed information in our 2nd Announcement that can be downloaded from our website [2]. If you’re not ready to register yet, you can always express your interest in the congress on our website.

We are looking forward to welcome you in The Hague in June 2018!

References

[1] EUTERP Newsletter 13, March 2017
[2] www.irpa2018europe.com

TRAINING COURSE ON CALIBRATION OF RADIATION PROTECTION MONITORS. AN EXAMPLE OF COLLABORATION BETWEEN PROFESSIONAL SOCIETIES, METROLOGY EXPERTS AND RADIATION PROTECTION PRACTITIONERS

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ABSTRACT

The Spanish Radiation Protection Association (SEPR) is a non-profit professional organisation that supports the scientific promotion and dissemination of personal and environmental radiation protection against ionizing and non-ionizing radiation. The organisation of training courses is one of its key activities. Thanks to the multidisciplinary background of its members, the SEPR is well suited to promote networking and collaboration between experts and practitioners.

One of the latest initiatives was the organisation of a 2.5 days training course on the calibration of radiological protection equipment. The course has been organized twice by the SEPR in collaboration with the three Spanish metrology laboratories in the field of radiation protection: CIEMAT (Madrid), CND (Valencia), and UPC (Barcelona).

The aim of the course is to introduce the basic concepts of ionizing radiation metrology and provide the necessary tools to understand and correctly use the calibration certificates of radiation protection detectors. Particular emphasis is placed on the theoretical presentation and practical application of the calibration procedures of personal dosemeters, portable and area monitors for environmental monitoring, and surface contamination monitors, as well as the application of the "Guide for the expression of Measurement uncertainty" (GUM). In addition, the course allows attendees to have a better knowledge of the metrology facilities in Spain and the available instrumentation. It includes a visit to the premises of the host calibration laboratory, as well as case study discussions in small groups.

1. Introduction

Monitoring of the individual exposure of workers and of the workplaces constitutes an essential requirement of any radiation protection programme [1, 2]. Radiation monitoring instruments used for quantitative radiation measurements are needed for the assessment of occupational doses in practices and in emergencies, for the application of the ALARA principle and to prove compliance with radiation protection regulation. To ensure the reliability of these measurements, the equipment needs to be properly calibrated.

The Spanish Radiation Protection Association (SEPR) is a non-profit professional organisation that supports the scientific promotion and dissemination of personal and environmental radiation protection against ionizing and non-ionizing radiation. The organisation of training courses is one of its key activities. Thanks to the multidisciplinary background of its members, the SEPR undertook the organisation of a series of practical courses on *Calibration of radiation protection monitors* with the collaboration of the national calibration laboratory, CIEMAT (Madrid), and of the two accredited laboratories in this field, CND (Valencia) and UPC (Barcelona).

The courses were planned to respond to an expression of interest from the SEPR members in an opinion survey at the end of the year 2015.

2. Scope

The aim of the course is to introduce the basic concepts of ionizing radiation metrology and provide the necessary tools to understand and correctly use the calibration certificates of radiation protection monitors. It is aimed at professionals of the different types of application of ionizing radiation. It is particularly suitable for those who have already experience as radiation protection advisers and want to strengthen their knowledge in metrology, especially in the correct interpretation of their radiation protection measurements.

2.1 Venue and facilities

The first edition of the course was held in September 2016 in Barcelona (North East of Spain), at the premises of the Calibration Laboratory of the UPC. The participants had the opportunity to visit the facilities for X-rays, gamma and beta calibration, as well as the laboratory for calibration of superficial contamination monitors. An example of calibration was shown to highlight how the instruments are used, to familiarize participants with the typical secondary standards as well as with the different types of phantoms used for the calibration of personal dosemeters.

The second edition was organized in April 2017 in Madrid at the National Calibration Laboratory of Ionizing Radiation. Besides visiting the gamma and beta calibration facility, participants were also invited to visit the neutron facility. At the end of 2017 a new edition is planned in Valencia.

The course material and the lecturers who teach in the different editions are usually the same. But, organizing courses in three different labs located in different areas of Spain has two main advantages: on the one hand, the movement of participants and, on the other hand, the chance to visit several facilities.

2.2 Attendees

The number of attendees was limited to 26 people to ensure high interaction between experts and participants and allow the set-up of small groups for the case studies and the visit. The first edition was attended by 26 people, 78% of which were SEPR members. Participants came from different fields: 23% medicine and public health, 35% research and teaching, 19% industry and energy, 8% technical and commercial activities, and 15% regulatory body. As expected, most of the participants (50%) came from Eastern Spain, area close to the venue, 42% from Madrid and central area, 4% Southern Spain and 4% Northern Spain.

The second edition was attended by 21 people, 48% of which were SEPR members. Participants came from different fields: 24% medicine and public health, 19% research and teaching, 14% industry and energy, 24% technical and commercial activities, and 19% regulatory body. As expected, the most important changes were related to the origin of the participants. In this case, most of them (81%) came from Madrid and central area, 9.5% from Eastern Spain and 9.5% from the Northern area.

3. Course outline

The course is structured into four theoretical background sessions dealing with:

1. Introduction: metrology basic concepts and objectives; radiation protection quantities, Standards.
2. Radiation protection instruments: personal dosemeters, portable and area monitors, surface contamination monitors.
3. Calculation of uncertainty: basic concepts, methods for the statement of uncertainties in measurements, the "Guide for the expression of Measurement uncertainty" (GUM) [3], examples.
4. Calibration procedures: description of procedures using external beams (X-ray, gamma and beta), secondary standards, chain of traceability, calibration of contamination monitors, calibration phantoms for personal dosemeters, determination of the calibration factor, example of calibration certificates.

It includes as well the discussion about three realistic practical cases, analysed in small groups of 8 people and coordinated by a responsible of one of each of the calibration laboratories. From the data collected in calibrations of different types of measurement, the participants are asked to prepare a calibration certificate, determining the calibration factor and the associated measurement uncertainty. The examples include the calibration of:

1. Portable ionization chamber in units of $H^*(10)$ using ^{137}Cs external beams.
2. Electronic personal dosemeter in units of $H_p(10)$ and $H_p(0.07)$ using ISO x-Ray narrow series beams [4].
3. Portable surface contamination monitor in units of Bq/cm^2 using 10 cm x 10 cm reference beta sources.

The discussions are very useful to clarify and illustrate the theoretical presentations and to solve specific problems or issues raised by participants. Moreover, guidance about whether a particular radiation monitoring instrument is adequate for its intended use and assessment about the most suitable calibration procedure for this use are given.

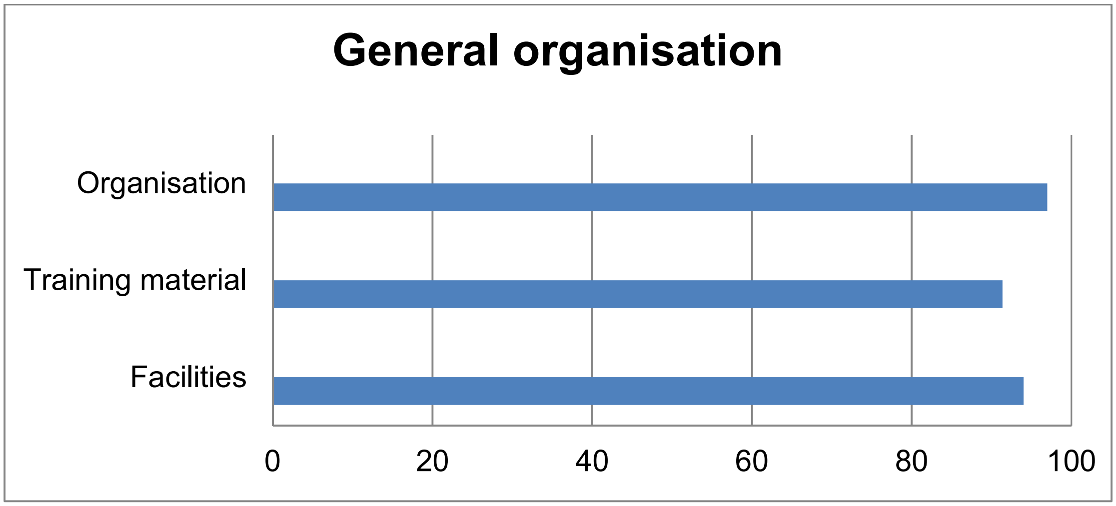
As indicated in paragraph 2, the course includes a visit to the premises of the host calibration laboratory.

A comprehensive course booklet and a certificate of attendance are provided.

4. Participants' feedback

At the end of the course, a questionnaire was distributed to the participants. They were asked to provide views and comments as regards general organisation, facilities and equipment, training material, lecturers, their interest in the course and a final general grade. The quantitative answers were graded as 100% very positive, 67 % good-positive, 33% needs improvement, 0% negative.

As an example, a summary of the results of the first edition is presented in percentage form, following the numerical criteria specified above.


General organisation
Organisation
Training material
Facilities
0
20
40
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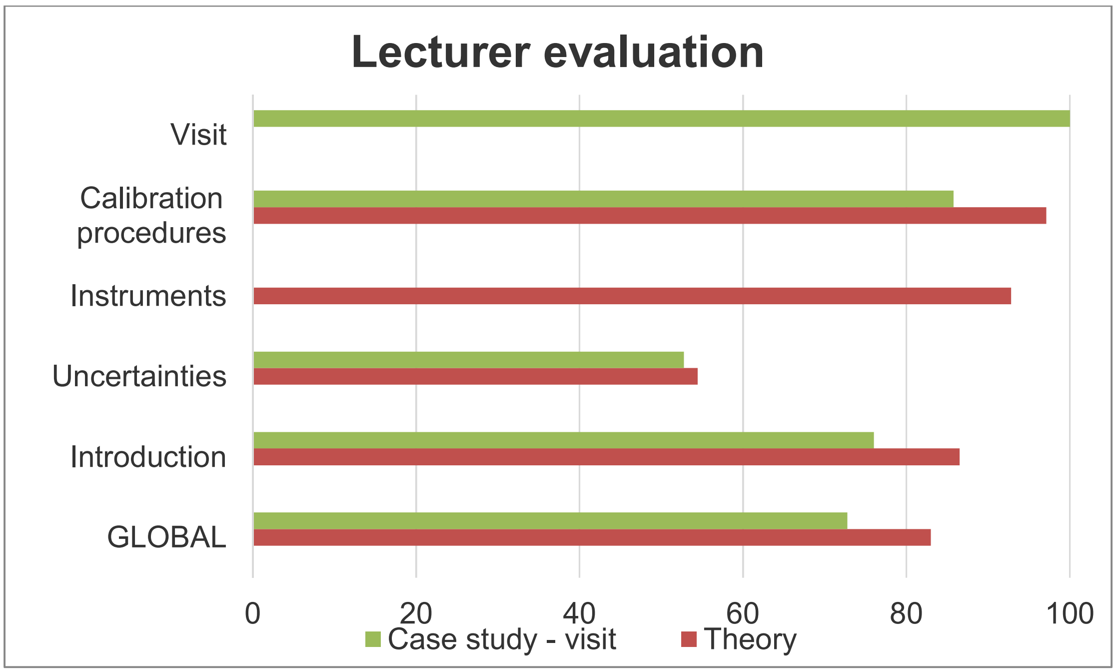
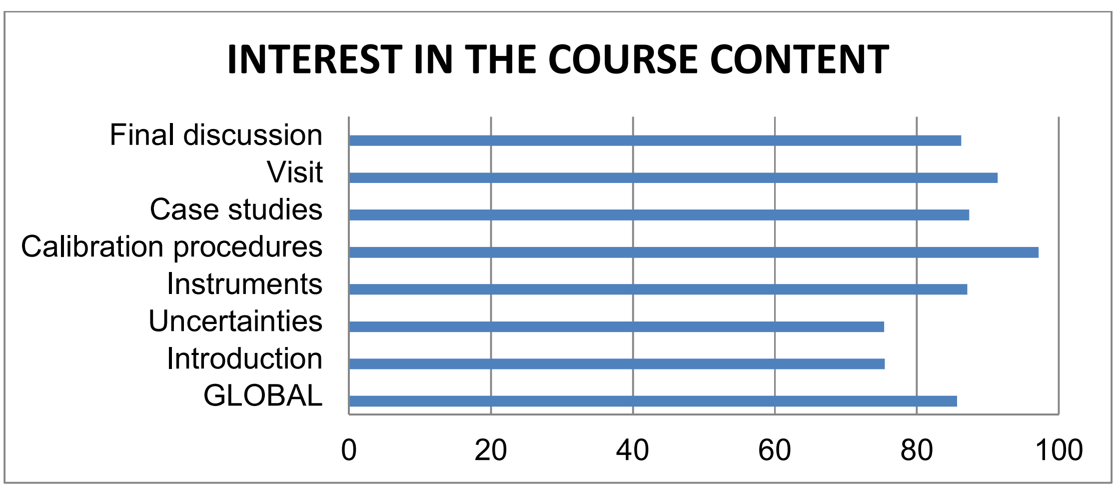
80
100


Lecturer evaluation
Visit
Calibration procedures
Instruments
Uncertainties
Introduction
GLOBAL
0
20
40
60
80
100
Case study - visit
Theory


INTEREST IN THE COURSE CONTENT
Final discussion
Visit
Case studies
Calibration procedures
Instruments
Uncertainties
Introduction
GLOBAL
0
20
40
60
80
100

Most of the parameters were evaluated as very positive, generally exceeding 80%. The topic about uncertainty calculation obtained a score around 50%. Several comments about it indicated that it was found to be too theoretical and participants suggested it could be improved by simplifying the content and introducing more simple examples.

There were also some suggestions about increasing the time assigned for the case study sessions and for the visits and this was introduced in the second edition, which is now under evaluation.

5. Conclusions

The feedback and interest of participants have been very satisfactory. They have particularly appreciated the discussion of the case studies, the wide experience of the lecturers and the possibility to visit the calibration facilities.

This course is an example of collaboration between organisations. The SEPR, as other Radiation Protection Associations, is an excellent platform to contribute generating networking between peers, to promote training in the field, to identify education and training needs and to propose solutions focused on the needs.

6. References

[1].ICRP Publication 103. *The 2007 Recommendations of the International Commission on Radiological Protection*. Ann. ICRP, 37 (2-4), 2007.

[2].IAEA Safety Standards Series No. GSR Part 3 *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards.* ISBN, 978-92-0-135310-82014, 2014.

[3].ISO/IEC Guide 98-3:2008 – *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995),* 2008.

[4] ISO 4037-1*, X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy -- Part 1: Radiation characteristics and production methods*, 1999.

RADIATION PROTECTION EDUCATION AND TRAINING PROCESS FROM CLASSROOM TO CLINICS

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ABSTRACT

Ionizing radiation is becoming an increasingly relevant part of modern healthcare, but it is not without its own side effects. Currently more than three billion medical exposures to radiation are conducted per year, which now accounts for a major portion of all background radiation. It is well established that radiation exposure can give rise to both deterministic and stochastic side effects, both of which can be seen in the clinical setting. As such it is important that national and international regulation of radiation exposure exists to ensure the safety of patients and personnel. An important factor in radiation risk management is adequate education and training of radiation staff at both the university and workplace settings. Medical Imaging Radiographers (MI), radiation therapists (RT) and nuclear medicine technologists (NM) receive training at university on managing radiation risk, yet the transition to workplace remains a significant challenge and is subject to site specific practices. The aim of this paper is to present the radiation protection needs and training at both the university and workplace setting, as experienced in a major metropolitan city in Australia. Our three-year undergraduate medical radiations program consists of lectures, tutorials, lab work and 22 weeks of clinical placement during their study. Stream specific radiation safety and protections for working as MI, RT, and NM are taught including radiobiology, radiation regulations, radiation management plan, dose monitoring, and risk communication. In the workplace setting, knowledge retention has been identified as a major issue in the radiation awareness of staff members. Despite regular educational courses provided by the hospital in question, staff knowledge overall remained poor when surveyed. An important finding of the hospital audit showed that staff members who received tailored educational talks rather than the general radiation safety induction consistently scored better in radiation awareness. This knowledge has in turn been used successfully to shape future refresher courses and inductions with the outcome of greater overall knowledge retention in hospital staff. Adequate education and training of staff remains an important factor in managing radiation risk. Such training begins at the university level and is further shaped from workplace practice. The authors suggest that optimal workplace training occurs from personalization to the target audience rather than reliance on traditional, theory based learning methods.

1. Introduction

The use of ionizing radiation in modern healthcare is continuously increasing however, it is not without its own risks. According to reports published by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), more than three billion diagnostic medical radiological examinations are made per year, which accounts for four million Sieverts (Sv) of annual collective effective dose [1]. Ionizing radiation used in healthcare is responsible for more than half of the total background radiation in the world. It is well established that radiation exposure can give rise to both deterministic and stochastic side effects. Hence safety and protection from radiation is an important task of radiation service providers.

Radiation workers in the healthcare system in Australia consists of physicians, radiographers, radiologists, nuclear medicine technologists, radiotherapists, radiation oncologists, cardiologists, nurses and administrators. At the time of writing more than half of the medical radiation technologists (radiotherapists, nuclear medicine technologists, radiographers) in the Australian state of Victoria are graduates of RMIT university.

The aim of this paper is to cover current radiation practice guidelines in Australia and present the radiation protection needs and training at both the university and workplace setting, as experienced in a major metropolitan city in Australia. A further aim is to explore how best to approach the transition from university to workplace as well as which teaching strategies optimize workplace specific knowledge retention.

2. Methods

Current radiation practice guidelines as distributed by regulatory bodies were examined and correlated to current university teaching curricula. The radiation protection education needs from a lecturing perspective was presented. In the hospital setting radiation protection training at hospitals is a mandatory requirement for all individuals that may potentially be occupationally exposed to ionising radiation. It is also a requirement of the Radiation Management Plan that it addresses training of occupationally exposed staff members. Ongoing workplace education strategies and their effectiveness was examined.

3. Radiation Safety Guidelines

The International Commission on Radiological Protection (ICRP) have made recommendations for education and training for radiation healthcare personnel in many of their publications [2-4]. It is recommended that education should cover the safe management of radiation dose among patients, radiation staff, general public and the environment.

According to ICRP report 113 [2], there are definite scopes of education and training in radiation safety and protection. Knowledge and understanding of radiation hazards, radiation quantities and units, principles of radiation protection, radiation legislation and patient and staff dose factors are considered education. On the other hand, training refers to the individuals' practice relating to the ionizing radiation modalities in medicine.

Radiation protection education and training in Australia are guided and promoted by federal and state government organisations. Adequate education and training of staff remains an important factor in managing radiation risk. Such training begins at the university level and is further shaped from workplace practice.

The Australian Health Practitioner Regulation Agency (APHRA) is the organisation responsible for the implementation of the national regulation and accreditation scheme across Australia. The Medical Radiation Practice Board of Australia (MRPBA) regulates Australia's medical radiation practitioners. The MRPBA sets the professional capabilities for medical radiation practice identifying the minimum knowledge, skills and professional attributes necessary for safe independent practice in diagnostic radiography, nuclear medicine technology and radiation therapy. One of the main professional capability domains is radiation safety and risk management [6].

The education provider has to demonstrate the medical radiation practice educational program's learning outcomes and assessment ensure each student meets the requirements for the professional capability domain. Medical radiation practitioners' responsibility to protect people and environment from harmful effects of radiation is covered in radiation safety and risk management domain. The task and evidence of capabilities to ensure the high level of radiation protection knowledge and skills are given in table 1 [6].

Capability	Task
1. Implementation of safe radiation practice	a. Understanding of state and federal radiation safety legislation. b. Application of principles of risk management. c. Identification of radiation risks d. Identification and application of safe radiation practice
2. Protection enhancement	a. Identification procedure of patients b. Maintaining of patient/client records c. Identifying and managing patient/client transfer d. Identifying and managing risk of infection
3. Safe and appropriate use of radiation equipment	a. Applying knowledge of equipment to identify if there is any problem with the equipment b. Identifying the problem in equipment and taking action to correct it. c. Reporting non-conformance of equipment
4. Maintaining safety in workplace	a. Demonstrating legal responsibilities for health and safety b. Identification and notification of safety hazards in the workplace c. Identifying and implementing methods of radiation management d. Applying knowledge of biological effects of radiations e. Identification of radiation risks of being close to radioactive source f. Communicating radiation risks and control measures to others in the workplace g. Using appropriate personal protective clothing and equipment
5. Managing radiation and radioactivity in the environment	a. Applying knowledge of environmental risk of radiation and radioactivity b. Identifying safe and legal methods of storage, disposal and handling radioactive materials c. Implementing procedures and protocols of radiation incidents d. Reporting radiation incidents in accordance with protocols, procedures, and legal requirements

Table 1: Capability tasks to ensure the radiation safety education and training

In Australia, no radiation practice is allowed without having appropriate licences. Radiation practice includes the activities of possessing, selling, transporting, repairing, maintaining, controlling, testing, processing, disposing, decommissioning radiation source or radioactive materials. Every Australian state and territory has its own radiation legislation. In Victoria, the Radiation Act 2005 [5] is the state law which governs radiation practice. Radiation facilities must have management licences prior to conducting any radiation practice. For any individual working as a radiation worker must have a radiation use licence. This is obtained by demonstration of adequate education and training in radiation protection. The primary condition to hold the licence is to ensure the safety and protection of people and environment from the harmful effects of radiation. Adequate education and training in radiation protection is the key factor for obtaining a radiation licence and complying with its conditions.

4. Tertiary Radiation Curricula

University courses in medical radiation must incorporate radiation practice guidelines as well as educate students as to the importance of radiation safety. At RMIT University, students achieve APHRA registration after the completion of a three year BAppSc (Medical Radiations) degree, which allows them to start a career as a medical imaging technologist (MI), nuclear medicine technologist (NM) or radiation therapist (RT).

Students are admitted into one of the three study streams: Medical Imaging, Radiation Therapy, and Nuclear Medicine. This consists of lectures, tutorials, lab works and 22 weeks of clinical placement during their study. Stream specific radiation safety and protections for working as MI, RT, and NM are taught including radiobiology, radiation regulations, radiation management plan, dose monitoring, and risk communication. The list of subjects they complete in three years are given in tables 2-4.

Year/Semester	Course Code (Subject Code)	Course (Subject)	Credit Points
Year 1/ Sem 1	RADI1125	Introduction to Medical Radiations	12
	ONPS2343	Medical Radiations Technology 1	12
	BIOL2280	Human Structure and Function 1	12
	XXXX0000	One Elective	12
Year 1/Sem 2	RADI1184	Introduction to Medical Imaging	12
	RADI1154	Research in Medical Radiations	12
	ONPS2344	Medical Radiations Technology 2	12
	BIOL2281	Human Structure and Function 2	12
	CLINICAL	Clinical Placements 2 Weeks	
Year 2/Sem 1	RADI1130	Medical Imaging Method 1	12
	RADI1132	Medical Imaging Practice 1	12
	ONPS2347	Medical Imaging Technology 1	12
	MED2118	Introduction to Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 2/Sem 2	RADI1131	Medical Imaging Method 2	12
	RADI1133	Medical Imaging Practice 2	12
	ONPS2348	Medical Imaging Technology 2	12
	MED2132	Imaging Anatomy and Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 1	RADI1178	Medical Imaging 3	12
	ONPS2353	Medical Imaging Technology 3	12
	ONPS2437	Computed Tomography	12
	ONPS2438	Sonography	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 2	RADI1177	Medical Imaging 4	12
	RADI1179	Medical Radiations Interdisciplinary Applications	12
	ONPS2436	Magnetic Resonance Imaging	12
	BESC1409	Health Psychology	12
	CLINICAL	Clinical Placements 5 Weeks	

Table 1: Subjects taught in Medical Imaging stream

Year/Semester	Course Code (Subject Code)	Course (Subject)	Credit Points
Year 1/ Sem 1	RADI1125	Introduction to Medical Radiations	12
	ONPS2343	Medical Radiations Technology 1	12
	BIOL2280	Human Structure and Function 1	12
	XXXX0000	One Elective	12
Year 1/Sem 2	RADI1186	Introduction to Radiation Therapy	12
	RADI1154	Research in Medical Radiations	12
	ONPS2344	Medical Radiations Technology 2	12
	BIOL2281	Human Structure and Function 2	12
	CLINICAL	Clinical Placements 2 Weeks	
Year 2/Sem 1	RADI1134	Radiation Therapy Method 1	12
	RADI1136	Radiation Therapy Practice 1	12
	ONPS2349	Radiation Therapy Technology 1	12
	MED2118	Introduction to Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 2/Sem 2	RADI1135	Radiation Therapy Method 2	12
	RADI1137	Radiation Therapy Practice 2	12
	ONPS2350	Radiation Therapy Technology 2	12
	MED2132	Imaging Anatomy and Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 1	RADI1181	Radiation Therapy 3	12
	ONPS2355	Radiation Therapy Technology 3	12
	ONPS2437	Computed Tomography	12
	ONPS2438	Sonography	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 2	RADI1180	Radiation Therapy 4	12
	RADI1179	Medical Radiations Interdisciplinary Applications	12
	ONPS2436	Magnetic Resonance Imaging	12
	BESC1409	Health Psychology	12
	CLINICAL	Clinical Placements 5 Weeks	

Table 2: Subjects taught in Radiation Therapy stream

Year/Semester	Course Code (Subject Code)	Course (Subject)	Credit Points
Year 1/ Sem 1	RADI1125	Introduction to Medical Radiations	12
	ONPS2343	Medical Radiations Technology 1	12
	BIOL2280	Human Structure and Function 1	12
	XXXX0000	One Elective	12
Year 1/Sem 2	RADI1185	Introduction to Nuclear Medicine	12
	RADI1154	Research in Medical Radiations	12
	ONPS2344	Medical Radiations Technology 2	12
	BIOL2281	Human Structure and Function 2	12
	CLINICAL	Clinical Placements 2 Weeks	
Year 2/Sem 1	RADI1126	Nuclear Medicine Method 1	12
	RADI1128	Nuclear Medicine Practice 1	12
	ONPS2345	Nuclear Medicine Technology 1	12
	MED2118	Introduction to Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 2/Sem 2	RADI1127	Nuclear Medicine Method 2	12
	RADI1129	Nuclear Medicine Practice 2	12
	ONPS2346	Nuclear Medicine Technology 2	12
	MED2132	Imaging Anatomy and Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 1	RADI1183	Nuclear Medicine 3	12
	ONPS2351	Nuclear Medicine Technology 3	12

	ONPS2437	Computed Tomography	12
	ONPS2438	Sonography	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 2	RADI1182	Nuclear Medicine 4	12
	RADI1179	Medical Radiations Interdisciplinary Applications	12
	ONPS2436	Magnetic Resonance Imaging	12
	BESC1409	Health Psychology	12
	CLINICAL	Clinical Placements 5 Weeks	

Table 3: Subjects taught in Nuclear Medicine stream

5. Bridging the transition to workplace

Implementation of radiation practice guidelines in a workplace setting requires constant training and assessment on the radiation providers. In order to maximise knowledge retention, it is best that such training is non-didactic and workplace specific. This can be substantiated from a number of studies that have found radiation knowledge of staff members within the workplace was low, even in departments that received regular training courses or were regularly occupationally exposed [7-9]. One reason for this was because training is usually delivered as a one-off lecture given at the commencement of employment, with further training taking place only by request.

The transition to the workplace involves translating the theory taught in university to practical skills relevant to the task at hand. It is in the authors' experience that methods of delivery must evolve to make the information more relevant, easier to understand and improve knowledge retention. This can be achieved by heavily tailoring the material to address department specific requirements. Typically, the lectures presented follow the same content no matter the audience; beginning with basic principles of ionising radiation and moving towards radiation protection strategies. More engagement has been found if lectures begin by acknowledging the risks, putting it into perspective with other occupations, covering the basic principles then finally advising how to best mitigate the risks.

It is also paramount that radiation courses in the clinical setting are routinely given, not just when requested. This will not only refresh the knowledge of current staff but also capture new staff members that may not have yet undertaken the radiation induction. Surveying the participants or providing simple assessment tasks at the conclusion of the lecture can provide feedback on how well the key information has been retained and if any adjustments need to be made to the lecture material.

6. Conclusions

Adequate education and training of staff remains an important factor in managing radiation risk. Such training begins at the university level and is further shaped during workplace practice. Knowledge and teaching of radiation protection guidelines as administered by regulatory bodies is a fundamental component of both undergraduate curricula and continual regulation of radiation protection education in the workplace. The authors suggest that optimal workplace training occurs from personalization to the target audience rather than reliance on traditional, theory based learning methods.

References

1. UNSCEAR, *Sources and Effects of ionizing Radiation*, in *UNSCEAR 2008*. 2010, United Nations: New York. p. 33-34.
2. ICRP, ICRP Publication 113, in Education and Training in Radiological Protection for Diagnostic and Interventional Procedures. 2009, ICRP.
3. ICRP, The 2007 Recommendations of the International Commission on Radiological Protection, in Annals of the ICRP, J. VALENTIN, Editor. 2007, ICRP.
4. ICRP, Radiological Protection in Medicine, ICRP Publication 105. Annals of the ICRP, 2007. 37(6).
5. Victoria State Government. Radiation Act 2005. 2007 [cited 2017 April 5]; Available from: https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory framework/radiation-laws/radiation-act-2005.
6. Australia, MRPBA. Professional capabilities for medical radiation practice. 2015 [cited 2017 April 5]; Available from: http://www.medicalradiationpracticeboard.gov.au/Registration/Professional-Capabilities.aspx.
7. Badawy, Mohamed Khaldoun, et al. "An assessment of nursing staffs' knowledge of radiation protection and practice." Journal of Radiological Protection 36.1 (2016): 178.
8. Badawy, Mohamed Khaldoun, Dheeshana Sayakkarage, and Mehmet Ozmen. "Awareness of radiation dose associated with common diagnostic procedures in emergency departments: A pilot study." The Australasian medical journal 8.11 (2015): 338.
9. Günalp, Müge, et al. "Ionising radiation awareness among resident doctors, interns, and radiographers in a university hospital emergency department." La radiologia medica 119.6 (2014): 440-447.

NUCLEAR AND RADIOLOGICAL SECURITY AND SAFETY TRAINING COURSES. REGIMIENTO NBQ – CIEMAT EXPERIENCE.

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1. Introduction

The Amendment to the Convention on the Physical Protection of Nuclear Material – ACPPNM – establish that every state is responsible for ensuring that appropriately trained personnel support its nuclear security infrastructure. Furthermore, international community recognises the increase in illicit trafficking of nuclear and other radioactive material as a significant security threat.

Council Directive 2013/59/EURATOM of 5th December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation establishes that every States shall ensure that emergency workers who are identified in an emergency response plan or management system are given adequate and regularly updated information on the health risks their intervention might involve and on the precautionary measures to be taken in such an event. This information shall take into account the range of potential emergencies and the type of intervention.

In this frame, in the Kingdom of Spain cooperation between the Armed Forces (Regimiento NBQ Valencia nº 1) and National Research Centre (CIEMAT) was implemented for designing, developing, and assessment training for first responders. This enlightening experience began on 2013. During the last 4 years, the scope of the training exercises and the scenarios have been modified as a consequence of the critical review done together at the end of the exercise.

2. Organizations capabilities

The NBQ Regiment has a wide experience in CBRN activities including participation in International Missions (such as: Kosovo, Afghanistan, Iraq, Lebanon, among others). Due to the specific field of work, they need a continuous training on nuclear forensic (i.e., radiochemical, chemical and physical characterisation of bulk materials), detection, prevention and decontamination. It is performing at training grounds that allow outdoor use of radioactive sources for detection by the mobile vehicle.

The other partner is the National Research Centre CIEMAT, which has nuclear and radioactive facilities, radiological detection equipment's and a specific vehicle designed for measuring in nuclear and radiological emergencies. These capabilities permit the design and implementation of different scenarios for training courses. The exercises carried out at CIEMAT facilities have been performed by the NBQ Regiment according to its procedures, while CIEMAT researchers participated as observers. The same scheme of action has been followed when the scenario has been prepared by the Regiment and it has been the staff of the CIEMAT vehicle that has performed the radiological measurements in the training ground. Critical evaluation meetings were held at the end of each day to analyse the work that was carried out and mistakes made in order to develop a list of lessons learned that will be useful to improve the procedures of both organizations.

All the practices have been optimized from the point of view of radiation protection so, although different types of radioactive sources (encapsulated, drums of radioactive waste, etc.) are used, the adequate use of times and shielding has allowed to optimize the practices in a way that the collective dose in all activities was less than the trivial dose (10 μSv).

3. Training Activities - IR-17 Facility

The activities carried out in the CIEMAT radioactive facilities included several practical sessions in the operational radioactive installation IR-17 “Solid radioactive waste conditioning plant and temporary storage of very low-level and free release waste”. This facility includes waste storage and laboratories with glove boxes for the disassembly and conditioning of radioactive sources. These dependencies are classified as controlled areas with risk of irradiation and contamination and therefore before leaving these areas there is a scanner in order to ensure absence of external contamination. The scenarios prepared by CIEMAT in this facility are as follows:

3.1 Practical use of shielding for radiological protection and confinement of radioactive sources.

In a room of this installation that includes boxes of gloves for the disassembly and conditioning of radioactive sources and equipment of characterization of drums, a scenario was designed whose technical objectives were to locate hidden sources, to identify them and to confine them in suitable shields.

3.2. Identification and sampling

In a solid radioactive waste drums storing vessel, a scenario was designed whose technical objective was for the personnel of the regiment to perform with their equipment dose rate measures from background values to a few μSvh-1 to exercise equipment use and compare the results of the measurements with the equipment of the same type available in CIEMAT. In another storage place, they were trained in the application of smear sampling procedures on waste drums for analysis in a reference laboratory.

At the end of the exercises, the Regiment set up their own decontamination line to exercise the correct use of personal protective equipment. Finally, all personnel were checked again with the scanner portal available in the IR-17 facility before leaving the controlled area.

4. Underground training activities

The second type of scenario was the radiological characterization of a network of drainage manifold headers at CIEMAT premises. It is a special survey that includes detection, identification of isotopes and detailed mapping with underground radiological information of dose rate and surface contamination.

Training activities were carried out in confined spaces under the supervision of the Occupational Hazard Prevention Service of CIEMAT. Regiment personnel were equipped with oxygen control detectors and explosive atmospheres, carrying a portable continuous gas monitor to perceive oxygen, carbon monoxide and combustible gases. Operational dosimetry and protection measures were coordinated by the Radiological Protection and Occupational Hazards services of CIEMAT.

The technical objectives for training were the use of the instrumentation and equipment of the Regiment and the development and execution and of characterization procedures in sewage of urban areas. In addition, the procedures for classification of zones, exposure levels (dose rates) and calculations of permitted times in the confined spaces was practiced.

Measurements using portable measurement systems of the radiation levels and polyvalent surface contamination probe were performed. When a significant reading was produced, according to internal procedures samples are taken and "in situ" spectrometric identification is attempted.

All the radiological information is adequately recorded in several media (hardcopy, digital) that facilitates the report and data analysis. In particular, the production of three dimensions plans of the radiological results has been extremely useful for CIEMAT.

5. Emergency vehicle training activities

The CIEMAT emergency vehicle participated in 2015 in the “Pandora” exercise that was carried out in a training center of the Ministry of Defense.

The scenario involved consisted in an accident of a military aircraft containing radioactive and nuclear material in the territory of an allied country. As a consequence, the Regiment was called on a NATO support mission to determine whether the area had been contaminated, to manage the contaminated products detected and to advise the host nation authorities in taking protective measures.

CIEMAT participated in this exercise collaborating in the technical direction, as an observer during its development, as a participant with the emergency vehicle and giving a lecture on the radiological characterization of land.

The CIEMAT staff during the exercise was integrated with the Regiment teams and participated in the detection, localization, identification and quantification of radioactive sources. For this purpose, the technical equipment available to the vehicle was used, allowing the measurement of the equivalent environmental dose rate and gamma spectrometric analysis.

6. Conclusions

The authors would like to point out that this collaboration provided a good chance for showing to the public opinion how the government integrates the state capabilities in order to train the personal and achieve the best results for response in case of CBRN threat. The main conclusion of these training exercises is the synergy and trustworthy communication pathways between whole technical research, expert and units of each organisation.

Finally, it should be noted the high level of technical and human resources of the NBQ Regiment for the characterization of scenarios with radiological risk. To maintain this level of excellence in the future, it is of high importance to continue the collaboration between first responders and CBRN national research laboratories.

RADIATION PROTECTION PROFESSIONALS IN NUCLEAR FACILITIES: AN INTERNATIONAL OVERVIEW ABOUT REQUIREMENTS ON EDUCATION AND TRAINING

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ABSTRACT

Exchanging information on education and training (ET) in radiation protection (RP) is still an important aspect for **ISOE**[1] to strengthen RP in nuclear power plants now and in the future. On the ISOE Management Board meeting in 2016 one special session was dealing with education and training for radiation protection professionals in nuclear power plants (NPP). Representatives of France (FR), South Korea (KR), Switzerland (CH), United Kingdom (UK) and USA (US) presented and discussed the learning objectives, training scheme and other details on this subject. During an ISOE meeting in 2014 representatives from nine European regulatory bodies exchanged information on legal requirements about education and training in RP for personnel in nuclear power plants (add. Germany (DE), Finland (FI), Netherlands (NL), Spain (ES), Slovenia (SI), Sweden (SE)).

This report reveals the results of a comparison of demands on ET for “RP managers” and “RP technicians” in nuclear power plants, which with exceptions is also valid for other nuclear facilities. Although the requirements regarding the learning objectives for these particular professions with similar function, role and tasks are nearly conform, the demands on pre-education level, amount of lessons and duration of on-the-job-training are differing clearly between those countries operating nuclear facilities. On the other hand, several countries have nearly the same requirements, which would simplify the process of a mutual recognition of ET certifications.

1. Groups of different roles and functions

Radiation protection in nuclear power plants is a challenging issue and comprises numerous of different exposure situations. Therefore the staff of NPP has to deal with many different tasks in RP. Considering this, a clear distribution of reasonability and responsibility on different roles and functions is needed. In this report we focus on RP professionals only (RP managers and RP technicians), not dealing with other organizational units or positions for single persons in a NPP carrying responsibility in RP (for example: delegate of licensee in matter of RP, head of the NPP, control room staff, external RP services, radiation worker). In contrast to Radiation Workers and all other positions in a NPP the RP professionals work fulltime on RP issues and consequently RP is their first priority.

Other facilities within the nuclear cycle (as uranium mining, fuel production, waste management, fuel recycling, interim storages) as well as research reactors and nuclear (hot)

[1] ISOE = Information System on Occupational Exposure, supported by OECD/NEA and IAEA, representing around 400 nuclear power plants and 28 regulatory bodies

laboratories, may demand adequate functions and roles, but there are varieties concerning ET and the range of tasks.

1.1 RP managers

This term comprises positions or functions, which are termed as the “head of RP unit”, “RP radiation safety manager”, “RP commissioner”, “RP specialist”, “RP supervisor”, “RP surveyor” or “operational RP group leader” and her or his substitutes. They are responsible for the whole range of RP tasks including those of RP expert and RP officer as referred in the EU-Directive 2013/59/EURATOM called EU-Basic Safety Standards (EU-BSS). Only few countries (NL, UK) require an independent “RP advisor” or “RP expert” additionally to the “RP manager”. In few countries (SE, SI) the company or organization employs one well experienced RP expert who gives advices to the NPP management and supports the RP manager on strategic issues. These RP advisors or RP experts should meet the same requirements on knowledge and experience, so these functions may be added to this group of “RP managers” also.

1.2 RP technicians

Because the term “RP technician” is common in several countries, we use it within this report for all other RP professionals in contrast to “RP managers”. The RP technician perform tasks, which - referred to the EU-BSS - are assigned to the “RP officer”: preparing, realization and supervision of the RP measures inside the facilities to protect the personnel of a NPP. There are different levels of “RP technicians”, which are hereinafter called “RP senior officer”, “RP junior officer”, “RP foreman” “RP practitioner”, “RP controller” or “RP assistant”.

2. RP managers

2.1 Roles, functions, tasks, responsibility

These positions (comprised by the term RP manager) take responsibility to develop, implement, manage and control the radiation protection programme at the nuclear facility (ES, CH, DE, SI), including the translation of RP legislation or facility license requirements into company internal rules. The RP managers are particularly responsible for:

- prior critical examination of installation plans and its projected power operation and outages from the radiation protection perspective, including evaluation of activity inventory, radiation power, source terms, exposure paths, dose rates, contamination levels, radiological risk to exposed workers, persons on site, public and environment in normal operation, minor deviations and events;
- determination of generic RP measures as classification of radiological controlled areas (RCA) depending on potential dose rate and contamination levels, optimisation of structural, technical and personal protection equipment;
- implementation of monitoring for different areas, systems and workplaces, personal dosimetry, monitoring intakes, control of exhaust air, of effluent releases and of material outlet and immission monitoring outside the RCA in accordance with legal requirements;
- determination of policy, strategy, concepts, radiation protection tasks and responsibilities within a RP program;
- RP personnel staffing and qualification requirements necessary for completion of all RP tasks during power operation, outages as well as during incidents and emergencies;
- classification of workers into different categories;

- prior evaluation of procedures as well as single jobs regarding radiological risk; determination of additional job specific RP measures considering optimization as well as implementation of extra monitoring;
- evaluation and monitoring the status of radioactive goods before transportation in compliance with international regulation;
- acceptance into service modification of the installation, including new radiation sources, from the radiation protection perspective and
- giving advice to the facility management ensuring sufficient resources and authority for the personnel implementing radiation protection.

2.2 Necessary knowledge, experience and skills, requirements on ET

The necessary competence dealing with all the tasks from the list above comprises a deep understanding of the physics of radioactivity and radiation, interaction with material as well as of biological effects. Furthermore the optimized application of protection measures and measuring instruments demands knowledge and experience on the technology. The RP managers also need experience to imagine expectable events. Skills as leadership and communication are necessary to manage these complex tasks in collaboration with other divisions and RP professionals.

In some countries very detailed requirements about knowledge, experience and skills for the Head of the RP Unit and substitutes (CH, DE, ES) are laid down within the legislation.
The educational level for these positions is a graduate degree in technology or natural science (DE, CH, FI, ES, SI), as for example bachelor in engineering or architecture (ES). There are also exceptions for RP senior officer without university level but with long-term experience, which gives an adequate background comparable to high school level. With these educational levels, candidates have to participate in an ambitious RP-course and pass through an examination. In some countries the content of education and training, as well as the duration or amount of school lessons, theoretical and practical exercises and on the job training is described in a special ordinance or guideline about education and training in RP (CH, DE) or in the RP program approved by the authority (ES). The duration of these courses ranges between around 80 h (SE), 150 h (DE, CH), 200 h (SI), until 300 h (ES).

Another way to achieve the necessary knowledge is to study RP in specialised high schools and pass an exam for RP Bachelor, RP Master or RP engineer degrees. Additional to these studies knowledge about design and operation of NPP is required, if it was not in the content of the study.

Additional to the RP knowledge gained at high school or in specialised courses, in all mentioned countries the candidates have to gather RP work experience at least in the RP unit, where she or he takes over the function of RP manager. The minimum duration of on-the-job learning in RP ranges between 6 months and 3 years (CH: 12 months, ES, US: 3 years). Additionally the candidates have to get a detailed insight to the design, organization and processes of the facility (CH: 6 months, US 1 year). Some countries require the participation of RP managers within the emergency preparedness organization. Therefore particularly the candidates have to participate in emergency exercises as required for recognition.

2.3 Competence level and its recognition:

The competence level of RP managers described above is as high as of the “RP expert” referred in the EU-BSS. According to EU-BSS all EU member states have to install an recognition system for the RPE.

Nearly all countries (CH, DE, ES, FI, SI) already require the recognition of the RP manager competence level by an authority body. The candidate have to provide evidence about its competence with certification of course participation (knowledge), testimonial of exams (skills) and letter of references (experience). Some of the authority bodies perform final examination, take part during examinations or inspect emergency exercises.

3 RP-Technicians and other levels of RP-Professionals

3.1 Roles, functions, tasks, responsibility

In most countries, besides the RP-managers, positions in RP of NPP are installed which demands well trained and experienced RP professionals, although they are not defined as such in regulatory guides (DE, FI, US). The roles and functions of these positions are to support the RP managers by planning, preparing, performing and controlling the RP measures and monitoring including the tasks, which - referred to EU-Directive - are assigned to the “RP-officer (RPO)”.

In some countries different levels of RPOs exist, depending on the range and complexity of tasks assigned to them. These different positions demands different states of knowledge and experience. The amount of levels is typically two or three: RP senior officer, RP junior officer and sometimes a kind of RP officer assistant.

“RP senior officers” are postulated to deal with tasks including planning RP measures and monitoring for infrequent, high risk jobs which need a wide experience. The usual term of the competence level of those “RP senior officers” is “RP technician” (CH, FI, ES, US). In some countries, these senior RP officers are mentioned in the legislation (“Strahlenschutztechniker” in CH, “Expert Technicians in RP” in ES) or some legal document regarding the qualification of people engaged as RP senior officer positions (“Strahlenschutzmeister” may be translate as “RP Handcraft Master” in DE). These RP technicians typically manage and control all RP aspects within limited areas of the NPP (turbine hall, drywell, etc.) or on special aspects/projects (rad waste, monitoring systems, decommissioning etc.). These RP technicians may lead a group of RP professionals with lower levels of competence. They also instruct radiation workers.

The next lower level termed “RP junior officer” (or RP controller, RP practitioner) is used in several countries for RP professionals responsible for regular (scheduled, routine) RP tasks (CH, DE). For example, they are supporting the exposed workers respectively radiation worker in using protection equipment. They survey the radiological conditions on the workplace and generate radiation work permits.

In some countries, a so-called “RP assistant” level exist as a pre-stage of “RP controller” (CH, DE) or they are students (FI). They are supporting the RP-officer junior by preparing the protections measures. They do simple jobs without radiation risk. They take no responsibility and they need no experience.

In FR and in UK there is no distinction between RP senior officers and RP junior officers because the “Radiation Workers” (RW) complete tasks that are within the responsibility of RP junior officers in other countries (e.g., proper use of monitoring equipment and personal protective equipment). In FR the tasks of RP senior officers are undertaken by PCR (persons competent in radiation protection) in a RP service, RP engineering or SSQ (Service in charge of RP controls).

Beside of "RP engineering personnel" in the UK there are different levels of RW (training for unescorted access to controlled areas: 2 hour instruction; training for RW including monitoring on workplace and exit from RCA: 1 week).

In KR legislation does not require RP professionals but makes ET for Radiation Workers mandatory, which last between 12 and 40 h depending on the stage of RW (exposed persons or persons frequently handling radioactive materials)

In most countries RP technician from external RP companies are taken under contract supporting the RP unit during outages and other people-intensive projects.

3.2 Necessary knowledge, experience and skills; requirements on ET

Because of several differences in the countries, a detailed explanation of an example of a training career from CH starting from zero up to RP technician (RP senior officer) is given in the following:

- Normally starting with a basic vocational degree the "RP assistants" have to attend an introduction course. This introduction comprises a two weeks basic classroom training in RP plus 6 weeks on the job training in the facility and a one week basic course on NPP technology (main-systems and operation). This introduction into the career as a RP professional offers the opportunity for the candidate as well as for the employer to decide, whether this career path does or does not fit to the person.
- Based on this introduction, the training of "RP controller" (RP junior officer) starts with a detailed fundamental education and training on mathematics, physics, radioactivity and ionizing radiation. Further on the ET course deals with the most evident exposure situations in a NPP as well as the corresponding RP measures and monitoring procedures (without being too academic in contrast to those courses for RP managers). Accordingly, the course explains the technique of protection equipment and measuring instruments as well as their application. The course further contains a detailed study of the design and operation of NPP systems, which have an influence on RP, including water chemistry, decommissioning and waste management. This course comprises classroom training, table top exercises, exercise using real RP equipment and measurement instruments, exercise in one-to-one environment (or on-the-job-training inside radiological controlled areas). The duration of this intense course is approximately 500 h. The course finishes with written, oral and practical examinations.
- After several years of vocational experience as RP junior officer (in CH in total 3 years, exceptionally 2 years) the RP technician (RP senior officer) training may start, wherein candidates repeat the content of initial RP controller course in depth. The training objective focus on the generating of RP plans for typical (radiological high-risk) jobs in a NPP including the analysis of risk due to normal operation and events. The course lasts 350 h. As a final examination, the candidate has to work out a RP plan for a job within the nuclear facility and has to represent the plan to the examination board.

In total the training courses for reaching the RP technician level in CH comprise around 40 weeks, including 12 weeks of practical exercises, several month on the job training accompanied by an experienced RPE or senior RPO as well as at least 2 years of gathering experience. For the continued ET RP technicians as well as RP controllers have to attend a refresher course of two days each third year.

In DE the requirements on knowledge and experience for the first two stages “RP assistant” and “RP junior officer” (“Strahlenschutzfachkraft”) are nearly identical to CH, with one major difference; The candidates may attend the course voluntarily, but they have to pass written, oral and practical exam, which are rigorous. For the third stage “RP technician” the NPP in Germany arranged an agreement, that persons with a pre-education as technician or engineer having the knowledge of “RP junior officer” and several years of experience may be called “RP technician”. RP technicians may broaden their skills by attending a demanding course for “RP Handcraft Master” comprising several modules including business administration and project management.

In the US, RP technician candidates have to attend nearly the same amount of education and training lessons as in CH. A guideline for training and qualification of RP Technicians contains the requirements for initial and continuing training. The ET schedule starts with an initial training process for RP technician. Duration of initial training is generally six to nine months comprising classroom training, participation in on the job training and task performance evaluations. The RP continued training process consist of refresher training and of operating experience training (lessons learned from events). Duration and frequency of RP continued training: Approximately 24 to 32 hours each calendar quarter.

In UK, there exist a training programme for “RP engineering personnel”, which follows mainly the same scheme as the US RP technician guideline with an initial and a continued training.

In FR, an RP staff specific training program exists, which is a mixture between theoretical/practical training (12 weeks) and on-the-job training (in total 6 month duration). This programme includes lessons about conventional safety, fire safety and radioactive goods transport regulation additional to RP issues.

In most countries, RP technicians from external RP services usually have to meet the same requirements on ET as the RP technicians in the RP unit of the nuclear facility. Additionally to the core RP training as described above, these outside RP professionals have to participate in specific training given by the particular NPP.

3.3 Recognition

The upmost competence level is noted as “RP technicians” (CH, FI, US) and the course is recognised either by specialised company associations, by the Head of RP Unit or by RP Services (DE: Industrie- und Handelskammer, ES, SE, US: National Academy for Nuclear Training). In CH the regulatory body ENSI recognise the courses or individual qualification. Experts from ENSI take part in the final examination.

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THE ROLE OF VERT IN RADIATION PROTECTION EDUCATION

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ABSTRACT

Since 2015 the MBRT school in Haarlem, Netherlands is making use of a virtual system for education, the Vertual (VERT, Hull). The VERT has primarily been purchased for radiotherapy education for simulation of a linear accelerator, but is also being applied in radiation protection education.
Simulation is a derived form of experiential learning. It has to produce knowledge and insight, which are a reflection of knowledge and insight concerning the imitated reality; in this case dealing with the device linear accelerator and the within generated radiation beam. Actually the simulation goes beyond the reality: the course of the radiation beam within the object is visualized. For students this increases motivation, as they directly see the consequence of their acting and gain insight in previously discussed theoretical concepts. Possible mistakes can safely be made.
The VERT has proven its value in visualizing the radiation beam. Especially the display of the dose within the beam combined with anatomy is very insightful for the student. Under- and overdosing are visible across an entire organ 2D; previously this was only visible on Computed Tomography slices which did not give insight whatsoever. The influence of gantry angles, beam size and angulations is been made very clear through the possibility of seeing ‘inside’ the patient.
Beside the application in radiotherapy education, the VERT is used in radiation protection education. A part of the curriculum is a radiation protection practicum. With this practicum the student learns to apply radiation protection principles within radiology and nuclear medicine. Therefor use has been made of bucky systems, a gamma camera and a radiotherapy simulator. Since 2015 the VERT system is applied in the practicum. Initially this was out of necessity because of the removal of the radiation therapy simulator. Now this is an enrichment of the practicum, since the application of radiation protection principles within radiotherapy are discussed. In the practicum experiments with the VERT the relation between monitor units (MU) and dose under influence of different parameters such as distance and beam size are investigated. Aided by the VERT these parameters are readily and easily adjustable.
In both fields radiotherapy and radiation protection the VERT system offers the student the possibility to visualize a radiation beam and the influence of it, in a safe environment. By using the VERT concepts such as build-up, energy dependence and the square law get a practical- in stead of only a theoretical meaning.

1. Introduction

One of the subjects in the Higher Education Medical Imaging and Radiotherapeutic Techniques (MBRT) is radiation physics. The radiation physics subject educates to a separate diploma, the radiation expertise diploma level 4a/4b. The goal of the subject is to learn the student to work with ionizing radiation in his profession in a conscious and safe manner. For this it is necessary for the student to know, understand, apply and analyze the theory behind physical and radiobiological concepts. This by applying different forms of education and examining. One of the exams is the radiation expertise practicum 1. During this practicum the student performs a number of eight experiments, four with a bucky system, two with a cobalt source and gamma camera and two with the VERT system, Virtual Environment for Radiotherapy (Vertual, Hull,2007(1)).
The VERT is a virtual accelerator, with all features of a real accelerator apart from emitting radiation, which is projected on a large screen through a beamer. The accelerator can be handled by means of real remote controllers, which are similar to the remote controllers of the accelerator trade mark which is projected. The software program of the VERT gives the possibility to make use of a physics module. In this module various virtual measurements are possible with various sorts of detectors.
In the afore mentioned practicum the students perform two experiments with the VERT. The first experiment consists of a measurement with an ionizing chamber in a phantom, the second of a watertank measurement.

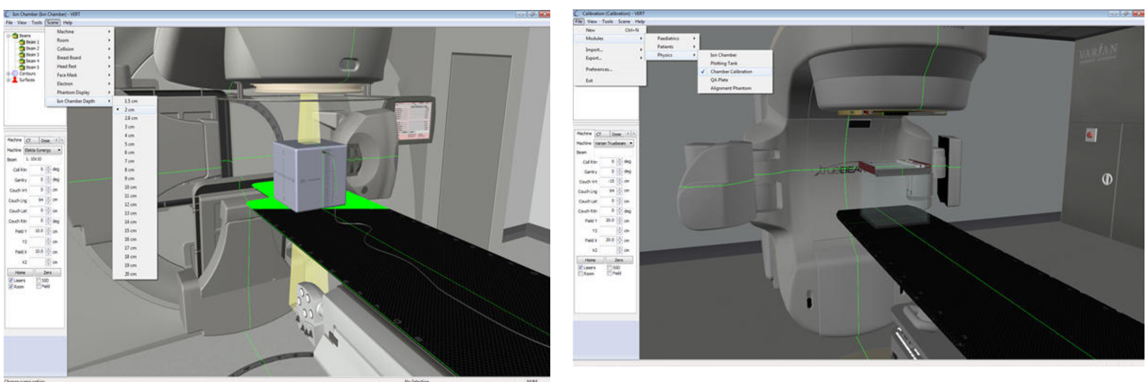


Fig.1 Ionising chamber and watertank in the VERT system.

These experiments have been introduced as replacement for two experiments on the radiotherapy simulator, which used to be located at the skillslab. One experiment is replaced for a similar one and the other experiment is newly written for the VERT. The VERT offered new possibilities for experiments because the system is very user-friendly and because it is a virtual environment and there is no building and pulling down during the experiment.
The simulator which was first used is written off and removed. This made it necessary to start performing the experiments on the VERT. The question raises if these experiments fit within the radiation protection education and give the same learning efficiency.
For this the following research question is formulated:
'In what degree can experiments on ionizing radiation, performed with radiation emitting apparatus, within the radiation protection practicum, be replaced by virtual experiments on ionizing radiation?'
To investigate this a survey is dispersed amongst current second year students, who have recently performed the practicum and furthermore a literature study is performed.

This study explores both applying VERT within medical education and applying other virtual simulations within medical education and the hereby acquired learning efficiency.

2. Methods and Materials

The exploration for the research question:
'In what degree can experiments on ionizing radiation, performed with radiation emitting apparatus, within the radiation protection practicum, be replaced by virtual experiments on ionizing radiation?'
consists of a literature study and a survey amongst second year full time MBRT students regarding their experience.
The literature study targets publications on the use of VERT in education and the experiences with virtual simulations in general in medical higher education. The purpose of the literature study is to investigate out of literature if virtual simulations give similar learning efficiency as 'real' practice situations within medical education. The search phrases; VERT, virtual simulations, radiotherapy education and medical education have been used. Articles up to 10 years back are included, this since the VERT system was first installed in 2007. The search engines PUBMED, Education Recources Information Centre and Google Scholar have been used. The articles are reviewed using criteria from Evidence-based practice voor paramedici by C.Kuiper.(2)
The literature study approaches publications from a broad and international perspective. Broad because the use of virtual simulations in medical education in general is taken into account, international because the experience of world wide users of the VERT (who have published) is taken into account. The outcome will then be broader deployable, for example in similar educations like the MBRT in Europe. A literature study is a valid method to investigate experiences of users with a new system like the VERT, because the published literature directly gives insight into the experiences.
The survey targets experiences of the current second year students, who followed the radiation protection practicum 1 (including the VERT experiments). The questions are about the learning efficiency of the virtual experiments compared to the 'real' experiments. The survey is publicized through Survey Monkey^{TM} (1999-2017 SurveyMonkey). The analysis took place in Survey Monkey and Excel (MS Office 2000).
For the survey amongst own students is chosen because the relevance of this study lies mostly within the MBRT and the results have to be applicable there. The survey gives insight in the experiences of the target group of the VERT which makes the results directly transferable to the education. The reliability of these results is high because the survey was conducted amongst the users of the VERT, and they recently performed this experiment. The questions have been discussed by both authors and are partially based upon previous studies on the VERT, like the one by Kane (3).
The resuts of both parts are combined to give answer to the research question.

3. Results Literature Study

First findings from the literature on VERT will be discussed below. Next findings from the literature on simulation in medical education in a more broad meaning are discussed.

3.1 Literature on the VERT system

Since 2007, the year in which the VERT system is introduced, there have been several publications on the system in journals like Radiography and the Journal of Physics. In this paragraph both positive- and negative outcomes on the use of VERT in the various publications are described.

In his article Beavis (4) describes that VERT offers possibilities to simulate complex situations in which set-up errors result in wrong dose measurement. Based on the measurement the student has to try to trace what set-up errors are made. The assessor has the possibility to configure the errors and change them per situation. This offers the possibility to produce much more various cases than in the clinical situation. The study by Boejen (5) also describes the various possibilities that VERT offers. The article describes that VERT offers a possibility for such problems as to little time for practicing in the clinic and it creates possibilities such as a better preparation on psychomotor skills and a safe environment for the student to learn in. Also, according to Boejen, the performance-related pressure on the student is decreased because the pressure of time and patient danger disappears compared to the clinical situation.

Bridge (6) describes that in his study under 42 students the understanding of radiotherapy techniques and concepts increased with 20%. This conclusion is made based upon assessments before and after the use of VERT and upon a focus group interview with the students on the experiences with VERT. On the contrary from a study by Flinton (7) is showed that in assessments where positioning techniques of electron beams are examined the VERT gives less well results than a non virtual simulator. The scores are 3.62 on the VERT against 5.23 on the simulator. The practicing of the positioning techniques was evaluated positively in this study; the 52 participants indicated they were in favour of practicing the technique on the VERT, but did not favour an assessment on the VERT.

However, for similar kind of positioning techniques the study by Green (8) gives very positive results. In this study 40 first- and second year students were followed during an assessment in which through software is measured how well the positioning went. Besides that students reported by means of a survey that their skills and confidence regarding positioning were improved.

The study by James (9) seeks to investigate how the VERT is deployed in Great Britain. In Britain the VERT is placed in many hospitals, where the system apart from educational purpose is also used for testing new techniques and patient informing. The 33 hospitals that posses the VERT all indicate that there are just advantages in the use of VERT, and than primarily in training. The main advantage according to this study is the possibility the system offers that students already possess skills an insight before they enter the clinic.

In the research done by Kane (3) under second year student for experiences with VERT within the course both positive and negative experiences come forward. The students believe the physics module is of value because in practice many students get no experience whatsoever about measurements in the department and VERT does offer this possibility. Another valuable aspect is the possibility to go through the complete routing of the patient on VERT. Considered negative is the lack of experience of the lecturers with the system; students indicate that lecturers do not master the system sufficiently and therefor do not deploy it optimal. In that case the system mainly distracts from the intended learning goal.

The study by Nisbet (10) focuses on the most optimal way of deploying the VERT system within the radiotherapy curriculum. Precisely to prevent inexperience and therefor to little or incorrect use of VERT, this study focuses on the making of a workbook for VERT. This is done by order of England’s National Radiotherapy Advisory Group’s (NRAG). Based upon previous studies this group advises to implement the VERT system into education. This to decrease student dropout, and to increase student’s skills and understanding before they

enter the practical situation. The study shows that the VERT can be utilized for both explaining anatomy, positioning, dose planning and physics to and to teach them skills.
From all above described studies it shows that the VERT system possesses many advantages and only few disadvantages. In the following table all positive and negative sides are once again made clear.

Positive conclusions
No interfering in clinical workflow
No risks of making patient errors (risk free learning)
Cost effective
Better 3D understanding of anatomy
Better 3D dose distribution understanding
Safe and controlled environment
More cases in less time compared to the clinic
Realistic and enjoyable
Better preparation for (psychomotor) skills
A 20% improvement in understanding and perfoming radiotherapy technics.
Practice without time pressure
The self-confidence of the students increases
Negative conclusions
Not suitable for radiotherapy assessments, testing of competencies
Because of inexperience and incorrect use of the system, its a distraction

Tab 2: Positive and negative conclusions for the use of the VERT system

3.2 Literature on virtual simulations in medical education

Medical education focuses on acquiring knowledge and skills. For these skills practicing is necessary; practicing on patients however leads to the risk of 'damaging' the patient. To prevent errors on patients and still provide students with the possibility to practice sufficiently, since the sixties simulators are being developed. The first one was the Sim One from the late sixties, a doll used for anesthesia skills, which possessed several body functions which could be influenced and read out by means of a computer. (11) Since then a lot has been developed and publicized on the use of (virtual) simulators in medical education. In this paragraph both the positive and the negative outcomes on the use of virtual simulators from the various publications are being described.
The study by McIntosh (12) is about the use of virtual reality colonoscopy simulation. The research under 18 medicine students shows that students who had practiced on the virtual simulator needed to call less for help from a supervisor at the first five colonoscopies on patients, 1.94 versus 3.43 times. The students were superior in the skills and had more self-confidence whereby they were better able in performing the procedure. The supervisors and nurses who attended the colonoscopies scored the students higher on their competences than the students who had not practiced on the virtual simulator.
The study by Arora (13) on the use of Virtual reality simulation training in surgery of the temporal bone under 18 students, shows that the students acquire skills better. The system offers the possibility to check the virtual operation for errors. For specific complex skills the system is not realistic enough.
The study done by Norman (14) shows that simulation has a positive effect on learning outcomes, but that the simulation does not need to be very complex and realistic. With recognising and dealing with heart tones a highcomplex simulation only gives 2% more learning effect than lowcomplex simulation.

On the contrary the study by Vankipuram (15) shows however that in more realistic cardiac support simulations the learning efficiency rises. In the study the results of 48 hospital employees with rescuscitation experience on a virtual complex simulator are compared with the results of 48 hospital employees with resuscitation experience on a simple simulator. The group who had worked with the complex simulator scored significantly higher and indicated themselves by means of a questionnaire to have a higher learning efficiency.
The study by Perry (16) looks into the use of virtual simulation in dentistry education. The positive outcomes herein are more effective learning, unlimited number of training hours possible, objective feedback from the system and possible cost reducing. The negative aspects are the start up costs, getting the teaching staff well trained and a limited variation in virtual patients. In the following table all positive and negative aspects are once again made visible.

Positive conclusions
No risks of making patient errors (risk free learning)
Cost effective
Objective feedback from within the system possible
Safe and controlled environment
Better preparation for (psychomotor) skills
Practising without time constraint
The self-confidence of the students increases
Negative conclusions
Limited amount of cases
High start up costs
Teaching staff needs an extensive training before the system can be employed.
A more realistic system does not provide a higher learning outcome.
For complex skills the system is not always sufficiently realistic.

Tab 2: Positive and negative conclusions for the use of a virtual simulator in medical education.

4. Results survey

4.1 Background of the survey

The survey has been spread under 72 second year students who accomplished the radiation expertise practicum I end of January 2017. The survey can be found in appendix A. For clarification of the survey questions in this paragraph the radiation expertise practicum I is briefly explained.
During this practicum the student performs a number of eight experiments, four with the bucky equipment, two with a cobalt source and the gamma camera and two with the VERT system.
The experiments on the bucky equipment are focused on clarification of the theory behind the concepts of half-value layer (HVL), scattered radiation the use of filtering at various tube voltages and Build-up. For these experiments use is made of a Samsung bucky system from the XGEO GC80/GC80V series. The experiments in which the activity of a cobalt source is measured on the gamma camera are related to the inverse square law and the linear relationship between reduction in exposure time and received dose. For these experiments use is made of an Inter Medical gamma camera, of the type MultiCam 2000 eco. The two experiments on the VERT system are about the influence of energy and distance on the

dose and about the influence of distance, energy and fieldsize on the Monitor Unit for a fixed dose of 1 Gy. The figure below clarifies the experiment on MU's.

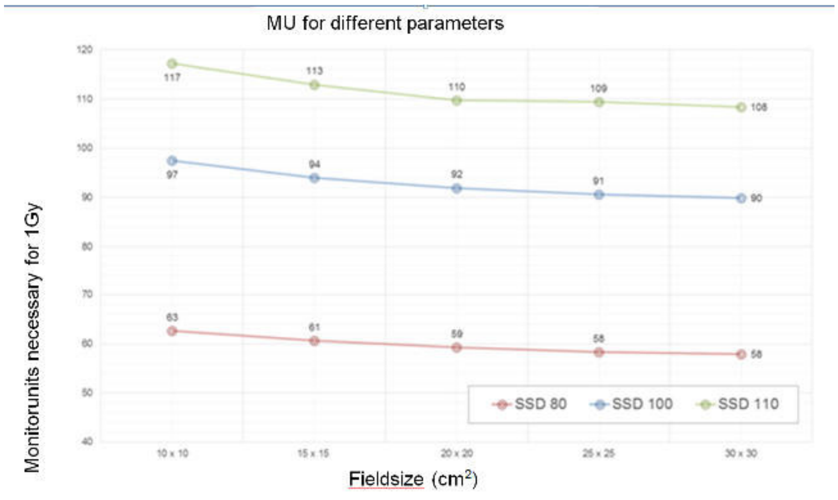
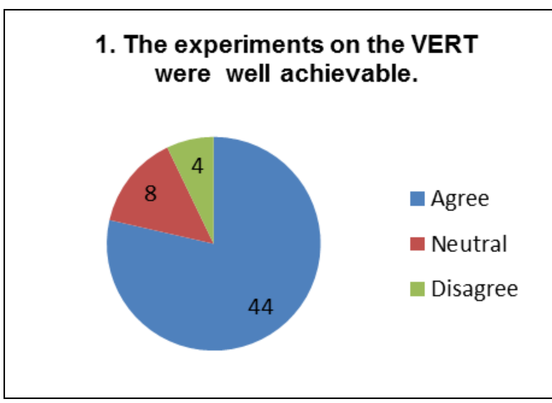


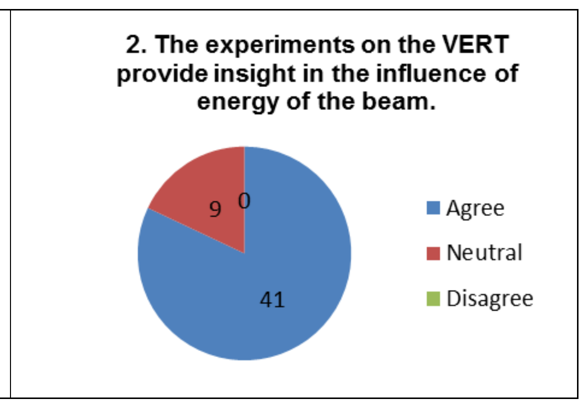
Fig. 2 results experiment on VERT concerning various influences on MU's (17)

4.2. Results Survey

The survey has been spread under 72 second year students by means of SurveyMonkey^{TM}. From this group 69,4 % (n= 50) completely filled in the survey, 8,3% (n=6) partially and 22,2% (n=16) did not respond.

At the first four questions the student was asked if the intended learning outcome was achieved, these questions scored 80,6% average 'Agree'.





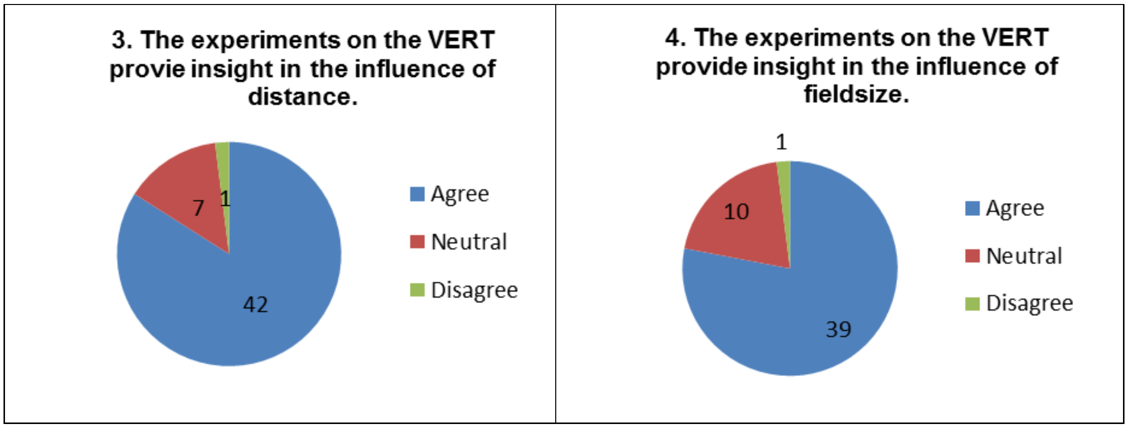


Fig.3 Outcome survey questions 1 to 4

At the fifth question; ‘The experiments on the VERT were equally informative as the experiments on the gamma camera and the bucky’ 58% scored ‘Agree’. At the sixth was asked on which modality the experiments were best executable, here the VERT scored 12% against 74% for the gamma camera and 14% for the bucky equipment.

The figure below shows the results of the seventh question; ‘Which experiment provided the most insight in the theory?’

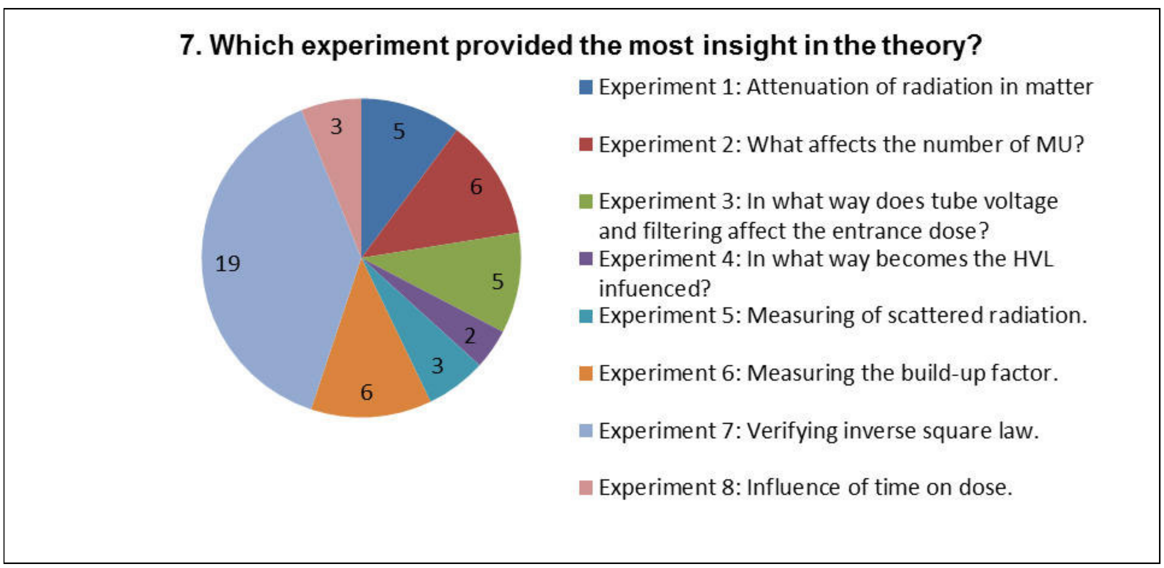


Fig. 4 Outcome question 7

The last question asked for the preference of the student for a ‘real’ setting or the VERT, in which the VERT scored 24% against 76% for the ‘real’ setting.

5. Discussion

The search for the literature study in this research is performed by only one person, whereby it is possible that publications have been missed. Besides it is probable that mostly positive experiences are published and this can give a too positive representation.
The survey is spread under 72 students with a non response of 16 students. In the survey the VERT system gets compared with other modalities like the bucky system and the gamma camera. On these modalities students already have a one-year experience, while on the VERT system the experience is still very limited. This can be the reason that questions on the workability and preference for a real setting or the VERT score that low for the VERT system. If this survey were to be repeated coming academic year the students have similar experience on all modalities and the outcome of the question will be more reliable.

6.Conclusion

From the literature it turns out that the deployment of virtual simulations in medical education primarily has a beneficial effect on the learning efficiency. The student has the possibility to learn theoretical concepts and psychomotor skills in a safe environment without pressure of time. Students are better prepared when entering the practice and have more self-confidence. An important concern is that the system is deployed in the right manner, and that the teaching staff is able to work in a proper way with the system. As far as very complex situations concerned some virtual systems fall short and are therefore not fit (13), also the variation in patients can be limited. On the necessity of making the system as realistic as possible the various studies do not agree , according to Vankipurum (15) the learning efficiency indeed increases while Norman (14) demonstrates that the learning efficiency hardly improves.
The literature focused on the VERT system shows for the greater part the same results. The learning efficiency improves however the system is not for everything deployable. For example for the more complex electron beam settings the opinions are divided. (7)(8)
From the survey under the second year it proves that the students are positive about the use of the VERT system in the radiation expertise practicum. The intended goals are reached ad the experiments are just as insightful as the experiments on the bucky systems and gamma camera. This indicates that in the case of the radiation expertise practicum the learning goal indeed is not to complex to achieve on the system. A remarkable outcome however was that despite the good learning efficiency the students still preferred a real setting instead of a simulator, and that the workability scored lower than on other modalities. This emphasizes that proper guiding in the performing of the experiments is necessary.
The conclusion that can be drawn from this research is that the VERT system can replace ionizing radiation emitting equipment within the radiation expertise practicum, provided the practicum is properly drawn up and the accompanying teachers are sufficiently skillful.
It would be valuable to repeat the survey next study year to investigate the influence of the difference in experience on the modalities.

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7. References

1. Vertual [Internet]. Available from: www.vertual.eu

2. Kuiper C, Verhoef J, Cox K, De Louw D. Evidence-based practice voor paramedici. Den Haag: Lemma; 2008.

3. Kane P. The impact of the VERT virtual reality system on teaching and learning associated with radiation therapy planning skills in the second year of the Bachelor of Radiation Therapy . 2014;(May).

4. Beavis AW, Ward JW. The use of a virtual reality simulator to explore and understand the impact of Linac mis-calibrations. J Phys Conf Ser. 2014;489(1):12086.

5. Boejen A, Grau C. Virtual reality in radiation therapy training. Surg Oncol. 2011;20(3):185–8.

6. Bridge P, Appleyard RM, Ward JW, Philips R, Beavis AW. The development and evaluation of a virtual radiotherapy treatment machine using an immersive visualisation environment. Comput Educ. 2007;49(2):481–94.

7. Flinton D. Competency based assessment using a virtual environment for radiotherapy. Procedia Comput Sci. 2013;25:399–401.

8. Green D, Appleyard R. The influence of VERT characteristics on the development of skills in skin apposition techniques. Radiography. 2011;17(3):178–82.

9. James S, Dumbleton C. An evaluation of the utilisation of the virtual environment for radiotherapy training (VERT) in clinical radiotherapy centres across the UK. Radiography. 2013;19(2):142–50.

10. Nisbet H, Matthews S. The educational theory underpinning a clinical workbook for VERT. Radiography. 2011;17(1):72–5.

11. Abrahamson S, Denson JS WR. Effectiveness of a simulator in training anaesthesiology residents. J Med Educ. 1969;44:515–9.

12. McIntosh KS, Gregor JC, Khanna N V. Computer-based virtual reality colonoscopy simulation improves patient-based colonoscopy performance. Can J Gastroenterol Hepatol. 2014;28(4):203–6.

13. Arora A, Hall A, Kotecha J, Burgess C, Khemani S, Darzi A, et al. Virtual reality simulation training in temporal bone surgery. Clin Otolaryngol. 2015;40(2):153–9.

14. Norman G, Dore K, Grierson L. The minimal relationship between simulation fidelity and transfer of learning. Med Educ. 2012;46(7):636–47.

15. Vankipuram A, Khanal P, Ashby A, Vankipuram M, Gupta A, DrummGurnee D, et al. Design and development of a virtual reality simulator for advanced cardiac life support training. IEEE J Biomed Heal Informatics. 2014;18(4):1478–84.

16. Perry S, Bridges SM, Burrow MF. A Review of the Use of Simulation in Dental Education. Simul Healthc J Soc Simul Healthc. 2015;10(1):31–7.

17. Adriaansz M. Onderzoeksrapport Stralingsdeskundigheid. Haarlem; 2016.

Appendix A

Survey VERT use in the radiation expertise practicum

The aim of the radiation expertise practicum is gaining insight in the theory by means of experiments. Since last schoolyear we use the VERT for this also. I would like to know what your experiences are and opinion is surrounding the use of the VERT in the Radiation Expertise practicum. The results of this survey will be handled in the poster that Marcel and Fleur are allowed to present on the International Education and Training in Radiological Protection congress. We hope that you participate, thank you in advance for your effort!

The experiments on the VERT were well achievable.

- *Agree*
- *Neutral*
- *Disagree*

The experiments on the VERT provide insight into the influence of energy of the beaml

- *Agree*
- *Neutral*
- *Disagree*

The experiments on the VERT provide insight into the influence of distance.

- *Agree*
- *Neutral*
- *Disagree*

The experiments on the VERT provide insight into the influence of fieldsize.

- *Agree*
- *Neutral*
- *Disagree*

. The experiments on the VERT were equally informative as the experiments on the gamma camera and the bucky.

- *Agree*
- *Neutral*
- *Disagree*

Which experiments were best workable:

- VERT
- Gammacamera
- Bucky system

Which experiment provided the most insight into the theory:

- Experiment 1: Attenuation of radiation in matter
- Experiment 2: What affects the number of MU?
- Experiment 3: In what way does tube voltage and filtering affect the entrance dose?

- Experiment 4: In what way becomes the HVL influenced?
- Experiment 5: Measuring of scattered radiation.
- Experiment 6: Measuring the build-up factor.
- Experiment 7: Verifying inverse square law.
- Experiment 8: Influence of time on dose.

What do you prefer; an experiment in a virtual setting like the VERT or an experiment in a 'real' setting like the bucky room.

- VERT
- ‘real’ setting

APPLICATIONS OF IONIZING RADIATION – DISCLOSURE IS NECESSARY

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ABSTRACT

Even though the increasing of the application of ionizing radiation in areas such as medicine, industry, safety and research, the general population remains unaware of its applications, risks and benefits. Generally, the terms radiation and nuclear energy are associated with the atomic bomb, cancer, or mutation. Thus, it is observed that people construct their own concepts, influenced by military applications, accidents or even superhero movies or cartoons, where radioactivity is regarded as something extremely dangerous that causes damage to the people and to the environment. Consequently, there is a cultural aversion over the peaceful use of ionizing radiation and their applications in various sectors of society. Since the use of IRs is increasing, misconceptions about radioactivity can harm society causing difficulties in implanting new technologies that involve ionizing radiation as well as panic in the face of a radiation emergency, as small as may it be, which can hinder the response to the emergency. Therefore, it is necessary to demystify radioactivity. This can be done in schools through the dissemination of the applications of IRs in various practices and associated radiological protection. The aim of this work was to evaluate the level of knowledge regarding IRs of students in the last year of high school, as well as present to them a response for radiation emergency and the various applications of IRs. The students answered a quiz with 10 questions in various applications of ionizing radiation, namely, nuclear medicine, food irradiation, computed tomography, industrial radiography, radioactive tracers, irradiation sterilization, radiotherapy and nuclear meters. The questions consisted of statements with the following options: right, wrong or I do not know. After the quiz, two lectures were presented: Radiological Accident in Goiânia and Ionizing Radiation Applications. The number of correct answers was small, confirming that most students are unaware of the applications of ionizing radiation, which could explain the phobia observed when addressing the topic. During the presentation of lectures, students clearly demonstrated their fascination with the themes, asking many questions and expressing surprise to know in which ways ionizing radiation is present in everyday life. Teachers were also very interested and participative. Partnerships are being signed with the schools so that this disclosure occurs annually in order to arouse young people's interest in the nuclear area.

1. Introduction

Applications of ionizing radiations (IRs) are increasing in world. Too many benefits are obtained to society by using radiations in different areas as engineering, industry, research, security, construction and mainly in medicine. But, these applications seem to be unknown by the population which generally associate the radiation with bomb, mutation or cancer. It is observed that people construct their own concepts, influenced by military applications, accidents or even superhero movies or cartoons, where radioactivity is regarded as something extremely dangerous that causes damage to the people and to the environment. Consequently, there is a cultural aversion over the peaceful use of ionizing radiation and their applications in various sectors of society.

Although Brazilian educational legislation requires issues as nuclear energy and radiation applications should be taught in high school, it is easy to find many points that hinder such law requirements. A research in Brazilian publications shows many difficult pointed by teachers to present radiations issues in high school: small numbers of scholar books presenting this issue; students have previous misconceptions about this issue; teachers themselves have previous misconceptions about the issue that prevent them to talk about it without own opinion [1].

A lesson learnt from radiological accident in Goiânia – Brazil put in evidence that people did not know the minimum about radioactivity, causing several difficult in the communication with public. Psychological, economic and commercial effects, as panic, stigmatizing, and shunning people were increased by the lack of knowledge. A psychologist who worked in Goiânia accident strongly recommends clarifying the population about applications of ionizing radiation as well as their risks and their benefits [2].

The need of talk about radiation threats and safety to community was pointed out by Ansari [3] in a book directed to professionals and to population. Using a common language, the author explains natural occurrence of radiation and tells to community how to protect themselves in a situation of radiation emergency. Impacts from a radiation emergency can be reduced by actions taken and by how the population reacts to such situation.

After Fukushima, some studies were carried out and they suggest a new approach about radiation needs to be addressed in schools [4, 5]. The demands for education on radiation subjects increased not only by professionals but also by students. The NIRS (National Institute of Radiological Sciences) is visiting school to conduct classes on radiation basics [6]. Authors conclude that the school visits significantly changed the students' feelings toward radiation from "fear" to "interest" and are helpful for school teachers because they do not have enough knowledge to teach about radiation.

A study carried out with elementary, middle and high school students' evaluated changes in the levels of their perception, knowledge, and attitude for each sector that uses radiation [7]. A communicating strategy was developed to form a consensus on the use of radiation and nuclear power and to improve public understanding. The authors found that the levels of perception, knowledge, and attitude increased highly for sectors that use radiation after the radiation class. They suggest that classes should be provided continuously once positive behavioural changes are expected.

Considering that there is a misconception about radioactivity, this can harm directly the society causing difficulties in implanting new technologies that involve the use of ionizing radiation. The lack of knowledge how to handle safely the radiation usually cause panic to the people about the possibility of any accident with radioactivity. Therefore, it is necessary to demystify what is radioactivity. This can be done in schools, in different levels, through the dissemination the concepts about this subject including several demonstrations of the peaceful applications of the ionizing radiation associated radiological protection.

The aim of this work was to evaluate the level of knowledge of students in the last year of high school regarding ionizing radiation, to clarify the misunderstanding concepts, to present the practices related to a response for radiation emergency and to show the several peaceful applications of ionizing radiation. The students answered a quiz with 10 questions about various applications of IRs.

2. Methodology

As the objective was to evaluate the level of knowledge regarding IRs of students in the last year of high school, a quiz with 10 questions on various applications of ionizing radiation, namely, nuclear medicine, food irradiation, computed tomography, industrial radiography, radioactive tracers, irradiation sterilization, radiotherapy and nuclear meters. The questions consisted of statements with the following options: right, wrong or I do not know.

The 50 students in this study did not have a special class on ionizing applications including quiz statements. The objective was to evaluate their knowledge with the regular classes from the school without any additional improvement in their knowledge. The students were encouraged to be extremely sincere; they had not the obligation to get a good score in the quiz. It was empathized to the students that the most import was to show what they actually known about ionizing radiation applications.

After the quiz, two lectures were addressed about the Radiological Accident in Goiânia - Brazil and The Ionizing Radiation Applications. After the class, the students evaluated their answers to the questions made previously.

3. Results and discuss

The answers percentages are presented in Table 1. The gray cells are the percentages of right answers.

From statement (a) answers, 37% of students recognize nuclear medicine. In statement (c) 36% seems to recognize that patient receive a radiation dose when undergo to this procedure and 51% seem to recognize the same in mammography and radiotherapy as can be seen in statement (f) and (g), respectively. As medicine presents the highest increasing of ionizing radiation applications, these concepts should be better discussed with students considering radiation dose received and risk-benefit relationship.

Statement (g) is a real case occurred about ten years ago. At that time, the conclusion was: the airline lost money! Only 22% of students considered that the airline decision has been wrong.

Tab 1. Percentage (%) results from quiz answered by last year high school students.

Statements	True	False	I do not know
a) Radioactive material can be injected in patient body to do an image exams or clinical treatment.	37	41	22
b) Foods as meals and fruits exposed to ionizing radiation increase the shelf life. These foods can be consumed without damage to health.	6	78	16
c) Computed Tomography is an exam with high resolution image which allows evaluating the health conditions and, the advantage is that patient does not receive radiation dose.	31	36	33
d) Some radioactive elements, in small amounts, are added to beverages to alter the colouring. As the amount of radioactive material is low, these drinks can be consumed freely.	24	37	39
e) In medicine, radiography is used to evaluate a broken arm. In industry, the radiography is used to evaluate manufacturing defects of an aircraft turbine or in a steering column of a car.	53	12	35
f) Mammography is a test recommended for women in order to diagnose early possible breast cancer cases and it reduces the mortality rates in certain age group; however, women who undergo this exam receive a dose of ionizing radiation in the breasts.	51	22	27
g) An airline has refused to carry medical equipment because it carries a radiation sterilization certificate. The airline had a correct attitude because this material could cause damage to the health of passengers during the flight.	31	22	47
h) Paper documents can be longer lasting if irradiated. One technique for conserving books, pictures, maps, photographs is to disinfect such documents by applying a significant dose of ionizing radiation.	16	23	61
i) Radiation therapy is a method capable of destroying tumour cells using bundles of ionizing radiation. A dose of radiation is applied at a given time to a volume of tissue encompassing the tumour, seeking to eradicate all tumour cells.	51	14	35
j) One of the applications of ionizing radiations in the industry are nuclear meters. An example is the density meter in a paper mill, which consists of positioning the source of radioactivity on one side of the paper and the radiation detector on the opposite side. When the radiation passes through the paper it is possible to evaluate the density of the paper.	27	10	63

Food irradiation had the minimum right answers (6% only!). This result is similar to other from students of other schools. Our results may be in accordance with HAN *et al* [7], who said: *"… if accurate information on irradiated food and nuclear power is not provided, (…) then students are expected to vote in opposition to nuclear power and avoid purchasing and consuming irradiated food.*"

The percentages of right answers in the statements (b), (g) and (h) indicate the need to present the use of irradiation in foods, sterilizing and disinfecting.

The major number or right answers was for industrial radiography (statement (f)). The analogy with medicine should be considered.

Statement (d) received 37% of right answers, which considering not possible to add radioactive material in beverages to change the coloring. It indicates that justification and risk-benefit relationship need to be addressed in presentations to students.

Nuclear meters have important applications in industry, but this application of ionizing radiation has to be presented with details to the students as can be observed from Table 1 in statement (j). A detailed presentation has to include issues as radiation properties, penetrating of ionizing radiation, etc.

Answers of the quizzes are presented in the Figure 1. The right answers percentage was 34%. The major number of answers was "*I DO NOT KNOW*", which corroborates the need to addressing the radiation issue in high school.

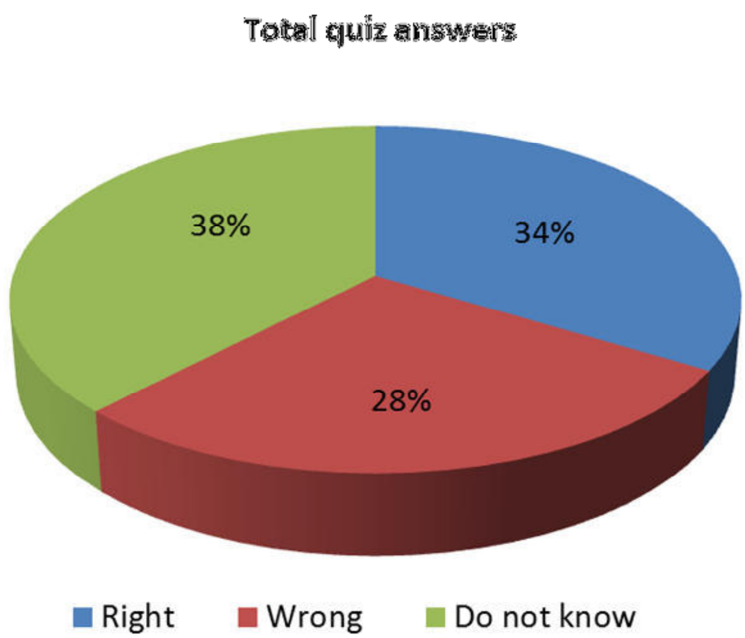

Fig 1. Percentage of total quiz answers of third year high school students: 34% right, 28% wrong and 38% do not know.

Two lectures about fifty minutes each one, are presented. The first one was about the Brazilian experience during the Goiânia radiological accident. Many slides of professionals who worked in that accident were showed. The second class was about the applications of ionizing radiation. In these two lectures the questions and answers of the quizzes that students did before were discussed.

During the presentation of lectures, students clearly demonstrated their fascination with the themes, asking many questions and expressing surprise to know in which ways ionizing radiation is present in everyday life. Teachers were also very interested and participative.

4. Conclusions

The number of correct answers was small, confirming that most students are unaware of the applications of ionizing radiation, which could explain the phobia observed when addressing the topic.

Disclosure of ionizing radiation applications can be the way to demystify radioactivity through the knowledge of many uses of it in the society. Some concepts as justification, risk-benefit and cost-benefit relationship should be addressed in the lectures.

Partnerships are being signed with the schools so that this disclosure occurs annually in order to arouse young people’s interest in the nuclear area.

Most data are being generated by the quiz application in other schools. That will allow a comparison among schools and grade schools. Quiz and a blank space to students make questions or give theirs opinion has help us to improve our lectures to this specific public.

5. References

1. LUCENA E. A., REIS, R. G., SORES, A. P., et al, **Radiação ionizante, energia nuclear e proteção radiológica para a escola,** *Braz J Rad Sciences*, DOI: 10.15392/bjrs.v5i1.215, 2017.

2. IAEA, International Nuclear Information System – INIS Collection. **The Physicological Impact of the Radiological Accident in Goiânia**. Disponível em <http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/20/008/20008221.pdf>. Último acesso: 10 de janeiro de 2017.

3. ANSARI, A. **Radiation Threats and Your Safety: a Guide to Preparation and Response for Professionals and Community**, Taylor & Francis Ltd, ISBN 13: 9781420083613, 2009.

4. Midori Yoshida, Eiichi Honda, Oyunbat Dashpuntsag, **Availability of Japanese Government's supplemental texts on radiation reflecting the Fukushima Daiichi Nuclear Power Plant accident for elementary and secondary education from dental students' understanding**, Journal of Environmental Radioactivity, pages 155-156, 2016.

5. Goto, S., Nozawa, I., Lino, S., **Characteristics of Nuclear Power and Radiation Education for Schools in Fukushima Prefecture, Japan** – *in: International Conference New perspective in Science Education*, 5ª Edition – Florence, IT, 2017.

6. Shimizu Y, Iida H, Nenoi M and Akashi M, **Importance of Supporting School Education on Radiation After the Fukushima Daiichi Nuclear Power Plant Accident**, *J Health Educ Res Dev*, DOI: 10.4172/2380-5439.1000214, 2017.

7. HAN, E. O., KIM, J. R., and CHOI, Y. S., **Educational Effects of Radiation Work-study Activities for Elementary, Middle and High School Students.** Nuclear Engineering and Technology. Volume 46, Issue 3, pags. 447 – 460, 2014.

THE COMPREHENSIVE INFORMATION SYSTEM FOR NORM MANAGEMENT IN KOREA

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ABSTRACT

Korea enacted the *Act on Protective Action Guidelines against Radiation in the Natural Environment* in 2011(effective in July 2012) to protect people against exposure to radiation in a daily life. Under the Act, the target is only natural radiation such as NORM, radioactive materials contained in recyclable scrap metal, including cosmic radiation and terrestrial radiation. It is necessary to manage systemically all this information regarding the radiation in the natural environment. To do so, the NSSC and KINS has developed the CISRAN, a comprehensive information system on radiation in the natural environment, for NORM management since 2012. This paper introduces the status of the development and operation of information system for NORM management, which is one of the ways to provide radiation information to the public.

1. Introduction

The social issues have arisen due to the natural radioactive materials usage since 2007. In addition, the public concerns about radiation have been increased after the Fukushima NPP accident in 2011. For these reasons, in Korea, the *Act on Protective Action Guidelines Against Radiation in the Natural Environment* was enacted in 2011(effective in July 2012), to protect people against the radiation exposure from household items, construction materials or recyclable scrap metals.

According to the Act, the raw materials (NORM), residues and products that contain the natural radionuclides were subject to the Nuclear Safety and Security Commission (NSSC)'s safety management. And also, it forced the NSSC to manage systemically all the information regarding the radiation in the natural environment such as the current status of

- Distribution of raw materials and residues/wastes
- Manufacture or export/import of products containing NORM
- Safety management of cosmic radiation for aircrew
- Etc.

Therefore, it was required to establish a national management system about natural radiation.

Finally, the Korea Institute of Nuclear Safety (KINS), designated as a specialized institute for safety management by the act, set up a web-based system, named CISRAN[i]. It is still being developed for everyone involved to be available for various and useful information and furthermore, made with the purpose of providing public safety.

[i] Comprehensive Information System on Radiation in the Natural Environment

2. Development & Operation of CISRAN

As mentioned above, the CISRAN has been developed since 2012 and started operating in 2014 by KINS. This system consists of three main sites, which are an electronic authorization application system, a field investigation and analysis system, and a radiation portal monitors (RPMs) operating information system.

The dedicated business flow diagram of CISRAN system is given in Fig 1.

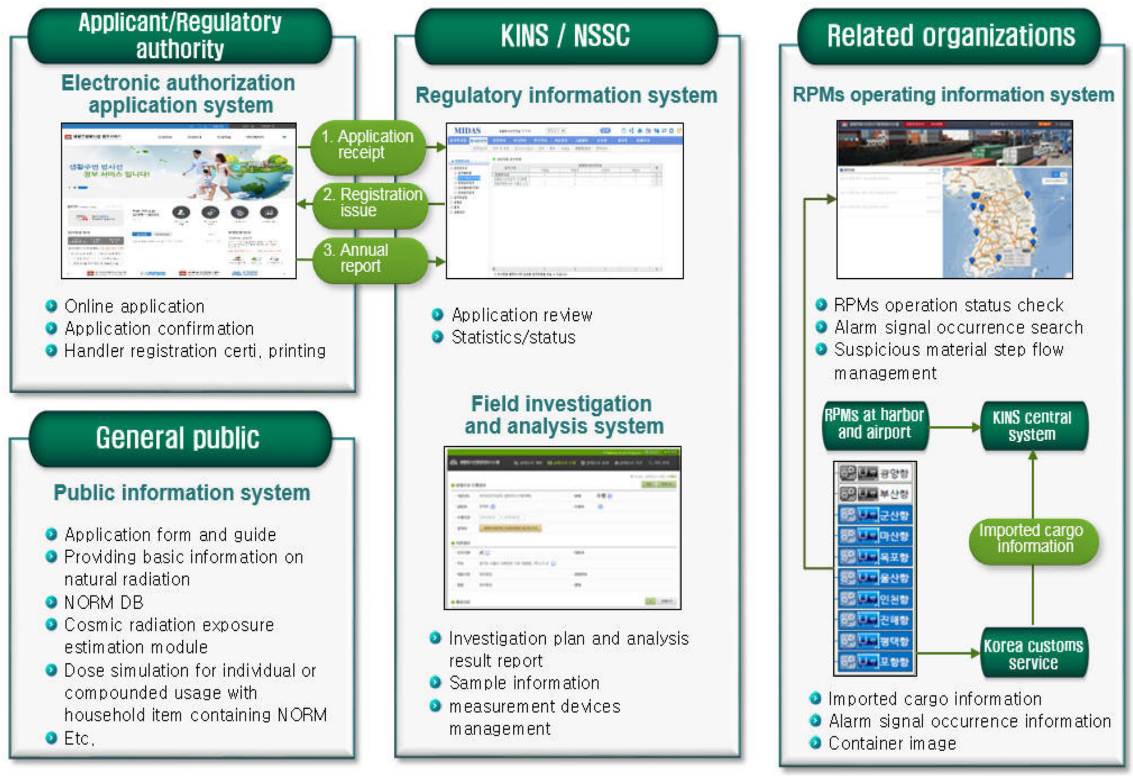

Fig 1. Business flow diagram of CISRAN

Firstly, the electronic authorization application system is a kind of regulatory supporting system to provide the information on regulatory authorization issues regarding handlers using the raw materials (NORMs) or residues. As shown in Fig 1, it can be connected to the regulatory information system (MIDAS) for KINS and NSSC to facilitate the regulatory authority's application review process based on an electronic document and to manage the registration information such as user, handler, materials, certificate and distribution status more efficiently.

Besides the electronic application service, including the public information like basic knowledge, it provides the general public much more useful information related to radiation in the natural environment.

The second is the field investigation and analysis system for KINS, KoFONS[ii], and NSSC. According to the Act, we have conducted the field investigation for safety management on the facilities using the above materials and the workers handling them. The system is covering the information such as an annual plan and schedule for the field investigation,

[ii] Korea Foundation of Nuclear Safety

sample, measurement device and its maintenance, analysis method, result report, and so on, which are being managed systemically through the system.

Lastly, for the RPMs operating information system, it is also related to fulfill the Act. By law, the NSSC shall install and operate the RPMs at airports and harbors to detect the radioactive materials in imported goods. As of the end of 2016, the total number of RPMs operating in Korea is 96. In addition, the government plans to establish up to 116 such devices. This system makes it possible to effectively monitor the operation of RPMs installed at each airport and harbor and grasp the status information of alarms that have occurred and recorded.

Likewise, the CISRAN is an integrated management system for natural radiation which is used by government and other related agencies like NSSC, KINS, KoFONS and even the handlers for the raw materials or residues.

The configuration of CISRAN system is shown in Fig 2.

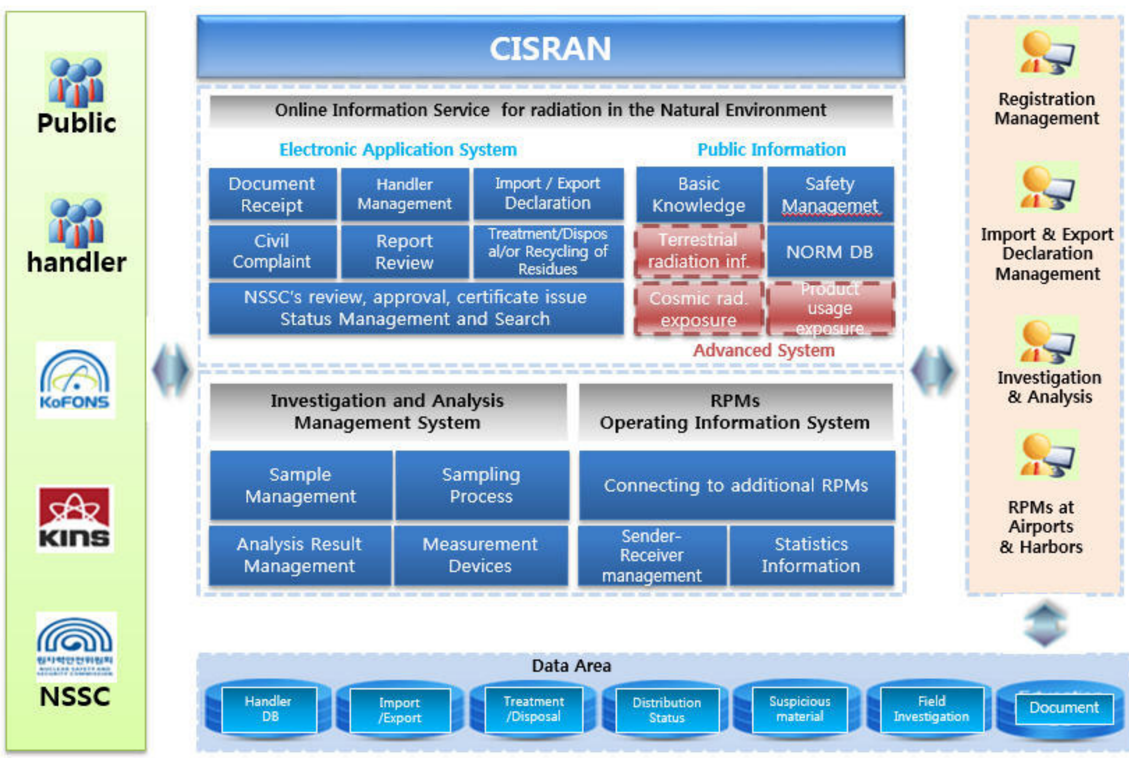

Fig 2. Configuration of CISRAN

3. Advanced function

3.1 NORM Database

NORM database, which is about the raw materials and residues available on domestic markets, was established based on the past 5 years of our field investigation results.

It provides handlers and public with the detailed information on type and concentration of natural radionuclides contained in NORM and even the regulatory judgment of whether or not some materials are subject to the safety management, including general information about industrial raw material and usage purpose of it.

The Fig.3 shows that it is implemented the NORM database in CISRAN.

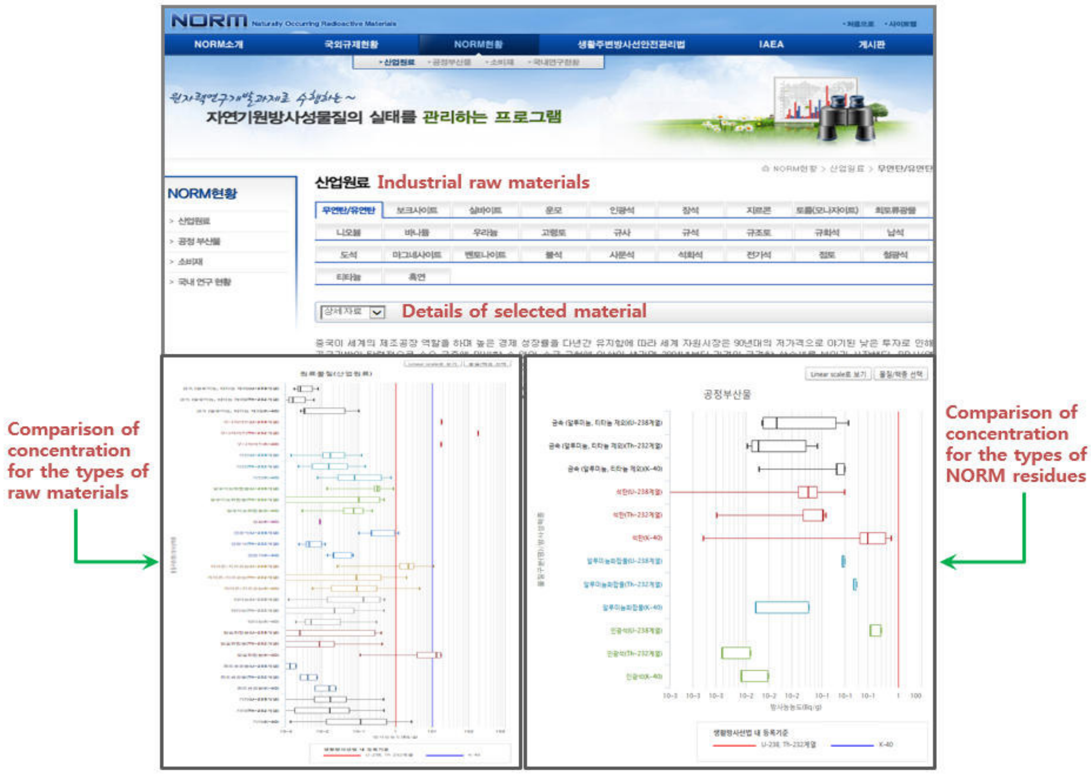

Fig 3. NORM Database

3.2 Cosmic radiation exposure information

There are currently around 14,000 of aircrew (4000 of cockpit crew and 10,000 of cabin crew) working in Korea and annual average about 16 million of people going abroad. Although cosmic radiation exposure during flights is low, as those who need to be in control exist and the popularity of air travel continues to increase, it is important to manage them and also provide the people’s right to know.

In accordance with the Act, it force the air transportation business operator to manage the cosmic radiation exposure for the aircrew on board international air routes. However, domestic airlines depend on the only cosmic radiation assessment program developed by foreign countries. As a result, the values calculated by each airline are different even if they use the same air routes.

It was necessary to develop our own calculation program to solve this problem. So, KINS and KASI[iii] carried out the related research project from 2014 to 2015 and finally developed the dose assessment program regarding cosmic radiation with the research results.

By benchmarking the SIEVERT[iv] of France, it is designed so that people can check the radiation dose received during a flight, by linking to CISRAN.

Simply, user puts some information for point of departure and arrival, then chooses the air

[iii] Korea Astronomy and Space Institute

[iv] https://www.sievert-system.org

routes on that day provided by domestic airlines, after that, the calculated dose value automatically appears on a screen, as shown in the following Fig 4.

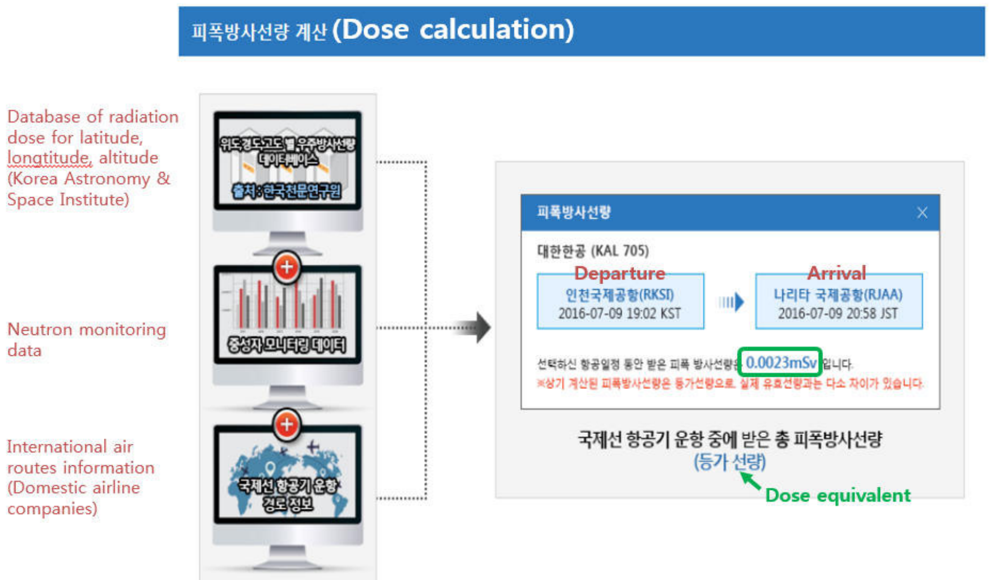

Fig 4. Cosmic radiation exposure information for general passenger

3.3 Consumer products usage exposure information

Due to the usage of building material or consumer product containing NORM, the program for calculating the radiation dose has been establishing and furthermore it would be implemented in CISRAN as following fig 5.

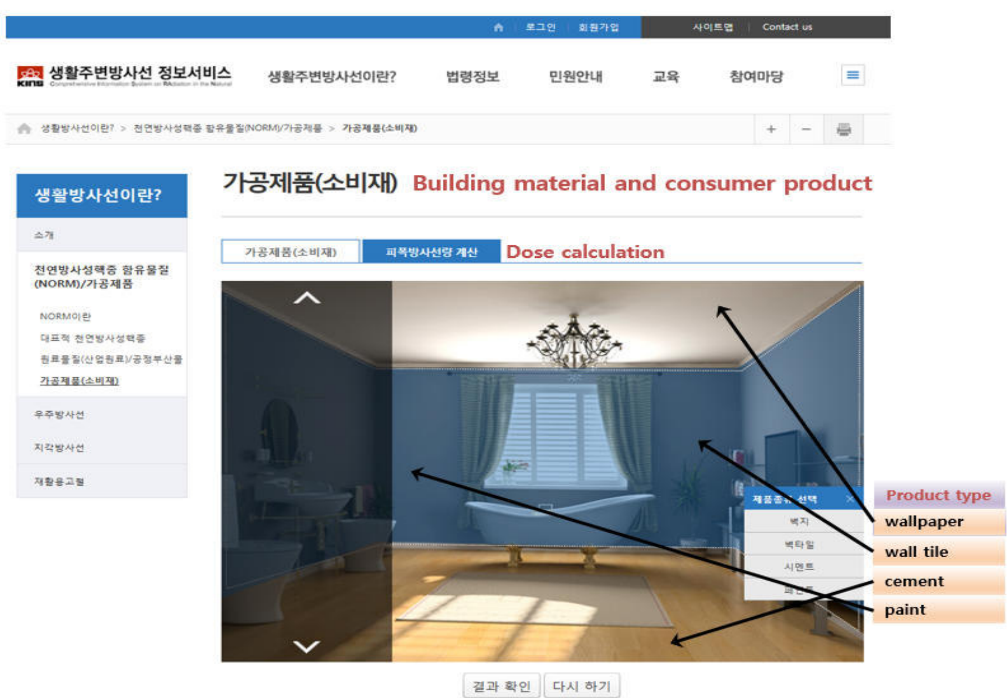

Fig 5. Calculation service for radiation dose to products containing NORMs

On a basis of the radioactivity results for building materials and products according to the latest surveys conducted by KoFONS, it is designed that when user specifies some sources such as the conditions and time of use, then the user's radiation exposure can be estimated automatically through this simulation program.

3.4 Terrestrial radiation exposure information

ICRP recommends the implementation of the optimization process in existing exposure situations and IAEA also emphasizes that national authority should implement the protective actions for the public against exposure indoors due to natural sources of radiation.

To fulfill harmoniously with the international standards, the national reference levels for Rn should be set up first. And then, by reflecting this to the Act, it is required that managing the public's existing exposure by a nation should be mandatory institutionally.

Meanwhile, in Korea, the researches on estimating the potential risk for the existing exposure have carried out for many years, to protect the public to the existing exposure. The terrestrial radiation and the exposure indoors due to radon are considered to be the most important factors in the existing exposure.

KINS completed the technology development for detecting and mapping the national background terrestrial radiation and has surveyed the concentration of radon in the existing dwellings and buildings. The Fig 6 shows these results surveyed, respectively.

In the near future, the information service on existing exposure will be provided to the public based on the collected results above. Through this system, the public might get the average indoor radon concentration and value in their living area. Also, the potential risk level due to existing exposure would be provided.

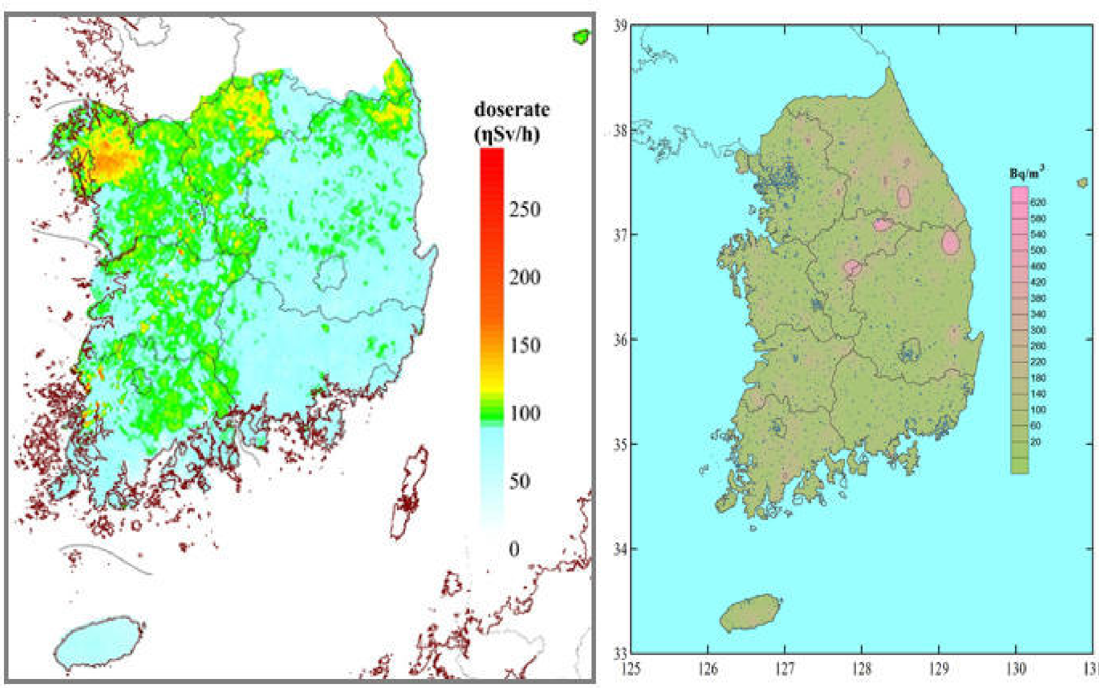

Fig 6. Total dose rate with terrestrial radiation (left) and concentration of radon (right)

4. Conclusion

Korea has completed the regulatory framework regarding the safety management of natural radiation. To fulfill the relevant regulation, the CISRAN for NORM management was developed and operated by the government.

There are not only public information like basic knowledge provided, but also the safety management information including the results of investigation and analysis that regulator performed and legal process between handlers and NSSC served.

With various highly functional items, it has been improving to make much more various information served. Furthermore, it is expected to use for the purpose of technical basis for decision-making related to radiation in the natural environment.

5. Reference

KINS, 2016, Safety Management for Radiation in the Natural Environment 2016

KINS, 2016, Development of Technology for Cosmic Radiation Assessment on International Air Route, KINS/HR-1459

KINS, 2016, Development of Potential Risk Assessment Technologies for Existing Exposure R&D Report, R&D/1305004

IAEA, 2014, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, No. GSR Part 3

ICRP, 2007, The 2007 Recommendations of the International Commission on Radiological Protection, ICRP 103

THE INITIAL KNOWLEDGE LEVEL OF THE PARTICIPANTS TO RADIATION PROTECTION COURSES

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ABSTRACT

The design of radiation protection training programmes involves significant efforts due to the different participants' knowledge levels and often to their various practices. Nuclear Training Centre (CPSDN) within "Horia Hulubei" National Institute of Physics and Nuclear Engineering IFIN-HH develops, over four decades, radiation protection training courses for all practices (excepting NPP ones) involving ionising radiation applications. Currently, CPSDN organises more than 20 training programmes yearly for 400 – 500 participants from different institutions, including IFIN-HH. Most of these courses involves training on radiation protection and radiological safety in medical, industrial and research practices and are approved by the national regulatory body (National Commission for Nuclear Activities Control – CNCAN).

This paper presents our results of the analysis on the initial knowledge of participants in radiation protection training courses with a view to support the programmes design and to ensure their efficiency. In this purpose we developed multiple-choice short tests for CPSDN trainees in order to be taken at the beginning of each training programme. The results of these tests are recorded and computer processed. Detailed analysis of these results was performed both for the initial radiation protection training programme (for beginners) and for the refresher radiation protection training programme.

As a result of these analysis the lacks of the trainees' knowledge were identified, as well as their misunderstandings or confusions. These results would be used in the design of CPSDN training programmes in order to improve training quality and to adapt it to participants' knowledge level.

1. Introduction

In the case of the radiation protection courses, the information about trainees' level of knowledge is difficult to be obtained because participants often come from different practices and have different educational background [1]. Of course, it is desirable the homogenization of the group, but this is not always feasible.

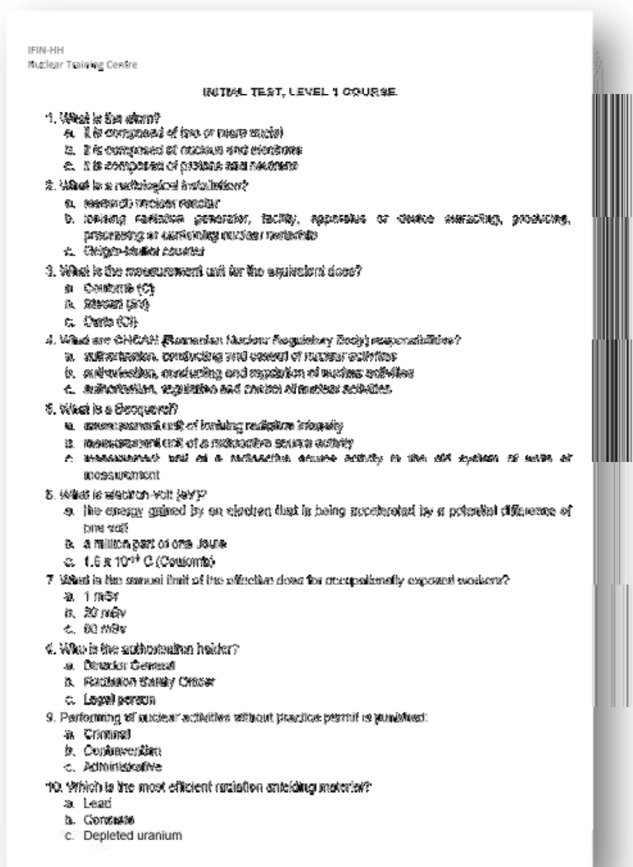
Within "Horia Hulubei" National Institute of Physics and Nuclear Engineering IFIN-HH, Nuclear Training Centre (CPSDN) is developing, since 1970, post-secondary and post-graduate trainings for the personnel involved in practices with ionising radiation sources or advanced physical techniques. The Training Centre offers mainly training programmes in radiation protection and radiation safety in all fields involving the use of radiation, excluding nuclear energy. CPSDN organises more than 20 training programmes yearly for 400 – 500 participants from different institutions, including IFIN-HH. These courses are approved by the national regulatory body (National Commission for Nuclear Activities Control – CNCAN).

In Romania, the system for the recognition of the competencies in radiation protection consists in obtaining the practice permit granted by the regulatory body (CNCAN). The

practice permits are classified into three levels: level 1 for radiation workers, level 2 for radiation protection officers and level 3 for radiation protection experts. The training requirements for personnel are specified in the national regulations [2] and are in compliance with the provisions of the Council Directive 2013/59/EURATOM [3]. Radiation protection training programmes shall be correlated with the specific level of practice permit and with domains of applications: x-ray generators, particle accelerators, sealed sources, unsealed sources, nuclear installations, transport of radioactive materials, practices with low radiological risk.
In order to design the radiation protection training programmes, the acquiring of information on participants' knowledge level is essential for improving the course quality and to fill the gaps [4, 5].
The aim of this paper is to present some of the efforts made by CPSDN in order to evaluate the initial knowledge of participants to radiation protection training programmes.

2. Material and methods

By its quality management system, CPSDN has implemented a procedure to assess trainees' knowledge at the beginning of each training programme. For this purpose we developed multiple-choice short tests with 10 questions and 3-5 answer options each. The tests (Fig. 1) are anonymous and include questions from various fields appropriate for the topic and level of the course (basic physics, legislation, applied radiation protection).


IFIN-HH
Nuclear Training Centre

INITIAL TEST, LEVEL 1 COURSE

1. What is the atom?
   a. it is composed of [illegible]
   b. it is composed of nucleus and electrons
   c. it is composed of protons and neutrons
2. What is a radiological installation?
   a. research nuclear reactor
   b. ionising radiation generator, facility, apparatus or device extracting, producing, processing or containing nuclear materials
   c. Geiger-Muller counter
3. What is the measurement unit for the equivalent dose?
   a. Coulomb (C)
   b. Sievert (Sv)
   c. Curie (Ci)
4. What are CNCAN (Romanian Nuclear Regulatory Body) responsibilities?
   a. authorization, conducting and control of nuclear activities
   b. authorization, conducting and regulation of nuclear activities
   c. authorization, regulation and control of nuclear activities.
5. What is a Becquerel?
   a. measurement unit of ionising radiation intensity
   b. measurement unit of a radioactive source activity
   c. measurement unit of a radioactive source activity in the old system of units of measurement
6. What is electron-volt (eV)?
   a. the energy gained by an electron that is being accelerated by a potential difference of one volt
   b. a million part of one Joule
   c. 1.6 x 10[illegible] C (Coulomb)
7. What is the annual limit of the effective dose for occupationally exposed workers?
   a. 1 mSv
   b. 20 mSv
   c. 50 mSv
8. Who is the authorisation holder?
   a. Director General
   b. Radiation Safety Officer
   c. Legal person
9. Performing of nuclear activities without practice permit is punished:
   a. Criminal
   b. Contravention
   c. Administrative
10. Which is the most efficient radiation shielding material?
   a. Lead
   b. Concrete
   c. Depleted uranium

Fig. 1. The initial test form for the level 1 training programme

Such specific tests were developed and implemented both for the initial radiation protection training programme (level 1) and for the refresher radiation protection training programme (level 2). In the latter case, the test has a higher degree of difficulty because the participants to the refresher course have relevant experience in the nuclear field (at least 5 years).
Data from 230 tests were collected and processed for the level 1 training programme. The results of these tests are recorded and computer processed using a spreadsheet software.
Only personnel who worked in the nuclear field at least 5 years and who have previously graduated an initial level 2 training programme could participate at the refresher radiation protection training programme (level 2). Therefore, in this case, the test is more difficult and includes more questions on applied radiation protection. Data from 79 tests were collected and processed for this type of training programme.

3. Results

We will present data and their analysis for the two types of courses mentioned above: level 1 (initial training) and level 2 (refresher training).
The data are processed automatically after entering the answers into a spreadsheet software. For the level 1 course, the data processed from 230 tests showed a mean score of 5.66 points (of maximum 10) with the distribution shown in figure 2.

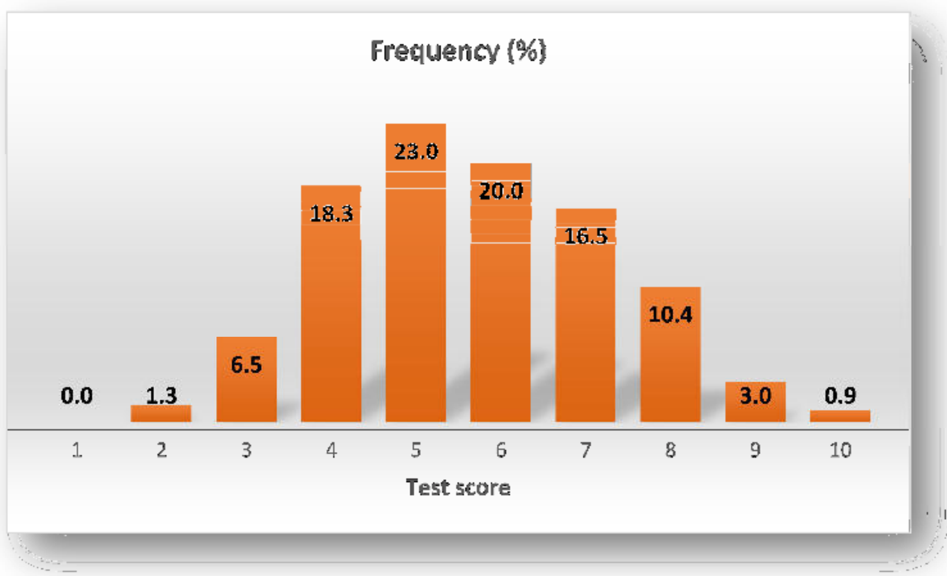


Fig. 2. Distribution of the test scores of the participants to level 1 course

A useful analysis is related to the correctness of answers given for each question (Fig. 3).

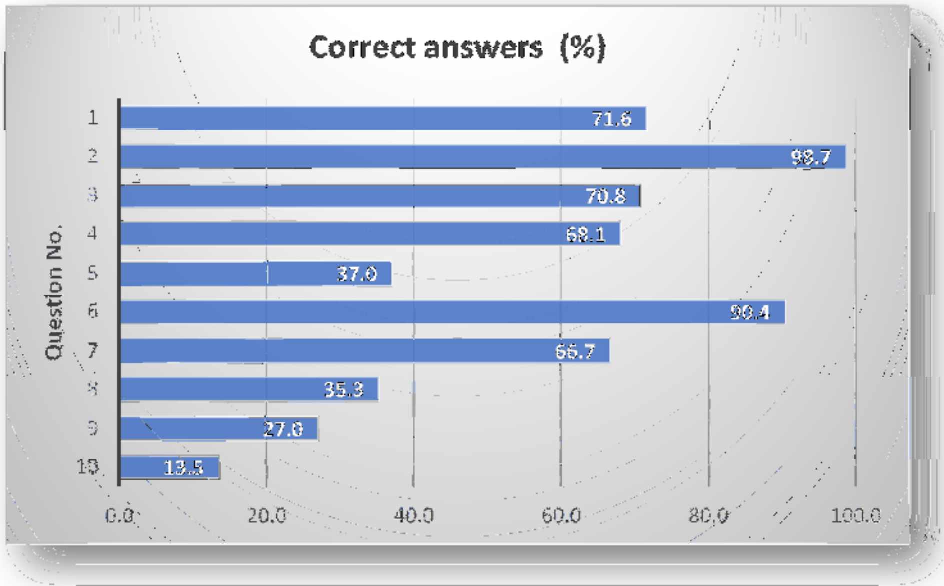


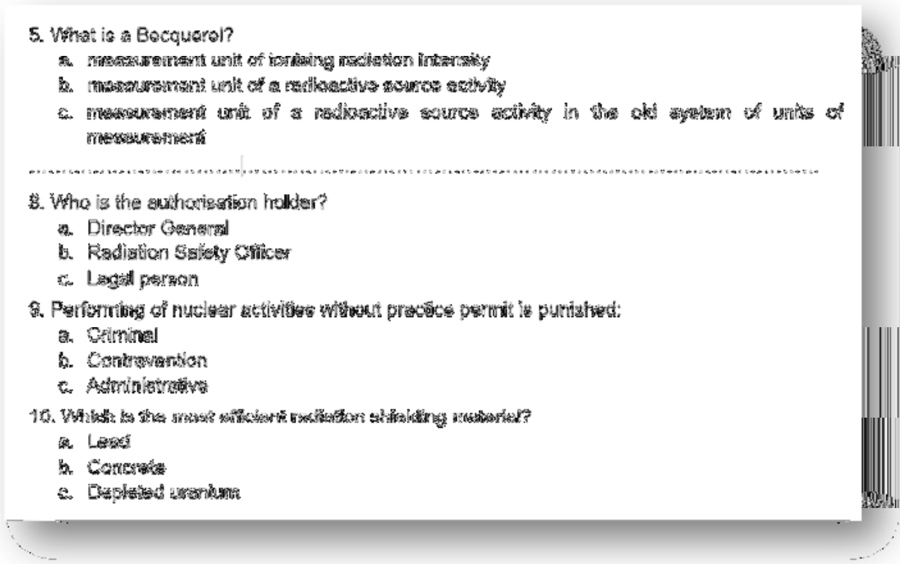
Fig. 3. Percentage values of correct answers for each question of the test (level 1 course)

In the electronic format there is recorded not only the correctness of the answer (correct / incorrect) given by trainee, but also the choice indicated for each question (the letter *a*, *b* or *c* that represents the given answer). Therefore it is possible to evaluate not only the correct answers but also the incorrect ones (Table 1) and hence it can be assessed deeper the initial knowledge of participants on various issues related to radiological protection.

Choice	Question No.									
	1	2	3	4	5	6	7	8	9	10
	%	%	%	%	%	%	%	%	%	%
a	2.2	0.4	11.9	17.9	31.7	90.4	21.6	14.3	69.9	83.4
b	71.6	98.7	70.8	14.0	37.0	0.9	66.7	50.4	27.0	3.1
c	26.2	0.9	17.3	68.1	31.3	8.7	11.7	35.3	3.1	13.5

Tab 1: The choices given for each question (percentage);
the correct answers are pointed in green (level 1 course)

Analysis of the answers given for each question (Fig. 3) shows that for two questions the correctness is more than 90%, for four questions is 60% - 90% and for four questions is less than 50%. The questions that have been answered correctly less than 50% are the Questions No. 5, 8, 9 and 10 (Fig. 4).


5. What is a Becquerel?
   a. measurement unit of ionizing radiation intensity
   b. measurement unit of a radioactive source activity
   c. measurement unit of a radioactive source activity in the old system of units of measurement

8. Who is the authorisation holder?
   a. Director General
   b. Radiation Safety Officer
   c. Legal person

9. Performing of nuclear activities without practice permit is punished:
   a. Criminal
   b. Contravention
   c. Administrative

10. Which is the most efficient radiation shielding material?
   a. Lead
   b. Concrete
   c. Depleted uranium

Fig. 4. The questions that have been answered correctly less than 50% (level 1 course)

It can be noted here that one of the questions is from basic physics, two are related to legislation and one is related to applied radiation protection. The analysis of the choices (a, b or c) shows that, regarding the Question No. 5, there is a confusion between the radioactive source activity and the intensity of radiation. Also, the using in practice of another unit (Curie) probably leads to significant choices of the option (c). On legislation, at Question No. 9, the selection rate of 69.9% for the incorrect answer (a) shows a perception even more restrictive than requires the nuclear law in force. The use of lead for shielding of ionizing radiation in many nuclear applications leads to the opinion that it would be the most effective shielding material and therefore the overwhelming wrong answers to the last question. Analysing these results, correlated with the results to the questions with correct answers more than 50%, some of the topics and sub-topics included in the syllabus of this type of course (basics of nuclear physics, some aspects of the legislation, the interaction of radiation with matter, etc.) can be adjusted.

For the refresher radiation protection training programme (level 2), the data processed from 79 tests showed a mean score of 5.47 points (of maximum 10) with the distribution shown in Figure 5.

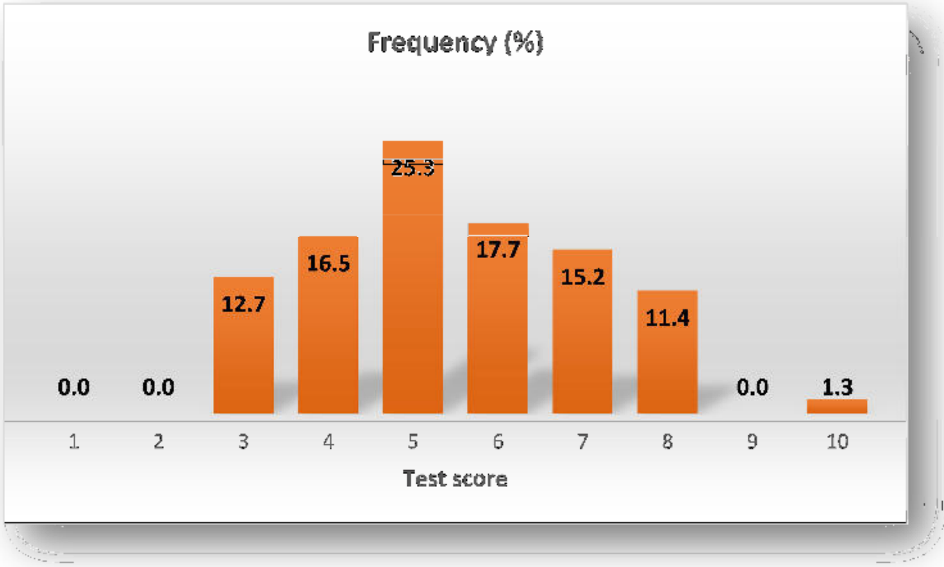


Fig. 5. Distribution of the test scores of the participants to level 2 course

Here it can be noticed the absence of the very low scores (1 and 2), and also of the higher scores (9, 10), probably due to the higher degree of difficulty of the test.
The analysis of the correctness of the answers (Fig. 6) in this case indicates that for one question has been answered correctly more than 90% participants, for two questions the correctness is 60% - 90%, for two questions is 50% - 60% and for five questions is less than 50%.

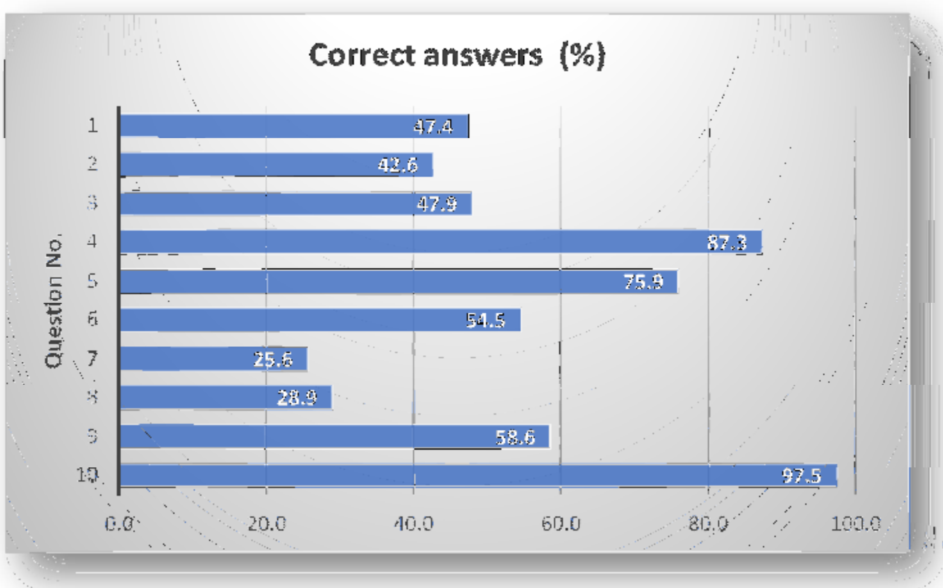


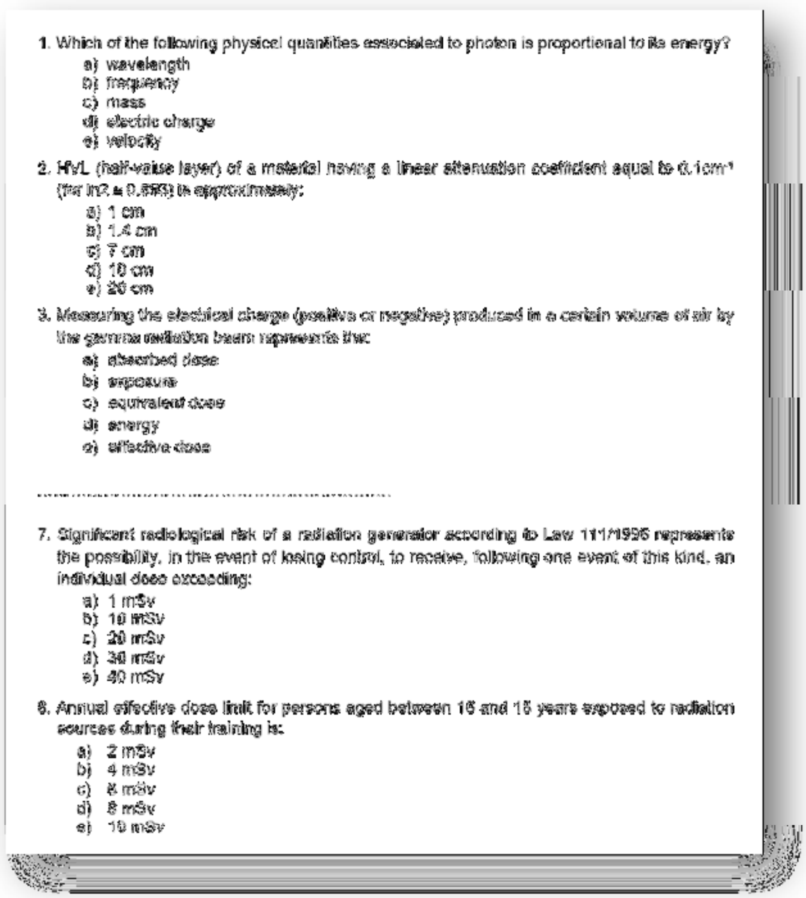
Fig. 6. Percentage values of correct answers for each question of the test (level 2 course)

The analysis of the choices selected by participants (5 options in this case) will allow to evaluate the knowledge of the trainees at the beginning of the training programme in order to improve the quality of this type of programme (Table 2).

Choice	Question No.									
	1	2	3	4	5	6	7	8	9	10
	%	%	%	%	%	%	%	%	%	%
a	29.5	20.6	19.2	2.5	17.7	7.8	25.6	50.0	1.4	2.5
b	47.4	36.8	47.9	87.3	0.0	5.2	21.8	3.9	58.6	0.0
c	5.1	42.6	16.4	1.3	2.5	13.0	50.0	28.9	28.6	0.0
d	1.3	0.0	12.3	7.6	3.8	54.5	1.3	1.3	10.0	97.5
e	16.7	0.0	4.1	1.3	75.9	19.5	1.3	15.8	1.4	0.0

Tab 2: The choices given for each question (percentage);
the correct answers are pointed in green (level 2 course)

The questions that have been answered correctly less than 50% are the Questions No. 1, 2, 3, 7 and 8 (Fig. 7).



1. Which of the following physical quantities associated to photon is proportional to its energy?
   a) wavelength
   b) frequency
   c) mass
   d) electric charge
   e) velocity
2. HVL (half-value layer) of a material having a linear attenuation coefficient equal to $0.1 cm^{-1}$ (for $\ln 2 \approx 0.693$) is approximately:
   a) 1 cm
   b) 1.4 cm
   c) 7 cm
   d) 10 cm
   e) 20 cm
3. Measuring the electrical charge (positive or negative) produced in a certain volume of air by the gamma radiation beam represents the:
   a) absorbed dose
   b) exposure
   c) equivalent dose
   d) energy
   e) effective dose

....

7. Significant radiological risk of a radiation generator according to Law 111/1996 represents the possibility, in the event of losing control, to receive, following one event of this kind, an individual dose exceeding:
   a) 1 mSv
   b) 10 mSv
   c) 20 mSv
   d) 30 mSv
   e) 40 mSv
8. Annual effective dose limit for persons aged between 16 and 18 years exposed to radiation sources during their training is:
   a) 2 mSv
   b) 4 mSv
   c) 6 mSv
   d) 8 mSv
   e) 10 mSv

Fig. 7. The questions that have been answered correctly less than 50% (level 2 course)

Two of these questions are from basic and specific physics (Questions No. 1 and 3), the Question No. 2 is a practical exercise in applied radiation protection field and the Questions No. 7 and 8 are from basic legislation with little practical application. The analysis of the choices in this case shows confusing answers to the questions of physics and practical exercise, and the answers to the questions on legislation were completely erroneous. It was a confusion with dose limits for occupationally exposed workers to the Question No. 7 and answers with no basis to the Question No. 8. Correlation with the questions that have correct answers in a greater extent, allows the experts of the Nuclear Training Centre to establish the didactic strategy for this type of training: emphasis on applied exercises in the field of radiation protection and on the advanced concepts of radiation physics and legislation.

4. Conclusions

The results of the analysis on the initial knowledge of participants in radiation protection training courses will support Nuclear Training Centre to identify the lacks in the trainees' knowledge, as well as their misunderstandings or confusions. This will allow trainers to determine teaching approach for each type of course.

The analysis will lead to continuous improvement of the contents of the radiation protection training programmes by adjusting some of the topics and sub-topics contained in the programme and emphasizing on the applied exercises on radiation protection.

Finding out as much as possible regarding the initial knowledge level of the participants is an important milestone in the success of a course. The results presented would be used in the design of CPSDN training programmes in order to improve training quality and to adapt it to the participants' knowledge level.

5. Acknowledgements

This work was partially supported by the Romanian Ministry of Research and Innovation through "Nucleu" Programme – Project PN 16 42 03 03.

6. References

[1] Matjaž Koželj, Where is the border between professional and radiation protection education and training, ETRAP 2013 5th International Conference on Education and Training in Radiological Protection, 13 - 15 March 2013 Vienna, Austria (2013)

[2] National Commission for Nuclear Activities Control, "Norms on issuing of practice permits for developing nuclear activities and designation of radiation protection qualified experts", Bucharest (2002) (in Romanian).

[3] European Commission, Council Directive 2013/59/ Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation. Official Journal of the European Communities L 13 (2014)

[4] P. M. Sadler, The Initial Knowledge State of High School Astronomy Students, unpublished doctoral dissertation, Harvard University, Cambridge, MA (1992)

[5] I.A. Halloun, D. Hestenes, The initial knowledge state of college physics students, American journal of Physics 53.11, 1043-1055 (1985)

POTENTIAL FOR ACTIVE ENGAGEMENT IN RADIATION PROTECTION TRAINING

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ABSTRACT

At Louisiana State University and Agricultural & Mechanical College (LSU) in Baton Rouge, Louisiana, USA, thousands of students have benefitted from the incorporation of active engagement strategies in STEM (Science, Technology, Engineering, and Math) disciplines. Students utilizing these opportunities are found to have statistically increased course performances and retention rates. Incorporation of these strategies at other universities in well-designed pre-test and post-test settings also indicated that students showed improvements in scores more than double those using traditional approaches. As LSU Radiation Safety Office conducts numerous trainings for different audiences regularly, we are interested in finding whether these strategies would also be effective if implemented in radiation protection training. Research suggests that as little as 5% of content is retained in lecture based trainings. This is unacceptable when a key component of safety relies on successful training of the individuals themselves. A comprehensive review was performed to summarize several of the utilized active engagement strategies in safety training and how they could be used in radiation protection training. The literature review revealed that several of the issues that lead to poor content retention in radiation protection training are very similar to those regularly studied in pedagogical research. Incorporation of applicable strategies that include problem based learning, andragogic approaches, and learner centered training manuals would likely significantly improve the amount of information that the trainee retains. While statistical testing of long-term training success is very difficult in a real world environment, data suggests that at minimum increased trainee self-efficacy is well reported. With such evidence of improvement, preliminary research has begun to determine whether full incorporation of these strategies could be feasible in this environment. Nonetheless, research suggests that there is not a consensus on the difficulty of implementation. While some argue that, in the long term, active-learning based teaching may take the same or less effort on the instructor. Others identify a large upfront time and effort investment that may not be cost effective. It is likely the case that starting small and slowly implementing these active engagement strategies over a long period of time may be the most prudent method.

1. Introduction

1.1 Background

At Louisiana State University and Agricultural & Mechanical College (LSU), initial radiation protection training (like many other environmental health and safety programs) involves a series of online slide presentations followed by written exams specific to the type of radiation the trainee plans to work with. The online portion of the training is separated into 12 modules (or 12 PowerPoint slide presentations); 6 of which are required of all users and are general radiation safety guidelines, and the other 6 are specific to different types of radiation sources such as radionuclides, x-ray production machines, sealed radioactive sources, and irradiators.

Once a trainee receives a satisfactory score on the written exams, the individual is considered as a radiation worker. After the first year, annual, in-person refresher trainings are required to be delivered by the principal investigator responsible for the trainee. Regular radiation surveillance inspections provide feedback on how successful the refresher trainings are. If a common trend is noticed in worker's weaknesses of understanding, the training and exams may need to be revisited to make sure the information is appropriately communicated. For example, during semi-annual inspections we may find that workers are forgetting to test the battery of a Geiger–Müller meter before use, the online slides are then modified to address this oversight and an additional related test question is added to the exam. Alternatively, the responsible principal investigator may be notified of certain information they need to include in that year's annual training.

This approach was historically chosen, because it maximizes not only the efficiency for accommodating new radiation workers, but also the number of people who can go through the training. It also keeps a benchmark of expectations consistent. There are hundreds of radiation workers in university settings and corresponding trainings must be realistic. However, recent research on classic approaches by lectures prompted the staff in the LSU's Radiation Safety Office (RSO) to reconsider if this was the optimal way to deliver the radiation protection training.

Members of the RSO who have been collaborating with LSU College of Engineering identified that small changes to lectures and review sessions would have large impacts on the percentage of students passing the courses [1]. Incorporation of active learning strategies were credited for these significant improvements. As deeper analysis continued, it was found that these improvements could not be explained by other biases (e.g., self-motivation or good student bias) and appeared to depend only on the active engagement strategies used in the review sessions [2]. Strategies used by LSU included "think-pair-share, group work, minute papers, scribe and orator, and simple techniques such as handing the white board marker to a student" [1]. All of these strategies can be summarized as practices of actively involving the students in the learning process and not simply talking to them.

While the above mentioned research focused on STEM (Science, Technology, Engineering, and Math) curriculum and teaching students, it may be extrapolated to argue that traditional lecture-based models of teaching, or worse so, online slides, are not engaging enough for students nor trainees to benefit from long-term retention of the content. A review of the connection among pedagogy (i.e., the science of teaching students), andragogy (i.e., the science of teaching adults), and safety training is contained herein with possible options for the radiation protection training program at LSU to enhance.

1.2 Pedagogy

Pedagogy, the method and practice of teaching, for many years has been investigating better methods of communicating information to students. The difficulties that may influence a trainee's inability to remember or apply radiation safety practices are numerous according to this field. However, three general principles can summarize well the overarching themes of pedagogy. These are Blooms taxonomy [3], dimensions of learning [4], and Ebbinghaus' forgetting curve [5].

Bloom's taxonomy [3], sometimes referred to as the learning domains, establishes a hierarchy of cognitive understanding and emphasizes that different levels of understanding require different cognitive skills [6]. Understanding of deeper learning could lead to better training of radiation workers. Bloom's taxonomy was modified as psychology research grew. The hierarchy, in order of increasing complexity, is now remembering, understanding, applying, analyzing, evaluating, and creating [7]. Each step in the hierarchy involves deeper understanding of the content. It specifically acknowledges that memorization (remembering) is the weakest level of understanding and long-term comprehension is best obtained by doing something more than just memorization. In 2015, Nancy Adams found that "information professionals who train or instruct others can use Bloom's taxonomy to write learning objectives that describe the skills and abilities that they desire their learners to master and demonstrate. The taxonomy is useful in two important ways. First, use of the taxonomy encourages instructors to think of the learning objectives in behavioral terms to consider what the learner can do as a result of the instruction. Second, considering learning goals in light of Bloom's taxonomy highlights the need for including learning objectives that require higher levels of cognitive skills that lead to deeper learning…" [6]. According to Bloom's taxonomy, radiation protection training should strongly consider not to make memorization-based test questions. Even if a trainee gets the question correct, it does not necessarily prove adequate understanding of the content.

Similar to the learning domains, the dimensions of learning establish that the progression of learning is a process. There are five dimensions in the original model [4]. These dimensions can directly apply to radiation protection training. The first dimension, *attitudes and perceptions*, recognizes that negative opinions towards safety or even the information delivery method can significantly decrease the trainee's ability to learn. The second dimension, *acquire and integrate knowledge*, is a recognition that new information delivery must be guided to first acquire the information (or model), then process the information, and finally internalize or practice the information. A radiation protection training example of this may be to first introduce steps for how to use a radiation survey meter, then show what those steps look like on an actual meter, and finally let the trainees use the meter themselves.

The third dimension is for the learner to *extend and refine the knowledge*. This dimension is where the learner takes the acquired knowledge and refines it by reviewing or comparing it with the reasoning process. In radiation safety, this is likely where the trainee discovers why certain regulations are in place and subsequently can think critically as to if and how the current procedures are good methods of implementing those regulations. The fourth dimension is *using knowledge meaningfully*. In training, radiation workers should use the meters themselves, or practice the calculations that they may be required to do. At a minimum, the workers should be able to describe how they will incorporate radiation safety practices into their jobs.

The final dimension is *habits of mind*. This important final stage is where trainees would look back on the information presented critically and ask themselves, "Do I understand this material appropriately?" While this is very difficult to incorporate in training depending on the audience, it may be most effectively seen in routine inspections of the radiation workers.

The curve of forgetting, another principle in pedagogy, is regularly debated due to its difficulty to accurately quantify the variable; strength of memory [5]. Regardless of the exact logarithmic or power function of this variable, the application remains consistent. As time passes, we forget things quickly. Ebbinghaus believed that this curve was exponential and that there is an obvious loss of information even after 20 minutes. The recommendation to alleviate this loss is regular study periods following the original information. This shift increases the information retained immediately and reduces the amount of information lost long term.

Pedagogy research has found that traditional teaching approaches are significantly improved (by a factor of 2-3 times) by more actively engaging in the communication process [8]. This active engagement (or active learning) can be accomplished in many ways, but it is summarized by using teaching strategies that require participation on the students and include regular feedback to the instructor on if the students are able to capture what is being spoken.

Pedagogy has also found significant variations in the preferred teaching methods that are dependent from student to student [9]. The ways students perceive, receive, process, and apply information may vary drastically depending on the individual. This strongly implies that no training program will be perfect for all trainees, but general approaches may be useful. For example, research inspired by Felder's learning styles found that 80% of engineering students preferred learning visually (input modality) and 90% of engineering professors preferred learning visually compared to verbally (in this context verbally was described as lecturing or reading and visually is described as charts, pictures, or graphs) [10].

1.3 Andragogy

The split between young adult and adult creates a grey area of training in a university setting. Andragogy specifically studies adult learning compared to pedagogy which generally focuses on children or young adults. While there is significant overlap in these two fields, Malcom Knowles identified several rules in his andragogic model that differs from pedagogy. These rules ought to be considered when designing a training program that may be geared towards adults.

There are 6 rules in the model. The first one is *the need to know*. This rule states that adults must know why they need to learn something before they will learn it [11]. Applied to radiation safety, the assumption here is obvious. However, it is not necessarily regularly communicated. One could consider using phrases such as "It is important to understand these principles to keep your dose as low as reasonably achievable (ALARA)" or "failure to uphold these rules will result in potential fines to the worker, principal investigator, or university." This will help adults recognize why the information is needed.

The second rule according to Knowles is *the learner self concept*. This rule accounts for an adults need to be treated by others of capable of self direction [11]. It is important that the training is neither to childish nor overly complicated. With adults, some assumptions of responsibility can be made such as the adult is metacognitive and wants to succeed at her/his job. Conversely, over simplification of the content may be too immature and be below the need this rule identifies.

The third and fourth rules are expansions of similar pedagogy themes. The third rule is *the role of the learner's experience*. This rule conveys students who have experiences already involved in every subject [11]. This rule is even more true with adults as experience will likely be even greater. Similar to the first rule, the fourth one is *readiness to learn.* If an adult can recognize that the training information relates to a realistic life situation, they will be much more likely to be ready to learn [11].

The fifth rule, *orientation to learning*, is where strong differences are obvious between children and adults. Children are typically taught subject-oriented when learning, where adults are normally more life-centered in their learning. This reiterates that adults are more interested in content that applies to their lives when compared to students who learn what they are told to learn [12]. Likewise, the sixth rule, *motivation*, acknowledges that adults are responsive to external motivators such as higher salary, but most motivation is internal pressures such as selfesteem, quality of life, and satisfaction [11]. Students, in general, respond more to external motivators such as grades [12].

1.4 Online Information Delivery

While not a field of science, slides, most often PowerPoint, as a lecture tool have been somewhat studied. Unfortunately there is little information about how slides do by themselves for delivery of information, and most conclusions drawn from research of slides are accompanying lectures. In 2012, Weimer summarized PowerPoint as "not inherently good or bad…it's all about how we use it."[13]. This conclusion was based significantly on research published by Hill et al. in the American Sociological Association's journal. This publication found that the only times PowerPoint slides offered grade improvements were in courses where the professor provided the slides before class. This increase was attributed to preparing the students, not the slides themselves. Most other research concluded that slides offered no measurable grade improvements but may improve grade perception [14]. The authors go on to point out that other literature has found PowerPoint inherent design counters critical thinking and is geared more towards marketing. The authors also argue that students' perceptions were indeed that PowerPoint helps significantly with paying attention and comprehension.

Although it is good that students' perceptions improve, there are no obvious benefits between during lecture and without lecture. Online delivery of training information leaves several holes when it pertains to pedagogy. Fortunately, the field of e-learning is growing. Even though at this point research is mostly anecdotal, there are several options and suggestions for using pedagogy and andragogy in online material.

Other researchers have found success in utilizing online videos, but recommend that there are critical decisions that must be made during development [15]. This research was based on 6.9 million video watching sessions in four courses measuring how long students watched the video (without skipping or exiting) and grading post-video assessment questions. Six of this study's conclusions offer strong aid to future radiation protection training ideas. They are: (1) videos need to be shorter than 6 minutes and planned well, (2) videos with a talking head (smaller video of the instructor speaking) and slides are more engaging, (3) personal feel in videos may be more successful then studio recordings, (4) tablet drawing tutorials are more engaging then PowerPoint slides, (5) classroom style recordings were not as engaging, and (6) fast talking and high enthusiasm is more engaging [15].

2. Considering Change

The goal of our radiation protection training is to equip workers with the knowledge necessary to use radiation safely, obey the ALARA guidelines, and comply with all federal, state, local, and institutional regulations. The better retained the training content is, the more likely it is that safety and regulations will be followed. The initial reasonable question we asked was, "does the radiation protection training need to be modified?" Since there is no measureable indication that the current training is not adequate, arguably the training is meeting expectations. However, based off literature review, there were reasonable suggestions that can be adopted to potentially improve the current radiation protection training.

Scheduling regular, small group, in-person trainings with active learner-centered and hands-on approaches would likely be the most effective method of training. While it may seem to be a desirable option, one must consider the potential constraints such as the number of radiation workers and lack of available time for the instructors. Per regulatory requirements, the radiation workers must successfully complete their training before they are allowed to work with any radiation sources. This may leave significant amount of time between hiring and training where the person is not utilized.

It was also decided that the current method of testing did not need to change. The tests are reviewed with the trainee immediately after the tests on a one-to-one basis. This offers an excellent avenue for active engagement, assures the trainee's understanding of the material, and sets a consistent benchmark of expectations for regulatory purposes. The online portion of the training content appears to be the area that could be improved from the aspects of active engagement and the science of teaching.

2.1 Interactive online modules

Based off of the summation of literature reviews, it was decided that interactive online videos were likely the best replacement for the current PowerPoint slides. Per pedagogy and andragogy recommendations, considerations for what material will be delivered was revisited.

Online videos will continue to use slides, but in video format with a talking head. This will allow for the video to be more engaging and the information to be better retained. The organization of the content would be kept in short (i.e., less than 6 minutes) modules which are relatively consistent with the current approach. The material within each module would follow the dimensions of learning where: (1) a benchmark of understanding or relation to the trainee will be established, (2) only what is considered directly relevant information would be included and the knowledge would be delivered, (3) examples of use will then be covered, and (4) expectations will be clearly reiterated. For example, a module on laboratory surveys may include: (a) introduction to why a laboratory survey is relevant to their work, (b) what a laboratory survey looks like, (c) an example laboratory survey, and (d) what may be looked at by a regulatory inspector. Finally, andragogic rules will be also considered. It will be repeatedly made clear why the information is applicable to the trainees' work and why they need to know it.

Each short video will be followed by multiple-choice, conceptual questions. While this will not be graded, it will prevent access to the next module until the correct answers are selected. This will also help reiterate what the instructor considers the most important message of the video.

3. Conclusions and Discussion

According to these findings, the LSU RSO plans to pilot a test, using a randomly selected group on campus, to measure the effectiveness, cost, and difficultly of implementing these alternative trainings. If successful, it is the intention of the RSO to replace all of the existing online training modules with similar videos.

Perfect modeling between training sessions and normal university classes is unrealistic. There remain obvious differences between these two groups, similar to the differences between pedagogy and andragogy. Students get grades based on their performance on exams and trainees simply pass or fail (and must retake the exam). Conversely, students pay for the courses, and most of the trainees are being paid to work at the university. However, it still seems reasonable that the scientific theories behind students better absorbing course material could be applied to trainings. Likewise, true testing of these changes will possibly be limited to anecdotal experiences as proper statistical setups would not be in the scope of many safety professional's responsibilities or goals.

Despite these differences and ability to easily test for success, the general ideas of pedagogy and andragogy can still relate to radiation protection training. Our ultimate goal is to help keep radiation workers safe. The more trainees actively and attentively engage in training, the more likely they will remember the training content. The better trainees remember and apply the content, the better they will understand the content. The better trainees understand the content, the safer the trainees will be.

4. References

[1] Wilson, C., Steele, A., Waggenspack, W., Wang, W., & Ramsey, L. (June 2015). Engineering Supplemental Instruction: Impact on Sophomore Level Engineering Courses. *2015 ASEE Annual Conference and Exposition Proceedings*. doi:10.18260/p.23983

[2] Wilson, C., Waggenspack, W., Steele, A., & Gegenheimer, J. (2016). The Unsubstantiated Cutoff: Deeper Analysis of Supplemental Instruction Sessions on Engineering Courses. *2016 ASEE Annual Conference & Exposition Proceedings*. doi:10.18260/p.27025

[3] Bloom, B. S. (1956). *Taxonomy of educational objectives: the classification of educational goals*. New York: D. McKay.

[4] Marzano, R. J., & Pickering, D. (2006). *Dimensions of learning: teacher's manual*. Heatherton, Vic.: Hawker Brownlow Education.

[5] Murre, J. M., & Dros, J. (2015). Replication and Analysis of Ebbinghaus' Forgetting Curve. *Plos One,10*(7). doi:10.1371/journal.pone.0120644

[6] Adams, N. E. (2015). Bloom's taxonomy of cognitive learning objectives. *Journal of the Medical Library Association : JMLA,103*(3), 152-153. doi:10.3163/1536-5050.103.3.010

[7] Anderson, L. W., Krathwohl, D. R., & Airasian, P. W. (2001). *A taxonomy for learning, teaching, and assessing a revision of Bloom's taxonomy of educational objectives*. New York: Longman.

[8] Redish, E. F. (2000). Discipline-Based Education and Education Research. *Journal of Applied Developmental Psychology*, 21(1), 85-96. doi:10.1016/s0193-3973(99)00052-0

[9] Felder, R. M., & Silverman, L. K. (1988). Learning styles and teaching styles in engineering education. *Engineering Education*, 78(7), 674–681.

[10] Felder, R. M., & Brent, R. (2005). Understanding Student Differences. *Journal of Engineering Education,94*(1), 57-72. doi:10.1002/j.2168-9830.2005.tb00829.x

[11] Crawford, S. (n.d.). Andragogy (PDF). Retreived April 13, 2017, from http://academic.regis.edu/ed205/knowles.pdf Regis University.

[12] Pappas, C. (2015, November 09). Pedagogy Vs Andragogy In eLearning: Can You Tell The Difference? Retrieved April 13, 2017, from https://elearningindustry.com/pedagogy-vs-andragogy-in-elearning-can-you-tell-the-difference

[13] Weimer, M. (2016, May 23). Does PowerPoint Help or Hinder Student Learning? Retrieved April 13, 2017, from http://www.facultyfocus.com/articles/teaching-professor-blog/does-powerpoint-help-or-hinder-learning/

[14] Hill, A., Arford, T., Lubitow, A., & Smollin, L. M. (2012). “I’m Ambivalent about It”. *Teaching Sociology,40*(3), 242-256. doi:10.1177/0092055x12444071

[15] Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement. *Proceedings of the first ACM conference on Learning @ scale conference - L@S '14*. doi:10.1145/2556325.2566239.

THE DEVELOPMENT OF A DISTANCE LEARNING PLATFORM TO SUPPORT THE BLENDED LEARNING APPROACH FOR THE TRAINING ACTIVITIES OF THE GREEK ATOMIC ENERGY COMMISSION

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ABSTRACT

This work presents the experience of the Greek Atomic Energy Commission (EEAE) in developing, establishing and providing training through e-learning. The EEAE is the national competent authority for matters related to radiological protection. Moreover, it is responsible for the provision of E&T and the certification of the competence of occupationally exposed workers. In this framework, EEAE has a range of activities, in providing post-graduate and continuing E&T on radiation protection, at national and regional level. The training provided is mainly based on the traditional face to face component.
In order to increase the effectiveness of the training provided and to optimize the allocation of the related resources, EEAE has adopted the blended learning approach. In this respect, a distance learning platform has been established to support the asynchronous distance learning component. This Moodle based platform (edu.eeae.gr) was developed in house with the support of the EEAE IT department. The development phases included: design and development, implementation of internal test courses, evaluation and use in public. The platform is now fully operative with more than 110 users during its first year of operation. Moreover, in the near future it is expected to be incorporated within the EEAE's quality management system according to the ISO 29990:2010.
E-courses are provided through the platform at national (in the Greek language) and international level (in the English language). At national level, the courses are mainly used to support the face to face training of occupationally exposed workers (e.g. industrial radiographers, veterinarians, technologists, etc.) by providing supplementary information. At international level, the platform supports the e-learning elements of the Erasmus+ programme: Blended Learning in Radiation Protection and Radioecology, in which EEAE participates as a partner. Moreover, it is intended to support the EEAE activities as an IAEA RTC and more specifically the needs of the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC).

1. Introduction

The Greek Atomic Energy Commission (EEAE) is the competent national regulatory authority in the fields of radiation and nuclear safety. The EEAE's mission is the protection of the public, workers and the environment from ionizing and artificially produced non-ionizing radiation. The EEAE's responsibility is to establish and supervise the implementation of a sustainable radiation protection program in the country. Therefore, the appropriate education and training on radiation protection issues of the people involved occupationally in procedures using ionizing radiation is undoubtedly necessary [1]. This fact is clearly stated in the Greek Radiation Protection Regulations (GRPR, 2001) [2]. It is also mentioned in an emphatic way in the new European Council Directive concerning the basic safety standards (new EC BSS, Chap. IV, Art. 14) [3], while the significance of education and training and the importance of the establishment of a sustainable education and training program is emphasized as well. The EEAE has also an important role in providing education and training specifically in the field of medical radiation protection in the country. Furthermore, the EEAE has acted as the IAEA's Regional Training Center (RTC) for radiation, transport and waste safety in Europe in the English language since 2003 and was recognized as an IAEA RTC for nuclear security in the English language in 2013 [1].
The training provided is mainly based on the traditional face to face component. In order to strengthen the capabilities and the potentials of the provided education and training and to optimize the allocation of the related resources, EEAE has adopted the blended learning approach. In this respect, a distance learning platform has been established to support the asynchronous distance learning component. The distance learning platform was developed in house, by the EEAE IT department, and was based on Moodle, an open source learning

management system. The provided e-courses are addressed to national and international educational purposes. This paper provides an outline of both the Moodle based e-learning platform and the e-courses which have been developed and are already in use.

2. Education and training at the National and International level

2.1 National level

The GRPR (2001) [2] require that the persons involved in the practical aspects of radiological procedures shall have knowledge of radiation protection and adequate theoretical and practical training. The EEAE issues certificates of competence to occupationally exposed personnel or recognizes corresponding diplomas or certificates awarded on the basis of the authorized curricula. Moreover, there are provisions for continuous training in the field of radiation protection, addressing in this way the educational needs arising from the introduction of new techniques. In the GRPR it is also stated that a person can only be employed in professions dealing with ionizing radiation if his/her radiation protection training has been approved by the EEAE. Under this legal framework the EEAE undertakes initiatives at the national level covering all the spectrum of applications and facilities of ionizing radiation [1].

In the medical field, the EEAE, since 1994, has been a participant in and a major contributor to the Inter-University Postgraduate Course on Medical Radiation Physics (PGCMRP syllabus) [1].

The Article 18 of the new EC BSS [3] is dedicated to education, information and training in the field of medical exposure. Taking into account the non-medical personnel related to medical exposure, the EEAE recently (2010−2011) organized and accomplished a nationwide extensive education and training project, 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 [1].

Following this direction, a new training course addressed to veterinarians has been developed by the EEAE and the Department of Veterinary Medicine (Aristotle University of Thessaloniki, AUTH), entitled “Radiation Protection during conventional radiographic systems in Veterinary Medicine”. The veterinarians who use radiographic systems should be properly trained and competent with regard to radiation protection issues. The Veterinary Medicine Schools syllabus does not cover adequately the field of radiation protection. Thus, the course is addressed to professional veterinarians who use conventional radiographic systems for diagnostic purposes as well as to veterinarians who proceed to radiographic procedures outside their private clinic (for example, breeding units, equestrian clubs, etc.).

Industrial applications cover about 10% (in terms of occupationally exposed personnel) of the applications of ionizing radiation in the country. The EEAE through its training activities aims at the development of a safety culture in this area as well. To this end, the EEAE has designed a series of two-day seminars on radiation protection in industrial radiography [1].

For the purposes of the national education and training program described, educational material has been developed. Depending on the seminar, syllabi, lecture plans, presentations, text books and/or laboratory exercises, on-the-job training activities and procedures for the assessment of the participants’ competence have been developed. The curricula of the courses have taken into account the recommendations of international organizations (EC, IAEA, ICRP) and are approved by the EEAE’s board [1].

2.2 International level

Since 2003, the EEAE has acted as the IAEA’s Regional Training Center (RTC) for “Radiation, Transport and Waste Safety” in Europe in the English language. Following the successful completion of the IAEA’s Education and Training Appraisal Mission (EduTA) in 2008, a Long-Term Agreement (LTA) was signed in 2011 between the Hellenic Government and the IAEA to support the EEAE as an RTC in Europe. The LTA was ratified by Law (No. 4085, Official Gazette Folio No. 194, First issue) in October 2012. Moreover, since 2013 the EEAE has been recognized as the IAEA’s Regional Training Center (RTC) in nuclear security in the English language [1].

The EEAE is certified according to ISO 29990 standard for the design, development and provision of non-formal education and training in radiation protection and nuclear safety.

3. Distance learning platform – edu.eeae.gr

The training provided is mainly based on the traditional face to face component. In order to upgrade and broaden the effectiveness of the training provided and to optimize the allocation of the related resources, EEAE has adopted the blended learning approach. In this respect, a distance learning platform has been established to support the asynchronous distance learning component.

Asynchronous distance learning offers the potentiality to expand the provided education and training to those interested parties, who due to practical limitations (distance, available time) are unable to attend the traditional face to face training. Thus, anyone interested may, in his own convenient time attend any course he/she wishes. Moreover, the asynchronous distance learning is a cost effective infrastructure that enhances considerably the education and training potentialities.

3.1 Development of the distance learning platform

The distance learning platform was developed in 2015, in house, with the support of the EEAE IT department. The distance learning platform was based on Moodle.

Moodle (Modular Object Oriented Developmental Learning Environment) is an open source learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalised learning environments. It provides a flexible tool-set to support both blended learning and 100% online courses Moodle is a modular system based on plugins for different kind of content and for all kinds of collaborative activities. Moreover it is easy to learn and use, as it provides a simple interface, drag-and-drop features, and well-documented resources along with ongoing usability improvements. Tens of thousands of learning environments globally and more than 90 million users across both academic and enterprise level use Moodle, making it the world's most widely used learning platform [4].

The EEAE has opted to implement Moodle on CentOS Linux server using MySQL database inside a VMware Esxi virtual machine, running on a cluster of VMware servers. EEAE has named its Moodle based distance learning platform as edu.eeae.gr and may be accessed through edu.eeae.gr.

The appearance of Moodle (theme, fonts, colors, plugins) was customized in order to blend with the EEAE preferences. Moreover, a special logo for the distance learning platform was designed. The picture in Fig. 1 is a screen shot of the front page of the distance learning platform of EEAE, edu.eeae.gr, and presents the special logo, the design and the appearance of edu.eeae.gr.

The operation and maintenance of the distance learning platform, edu.eeae.gr, are also supported by the IT Department of EEAE.

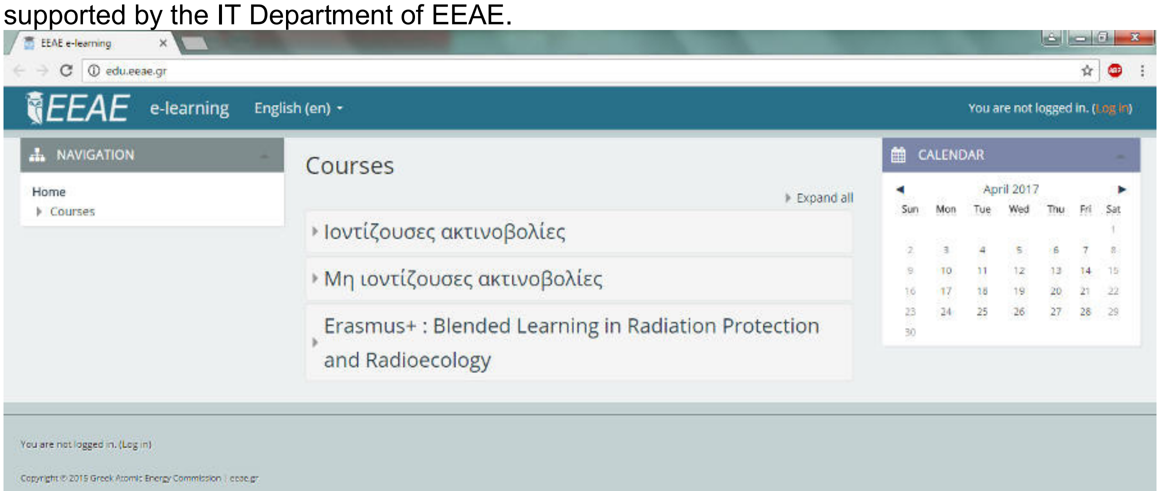

Fig. 1 The front page of EEAE distance learning platform, edu.eeae.gr

Following the installation and development of the distance learning platform, edu.eeae.gr, internal test courses were implemented in order to evaluate the performance of edu.eeae.gr. The distance learning platform was updated according to the reviewers' insightful comments and suggestions.
Afterwards, e – courses at national and international level were developed in the distance learning platform, edu.eeae.gr. The description of the e – courses follows in the next session.

The platform is now fully operative with more than 110 users during its first year of operation. Moreover, in the near future it is expected to be incorporated within the EEAE's quality management system according to the ISO 29990:2010.

3.2 E – courses

E-courses are provided through the platform at national (in the Greek language) and international level (in the English language).

3.2.1 National level

At national level, the courses are mainly used to support the face to face training of occupationally exposed workers by providing supplementary information. Currently three e – courses are available. The first is designed for and addressed to veterinarians, the second is for industrial radiographers and the third is for medical technologists.

Veterinarians' e – course: "Radiation Protection during conventional radiographic systems in Veterinary Medicine"

The purpose of the "Radiation Protection during conventional radiographic systems in Veterinary Medicine" e - course is to properly train and supplement the veterinarians with the necessary knowledge regarding radiation protection. This course embodies the importance that the new EC BSS attributes to the proper education and competence of those who use ionizing radiation.
The course covers the topics of the fundamental physical principles of radiation (both ionizing and non-ionizing) and their biological effects, dosimetry, Computed and Digital Radiography techniques, basic radiation protection standards, radiation protection in veterinarian radiography and the relevant legislation framework. There are also two practical training sessions regarding the basic safety standards in the small and exotic animals (the first) and the horses (the second) radiography techniques. The e – course is comprised of power point presentations and a relevant textbook.

Industrial Radiographers' e – course: "Radiation Safety in Industrial Radiography"

The e – course for industrial radiographers, "Radiation Safety in Industrial Radiography", covers the topics of the fundamental physical principles of radiation and its biological effects, radiation protection basic safety standards, radiation protection in industrial radiography, radiography equipment, design and use of shield enclosures, in situ radiography procedures, safety and transportation of radiation sources, emergency plans and accidents in industrial radiography. The e – course is comprised of power point and video presentations and a relevant textbook.

Medical technologists' e – course: "Radiation Protection for the medical technologists

The EEAE has developed an e – course which is addressed to the medical technologists, who use medical equipment that incorporates ionizing radiation, in order to support them during their preparation for the prerequisite exams for the acquisition of the certification of competence in radiation protection. The medical technologists'' e – course includes the fundamental physics of radiation and interaction of radiation with the matter, basic principles of radiology, nuclear physics and radiotherapy.
The educational material includes power point and video presentation as well as a relevant textbook. Furthermore, for the better preparation of the participants, self-assessment quizzes have been developed.

Besides the abovementioned courses, that have been developed in the field of ionizing radiation, in the field of non-ionizing radiation a training course for the sunbeds' operators has also been developed.

3.2.2 International level

At international level, the platform supports the e-learning elements of the Erasmus+ programme of the European Commission: "Blended Learning in Radiation Protection and Radioecology". The project has started in September 2015 and it is expected to be completed in August 2017. The project is implemented by 10 partners and EEAE participates as a partner. The objectives are to develop mixed educational actions (live and e-learning) on radiation protection and radioecology, as well as the ongoing education and training of personnel occupationally involved with radiation protection. The six modules that have been developed cover the basics of nuclear and radiation physics, the basics of measurement and dosimetry, radiation protection, general safety principles, basic radiochemistry and medical applications. There are also topics about training on risk assessment and waste management.

The distance learning platform, edu.eeae.gr, is intended to support the EEAE activities as an IAEA RTC and more specifically the needs of the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC).

4. Conclusion

The distance learning platform, edu.eeae.gr, which EEAE has recently developed, is now fully operative. Within less than the first year of its operation more than 110 users have participated in the provided e – courses. The distance learning platform, edu.eeae.gr, is expected to strengthen and expand the education and training provided by the EEAE, being a robust, proficient and cost – effective learning tool. Thus the EEAE, exploiting the potentials of the most sophisticated and modern learning tools, is able to provide up to date and flexible education and training to everyone occupationally exposed to ionizing radiation, according to its national and international obligations.

5. References

[1] K.L. Karfopoulos, E. Carinou, V. Kamenopoulou, P. Dimitriou, Ch. Housiadas. Building competence in radiation and nuclear safety through education and training – the approach of a national regulatory authority. Radioprotection 50(1), 59-64 (2015).

[2] Greek Radiation Protection Regulations (2001) Ministerial Order No1014, Official Gazette of the Greek Government No 216B.

[3] Council Directive 2013/59/EURATOM (2013) Basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/EURATOM, 90/641/EURATOM, 96/29/EURATOM, 97/43/EURATOM and 2003/122/EURATOM 05.12.13.

[4] www.moodle.com

THE DEVELOPMENT OF A SPECIALISED TRAINING COURSE FOR THE RADIATION PROTECTION WORKERS OF VVER TECHNOLOGY (CORONA II)

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ABSTRACT

The project CORONAII has the aim to provide a structure for training and qualification of personnel for serving VVER technology as one of the nuclear power options used in the EU. The CORONAII project is co-financed by the EURATOM 2014-2015 working program of HORIZON 2020. The main objective of the proposed CORONA II project is to enhance the safety of nuclear installations through the further improvement of the training capabilities aimed at building up the necessary personnel competencies. The project aims at the continuation of the European cooperation and support in the area for preservation and further development of expertise in the nuclear field by the improvement of higher education and training. The implementation of ECVET, which is one of the main goals of EC in the education and training areas, has to be tested through pilot courses; to integrate VVER education and training into European education and training in nuclear safety and radiation protection. Non-nuclear professionals or students who graduated at least from the level of bachelor’s or are currently bachelor’s students, with negligible prior knowledge or without knowledge and experience in the nuclear field could be trained. The aim of the pilot training for radiation protection workers is to provide an introduction to nuclear power technology and an overview of radiation protection, nuclear fuel and radioactive waste management for students and non-nuclear graduates to participate in further nuclear course(s) or to perform works related to VVER NPP, radiation monitoring and radiation protection of places of ionizing radiation for medicine and industry applications, radioactive waste management and custom offices. The pilot training course is going to give competencies at EQF Level 3. It is intended to cover different aspects needed to start working in the nuclear related area with sufficient general nuclear knowledge and culture. A pilot teaching course was organised and delivered in January 2017.

Introduction

The project CORONAII has the aim to provide a structure for training and qualification of personnel for serving VVER technology as one of the nuclear power options used in the EU.

The CORONAII project is co-financed by the EURATOM 2014-2015 working program of HORIZON 2020.

Education, training and maintenance of competencies i.e. knowledge management in engineering and sciences is a cornerstone in Europe's vision for the development of safe nuclear energy. If one is going to deliver the long term goal of sustainable nuclear fission, it will be necessary to have an adequate resource of well-educated and trained young professionals coming into the field, whilst retaining the expertise and competencies.

Within the European Union (EU) there is a strong need for maintaining and preserving knowledge and nuclear competence including VVER competence. Russian technology is very popular amongst European countries but is operated mainly in small countries, which do not have enough resources to maintain the entire necessary knowledge individually.

The general objective of the project is to enhance the safety of nuclear installations through further improvement of the training capabilities for providing the necessary personnel competencies.

The specific objectives of the CORONA II project are:

- To elaborate a harmonized approach to education in the nuclear science and nuclear engineering in VVER countries to support improving the safety of nuclear installations;
- To achieve co-operation and sharing of academic resources and capabilities at national and international levels;
- To accelerate and optimize the development of competences in the nuclear area to ensure the high quality of nuclear education and training in VVER area;
- To further develop the VVER training infrastructure;
- To promote the implementation of modern training methodologies and technologies, dissemination of experience and best practices in Europe in the field of training;
- To promote the establishment and development of national training systems for the nuclear power sector in the newcoming countries;
- To establish a framework for mutual recognition: the implementation of ECVET, which is one of the mail goals of EC in the education and training areas, will be supported through the testing of its elements and pilot implementations;
- To integrate VVER education and training with the European education and training in nuclear safety and radiation protection;
- To foster and strengthen the relationship with technology platforms, networks and other organisations in the nuclear education and training sector;
- To enhance knowledge sharing, dissemination and online collaboration through an advanced knowledge management portal.

The baseline for this structure is the work done in the previous CORONA project. The applied approach for the development of training schemes and target groups is based on the Systematic Approach to Training (SAT) and European Qualification Framework (EQF). A pilot implementation of ECVET system is planned as part of the work on the project. The list of participants of the CoronaII project can found in Table 1.

Table 1. The list of participants of the CoronaII project

Participant No	Participant organisation name	Country
1	Kozloduy NPP PLC (Coordinator)	Bulgaria
2	Institute of Nuclear Research and Nuclear Energy – Bulgarian Academy of Sciences	Bulgaria
3	Engineering Support and Intellectual Solutions (ESIS GmbH)	Germany
4	TECNATOM S.A.	Spain
5	Centrum Vyzkumu REZ S.R.O.	Czech Republic
6	National Research Nuclear University MEPhI	Russian Federation
7	Risk Engineering Ltd.	Bulgaria
8	Budapesti Muszaki és Gazdasagtudomanyi Egyetem	Hungary
9	Reseau Europeen pour l Einsegnement des Sciences Nucleaires (ENEN Association)	France

The structure of the pilot course

The unit of learning outcomes

The structure of the selected qualification of RPW was based on the job profile of the Radiation Protection Worker, developed by IET_JRC, which contains the role and functions, as well as the knowledge, skill and competences that are required for this qualification. The following unit of learning outcomes (ULOs) were defined:

ULO 1 Introduction to nuclear power technology
ULO 2 Radiation protection
ULO 3 Radiation monitoring
ULO 4 Nuclear fuel and Radioactive waste
ULO 5 Accident and emergency issues
ULO 6 Decontamination
ULO 7 Safety culture

Who could be trained?

Non-nuclear professionals or students who are graduated at least to the level of bachelor's or are currently bachelor's students, with negligible prior knowledge or without knowledge and experience in nuclear could be trained. It is expected that the candidates have the intention to perform works related to VVER NPP, nuclear applications and education or to participate in course(s) of nuclear education. The pilot training will be useful to students or professionals working in support of nuclear facilities as civil engineers, physical protection employees, government employees, secondary school teachers, journalists, etc.
For the training course within the training programme the following information was provided:

- Objectives of the training course
- Requirements for the trainees
- Content of the training course (topics)
- Suggested duration of the course (in working days and in academic hours)
- Type of training – theoretical, practical, simulator / initial, refreshing
- Methods for evaluation

Participants

Eight (8) trainees: three (3) from Bulgaria, three (3) from the Czech Republic and two (2) from Russia participated in the training. The main fields of activities during the last three years of the trainees were:

- nuclear technology and nuclear engineering
- radiation protection and radiation monitoring
- material science study
- dosimetric control in hot cells
- training (rad. protection, industrial and fire safety, first aid)

During the pilot training two observers from Bulgaria and the Czech Republic participated. The main tasks of the observation of conductance of the pilot training were to assess the training organisation and effectiveness and to evaluate whether learning outcomes had been achieved or not.

The venue of the pilot course

The lectures (classroom and video conference) were organised at the Budapest University of Technology and Economics (BME) (Figure 1.), the Institute of Nuclear Techniques. The practical training was conducted in the Training Reactor of BME (Figure 2.) and the National Research Institute for Radiobiology and Radiohygiene (OSSKI).

Figure 1. *Budapest University of Technology and Economics*

Figure 2. *Training Reactor, Institute of Nuclear Techniques*

The aim of the pilot training:

The aim of the training is to provide an introduction to nuclear power technology and an overview of radiation protection, nuclear fuel and radioactive waste management for students and non-nuclear graduates to participate in further nuclear course(s) or to perform works related to VVER NPP, radiation monitoring and radiation protection of places of ionizing radiation for medicine and industry applications, radioactive waste management, custom offices, etc. The training course aims to give competencies at EQF1 Level 3. It is intended to cover different aspects needed to start working in the nuclear related area with sufficient general nuclear knowledge and culture.

Three modules were organised during the pilot course:

1. Introduction to nuclear power technology (4 hours of lecture and 4 hours of laboratory work)
2. Radiation protection (12 hours of lecture and 4 hours of laboratory work (Figure 3 and 4.))
3. Nuclear fuel and radioactive waste (10 hours of lecture)

The duration of the training was 40 hours: introduction – 2 hours, lectures – 26 hours, laboratory practice – 8 hours, consultation – 2 hours and evaluation – 2 hours. The working language was English. All training materials were prepared in English. At the beginning of the training the trainees passed entrance tests in order to assess their level of experience and knowledge on the training topics.
The observers' evaluation was based on the preliminary prepared and agreed instructions. The instructions are intended for the unification of observers' responses and to highlight important areas to be evaluated.

Figure 3. Laboratory work in the Training Reactor

Figure 4. Laboratory work in the National Research Institute for Radiobiology and Radiohygiene (OSSKI).

Results

The knowledge of the participants became more homogeneous: the total average fraction of right answers is around two thirds (66%) varying between 58-76%. It is a remarkable increase compared to the results of the jump-in test where the total average of fraction of right answers was around half (50-55%) varying between 25-78%.
The participants' satisfaction survey was filled out by all of the trainees and observers directly before the end of the training.
Some important comments and suggestions from the trainees' can be found below:

1. The presentations were sufficient for them to understand the learning objectives required for Radiation Protection Workers
2. There was sufficient information on practicalities (e.g. organizational aspects, training material, assessment, etc.)
3. The knowledge, skills and attitudes supported by this course are in accordance with their expectations for radiation protection workers.

The participants answered the following for the question of "What 3 aspects of this course did you think were most effective in helping you achieve the learning objectives?":

- practicalities,
- guidance,
- the content of presentations,
- the approach of lecturers,
- practical examples, laboratory work,

The participants answered the following for the question of "What 3 changes could be made to improve this course?":

- more discussion,
- less lectures
- more practical lessons.

Observers' evaluations

The quality of organisation was very good. The working conditions were appropriate for carrying out the training. The laboratory exercises were provided in well-equipped facilities.
The duration of the training was 5 days and was enough for the training purposes. The duration of the training hours was 40 academic hours - 8 hours per day (one academic hour consists of 45 minutes of teaching plus a 15 minute break) - thus the time for self-study, review and assimilation of the obtained knowledge was not enough. The size of the group was appropriate and corresponded with the conditions for conducting lectures and laboratory work.

At the end of the training the trainees were awarded with certificates for attendance and for achieved competencies within the pilot training course.

References

[1] Recommendation of the European parliament and of the council of 18 June 2009 on the establishment of a European Credit System for Vocational Education and Training
[2] JRC Technical Reports, Second Workshop on Qualifications for Nuclear Decommissioning, Bergen, The Netherlands, 24-28 October 2015
[3] New Basic Safety Standards Directive 2013/59/Euratom

FINAL RESULTS OF A SURVEY ON THE AWARENESS OF THE RADIATION PROTECTION IN MEDICAL SECTOR IN TURKEY

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ABSTRACT

In this study, final results of a survey performed between 2012 and 2015 on the awareness of radiation protection were presented. The survey was conducted at six hospitals, four training and research hospitals, one medical faculty hospital, and one state hospital, in Istanbul. Target audience was medical doctors, technical staff (technicians and medical physicists) and patients. Besides, the survey was also applied for the participants of the 7th National Radiology Technicians and Professionals Education Seminars held in Antalya in 2013 May.

The questionnaires were prepared in different content for each group. Questionnaires prepared for physicians and patients consist of 20 questions, while those prepared for technicians have 30 questions.

Questions about demographic characteristics such as gender, age, occupation and experience years, education, etc., general knowledge about radiation and radiation protection and biological effects of radiation were asked for all target audience. Additionally, some questions were directed to the technicians and doctors about the ALARA culture and about the effective doses received by the patients during radiological examination.

The questionnaires were conducted by face-to-face interviewing with a total of 1372 people consisting of 208 physicians, 870 patients and 294 technicians. Survey results were analyzed using SPSS (Statistical Products and Service Solutions).

1. Introduction

There is a great increase in the use of ionizing radiation for medical purposes. According to the UNSCEAR 2008 report worldwide, the number of diagnostic radiology examinations increased by 2.25 times in about 20 years. Due to the increase in the number of diagnostic radiology examinations, the population dose increases by 1.7% [1]. In the United States, the effective dose from medical irradiation at the beginning of the 1980s was 0.54 mSv, but in 2006 this value increased to 3 mSv and increased by 600% [2-5].

In France, the annual average dose received from medical irradiation in 2002 was 0.8 mSv, while in 2007 it raised to 1.3 mSv with an increase of 57% [6]. Compared to 2007, in 2012 the average annual effective dose became 1.6 mSv with an increase of 20%. In 2012, the contribution of CT analyzes to the frequency is 10.4%, while the contribution of collective effective dose is 71.3% [7, 8].

In 2013, CT examination frequencies in Switzerland increased by 17% compared to 2008. While CT frequencies constitute 9.6% of the total frequency of X-ray examinations (i.e. Mammography, X-rays, Interventional Therapeutic, Interventional Diagnostic, Conventional Fluoroscopy, Dental), its contribution to the collective effective dose is 70.5% [9].

It is estimated that approximately 5807 (1.8%) of the cancer cases that took place in 2010 in the UK are directly related to radiation exposure from both natural and artificial radiation sources. 0.6% of all cancer cases are directly associated with diagnostic radiology examinations [10].

Because of the increase in the use of radiation for medical purposes, spreading of ALARA culture in medical sector has begun to be of great importance. Great effort have being made and various educational programs have being organized to spread the ALARA culture [11, 12].

The benefits and risks of the patient, constraints in occupational and patient exposures must be considered in the use of ionizing radiation. A successful practice requires well-trained staff. This study is a survey conducted to determine the needs and deficiencies about radiation awareness in the medical sector. Preliminary results of this study were presented in ETRAP 2013 [13].

2. Survey Details

In order to be able to implement the survey to the targeted group, necessary protocols were signed with the Ministry and Institutions to which the hospitals were affiliated and permission was obtained. According to the protocol signed with the institutions, the names of the hospitals where the survey carried out were not disclosed.

Survey was performed between 2012 and 2015. Questionnaires were carried out by means of one-on-one interview with the persons who accepted to participate. The target audience was the technical staff (technician and medical physicist), the physicians and the patients.

Additionaly, the questionnaire prepared for the radiation practitioners was also applied to the participants of the seminar held in Antalya in 2013.

The obtained data were analyzed using SPSS (Statistical Product and Service Solution). " **n** " expresses the number of people who answered the question.

3. Results

3.1 Profile of Target Audience

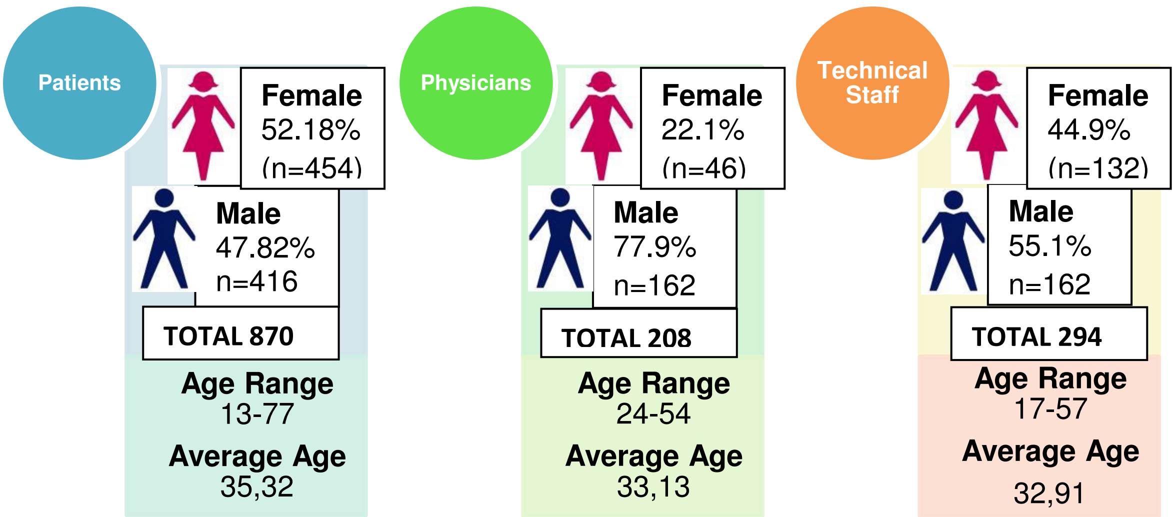


Fig 1: Profile of Target Audience

Patients					
Your Professions			**Educational Status**		
	%	n		%	n
Business Manager	0.7%	6	Illiterate	2.30%	20
Director	1.4%	12			
Engineer	2.8%	24	Literate	2.50%	22
House Wife	23.7%	206			
Officer	10.4%	90	Primary School	30%	260
Others	13.4%	116			
Retired	8.8%	76	High School	32.40%	282
Shopkeeper	4.4%	38			
Student	15.0%	130	University	31%	270
Teacher	2.5%	22			
Unemployment	2.5%	22	Post Graduate	1.80%	16
Worker	14.5%	126			

Tab 1: Education and Professions of the Patients

Physician						
Your Professions				**Experience**		
		%	n		%	n
Surgical Medicine Specialty	Cardiovascular Surgery	1.0%	2	<5	60.6%	126
	Emergency medicine specialist	27.9%	58	6-10 years	16.3%	34
	General Surgeon	4.8%	10	**≤10**	**77%**	**160**
	Neurosurgery	2.9%	6	11-15 years	6.7%	14
	Obstetrician and gynecologist	10.6%	22	16-20 years	7.7%	16
	Orthopedics and traumatology	20.2%	42	21-25 years	4.8%	10
	Otorhinolaryngology	1.9%	4	26-30 years	2.9%	6
	Thoracic Surgery	1.0%	2	30 <	1.0%	2
	Urology	8.7%	18	**10<**	**23%**	**48**
Internal Medicine Specialty	General Practitioner (GP)	1.0%	2			
	Internist	12.5%	26			
	Neurology	1.9%	4			
	Physiotherapy and Rehabilitation	2.9%	6			
	Pulmonology	1.0%	2			

Tab 2: Professions and Experience of the Physician

78.8% (n = 164) of the physicians participated in the survey was surgical medicine specialist, 19.2% (n = 40) of those was internal medicine specialist . 1.9% (n = 4) of those was general practitioner.

Technical Staff		
Experience		
	%	n
<5	24.57%	72
6-10 years	23.21%	68
≤10	**48%**	**140**
11-15 years	13.99%	41
16-20 years	23.89%	70
21-25 years	9.90%	29
26-30 years	4.10%	12
30 <	0.34%	1
10<	**52%**	**153**

Tab 3: Experience of Technical Staff

Table 3 shows the years of professional experience of radiation practitioners.

There is one radiation practitioner with 30 years or more of experience (> 30).

15 of the radiation workers who have 5 years or less experience are students who work as interns in the institutions where the work was carried out.

284 (97%) person are working in radiology, 8 (2.7%) person are working in nuclear medicine and 1 person is working in (0.3%) radiotherapy units.

3.2 Questions Directed to the Target Audience

"*Which examinations; X-ray, computed tomography, magnetic resonance imaging, barium meal, cardiac angiography studies, contain ionizing radiation*" was the common question directed to the target groups. They gave one of the following answers : "*Yes it includes radiation*", "*No it does not include radiation*", and "*I do not know*". Fig 2 shows the distribution of percentage for the answer "*Yes it includes radiation*" given by the Target Audience.

Fig 3 shows the distribution of percentage for MRI and USG examinations anwers given by Target Audience. Although MRI and USG do not contain radiation, 61% of the Patients, 7% of the physicians and 4% of the technical staff answered "*Yes*".

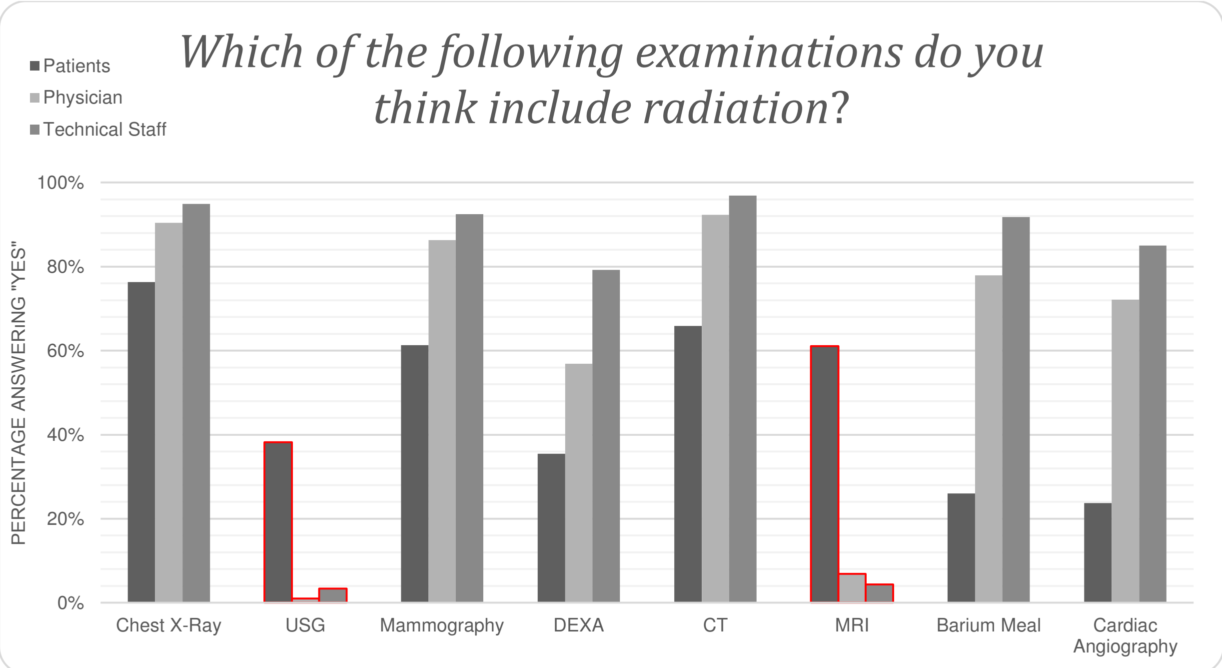


Fig 2: Distribution of Percentage for "Yes" Answers given by Target Audience

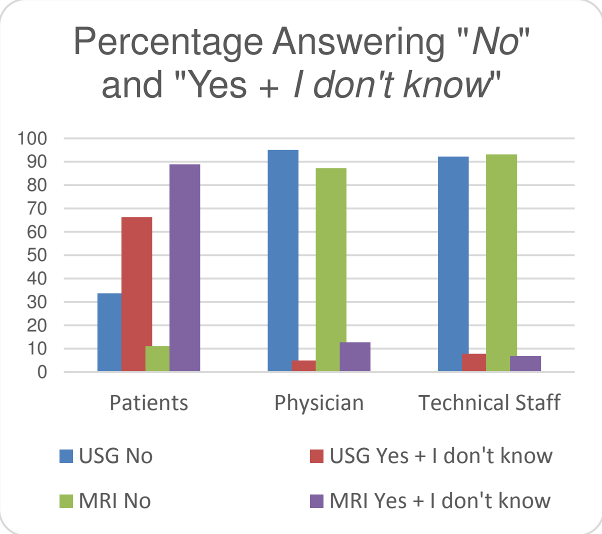


Fig 3: MRI and USG Distribution of Percentage for "*No*" and "Yes + *I don't know*" Answers Given by Target Audience

The proportion of those who answered all options correctly

- ✓ **%37 for the doctors**
- ✓ **%0.5 for the patients**
- ✓ **%63 for the technical staff**

- ➢ The vast majority of patients think that MRI involves radiation.

Only 30% (n = 62) of the physicians who participated in the survey were trained on radiation protection. 76% of the trainees were trained at the medical faculty, 5% at the workplace training, and 19% at the hospital or other institutions.

88.5% of the patients who underwent radiological examination stated that they have knowledge about radiation. Table 2 shows the distribution of answers given by the patients for the question "*What is radiation*". 25.5% of the patients defined the radiation as " *invisible harmful waves*". 15.6% think that radiation is an energy. Figure 4 shows the distribution of the studies that the patients think is most harmful. 23.3% of patients think that MRI examinations are the most harmful examination for them.

What is the radiation?	Percentage	Person(n)
Invisible hazardous waves	25.50%	222
Carcinogen	20%	174
Energy	15.60%	136
A hazardous material	12.60%	110
Poison	9.40%	82
Others	7.10%	62
I don't know	5.50%	48
Microbe	2.10%	18
A state of matter	1.60%	14
Temperature	0.50%	4

Tab 2. Distribution of Percentage for "***What is the Radiation*?"** Answers given by patients

Which of the following radiological examinations is more harmful on the basis of radiation? (Fig 4)

MRI	**X-RAY**	**CT**
23,3%	23%	17.3%

- ✓ Among these examinations, the CT is the one with the highest average effective dose.
- ✓ 17.3% of the patients gave the "*CT scan*" answer.

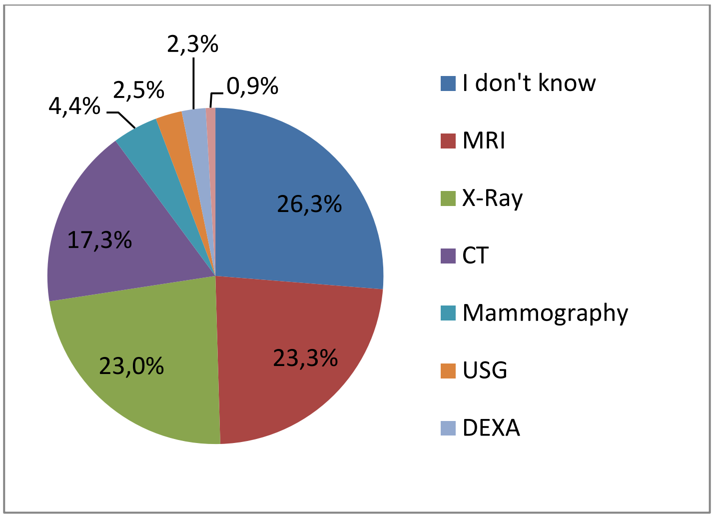


Fig 4: Distribution of Percentage for "***More harmful radiological examination***" Answers given by patients

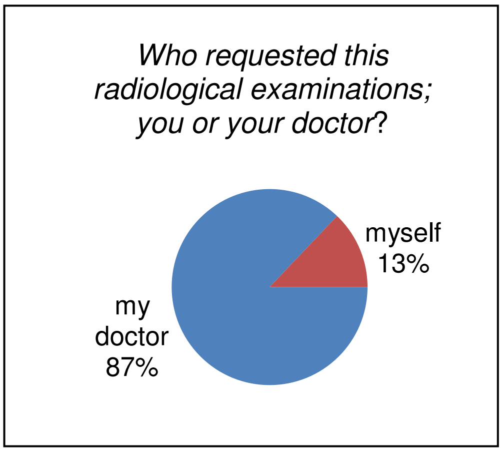


Fig 5: Distribution of Percentage for question answers given by patients

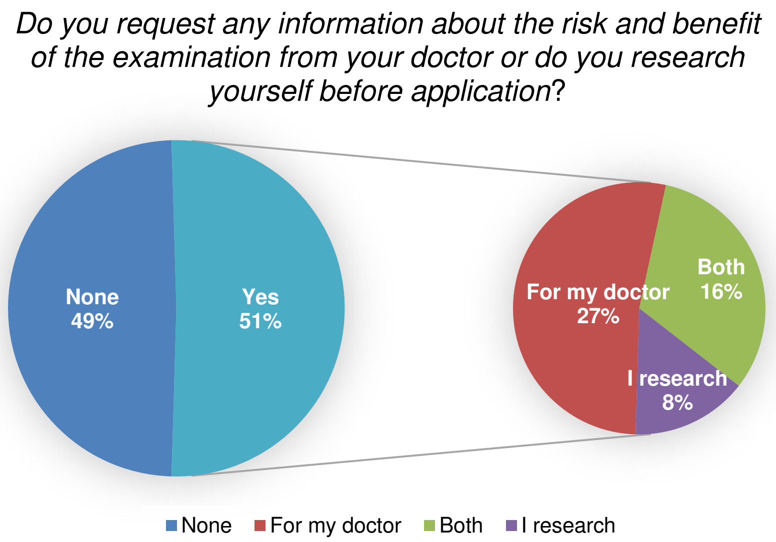


Fig 5: Distribution of Percentage Answers Given by Patients

The majority (38%) of the patients who did not have knowledge about the examination to be exposed had given the answer " I believe in my doctor" when asked why they should not do the research.

The proportion of those who said "I did not think about it before" was 18%

The rate of those who think "I do not think the examination is a risk to my health" is 4%.

55% of the patients in examination centers declared not believe that the properly and safely.

Fig.6 shows the distribution of the answers given by technicians and physicians about the ALARA ('***As Low As Reasonably Achievable***') principle. 44% of the physicians and 60% of the technicians answered correctly. Only 8 of 62 physicians who have been educated in radiation protection had heard about ALARA principle, only 6 of them responded correctly about ALARA.

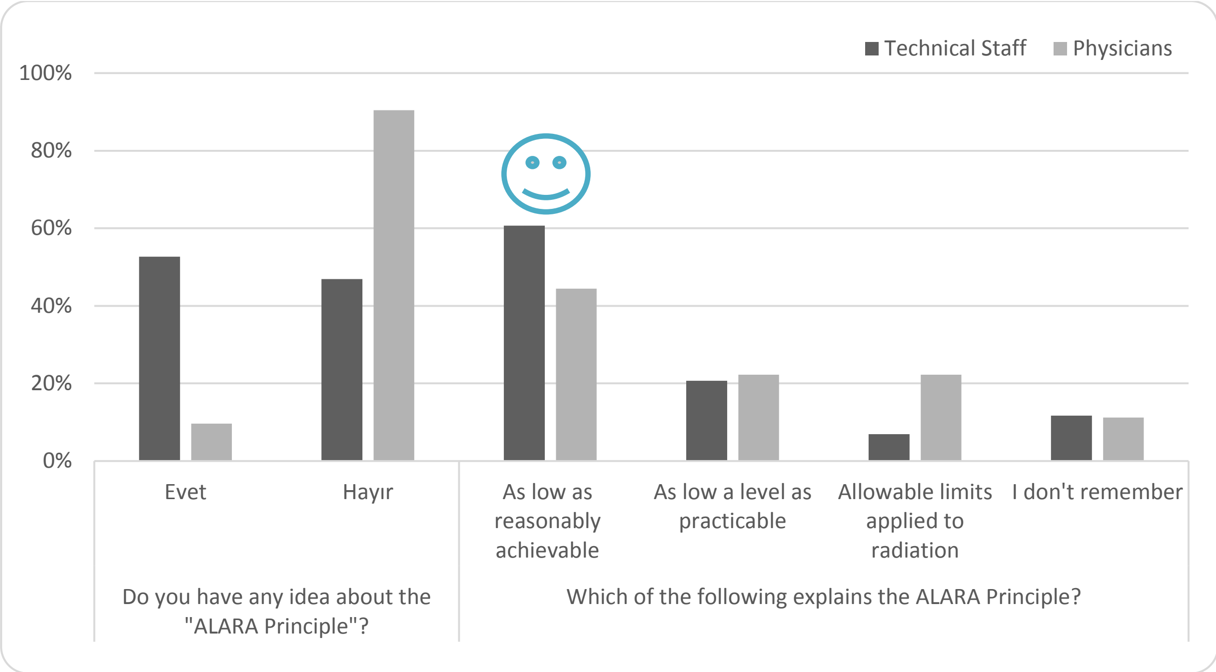


Fig 6: Distribution of Percentage for ALARA Questions Answers Given by Technical Staff and Physician

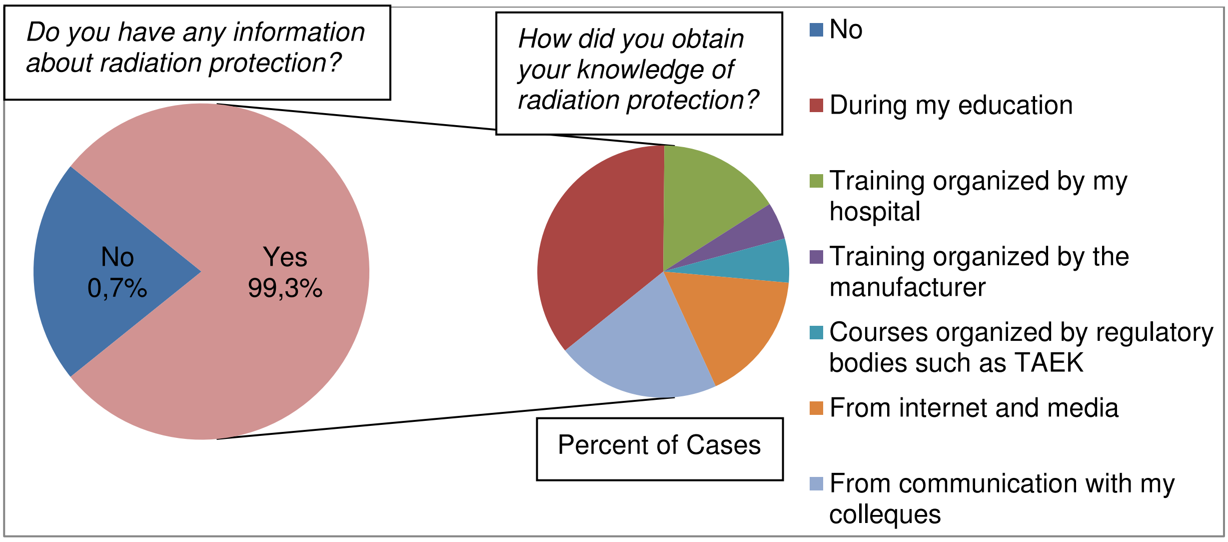


Fig 7: Distribution of Percentage for Radiation Protection Knowledge Question Answers Given by Technical Staff

Physicians and technicians were asked to estimate the contribution of medical exposures to the total effective dose. In this study, with reference to article of Mettler et al., the contribution of medical exposures to the total effective dose was assumed to be 50% [2-4]. 54.8% of the physicians and 49.8% of the technicians made an estimation less than this value. Tab.3 shows the distribution of answers given to the question.

What can you say about the contribution of the medical exposure to the annual effective dose?				
	Correct Responses (%)	**Underestimates (%)**	**Overestimates (%)**	**I have no idea**
Physicians	11.54%	54.81%	0.96%	32.69%
Technical Staff	15.8%	49.8%	2.9%	31.5%

Tab 3: Distribution of Percentage for "*Contribution of the medical exposure to the annual effective dose*" Question Answers Given by Technical Staff and Physicians

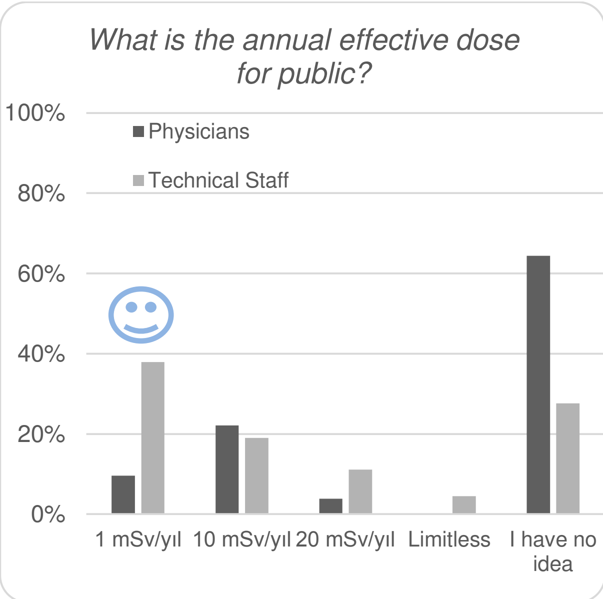


Fig 8: Distribution of Percentage for Dose Limits for Public Question Anwers Given by Technical Staff and Physicians

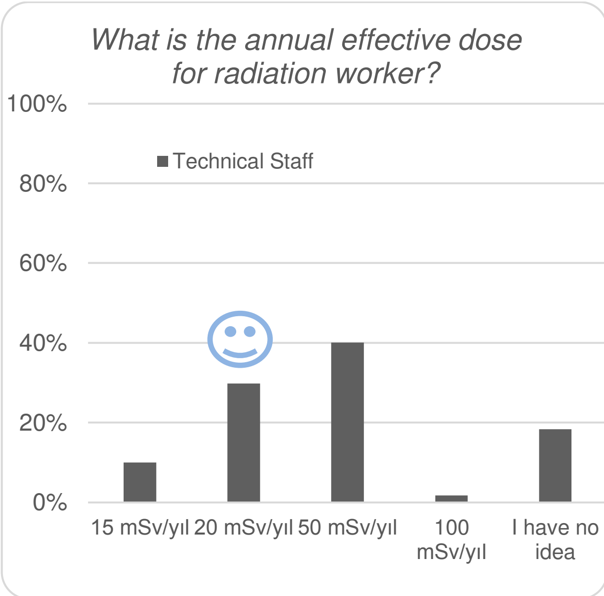
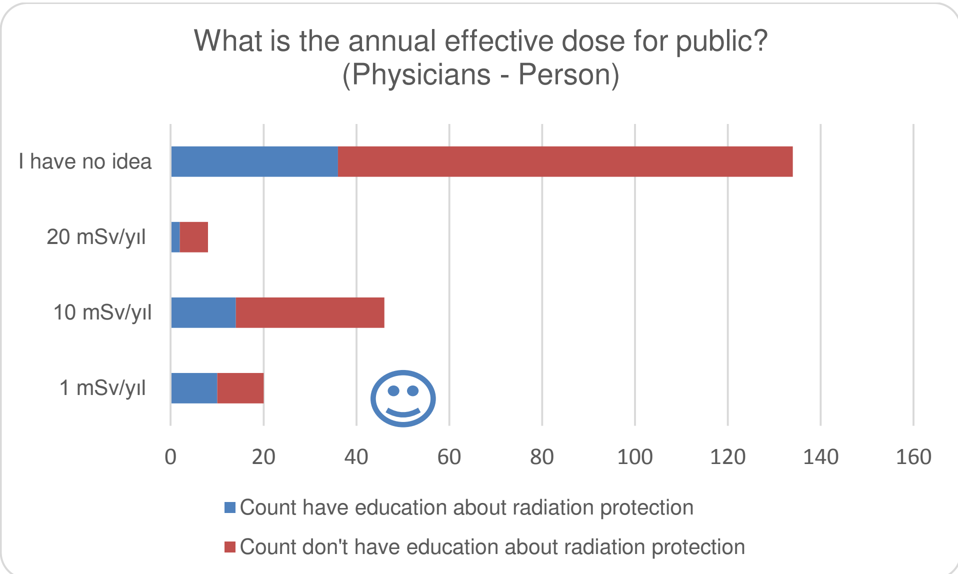


Fig 9: Distribution of Percentage for Dose Limits for Radiation Worker Question Anwers Given by Technical Staff



For the questions related to dose limits, ICRP 103 Directive was taken as reference.

Fig 10: Person-based distribution of the answers given by physicians who did or did not receive radiation protection training for the question of dose limits for public.

Fig.8 shows the distribution of the answers given by technicians and physicians for the annual dose limit for the individual. Fig.10 shows the distribution of the answers given by the physicians who did or did not receive radiation protection training. The physicians did not give the answer "*No Limit*" to the question. The maximum permissible dose limit that an individual can receive in a year is **1mSv** / **year** [14].

The technicians were asked the *maximum annual allowable dose limit for the radiation worker.* The maximum permissible dose limit for radiation workers in a year is 20 mSv / year. The average of 5 years does not exceed **20 mSv** / **year** and can not exceed 50 mSv in any one year [14]. 29.8% of technicians answered correctly. 36% of the technicians responded correctly to both questions regarding dose limits.

Finally, the target group was asked whether *diagnostic radiological examinations increased the risk of cancer.* The distribution of the answers given to this question is shown in Fig.11.

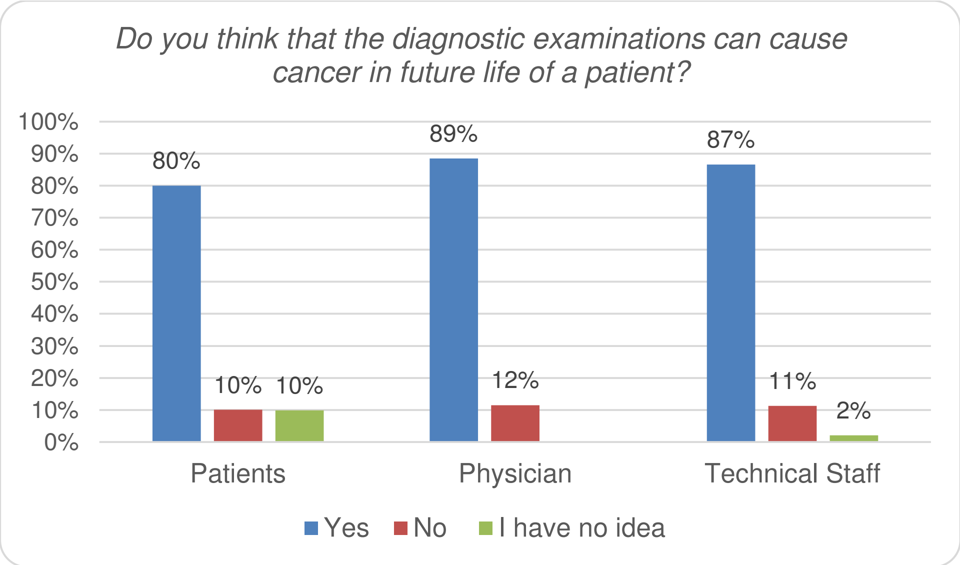


Fig 11: Distribution of Percentage for Cancer Question Answers Given by Target Audience

4. Discussion

Medical uses of ionizing radiation are being increased day by day. The population collective dose is also increasing as directly proportional to the dose of each individual. Even low doses could lead to long-term biological problems by accumulating.

It is observed that most of the physicians participated to the survey did not receive any education related to radiation protection before. The vast majority of technicians and physicians have estimated as less than the reference value the contribution of medical irradiations to the total effective dose.

Even the smallest dose could cause the stochastic effects of cancer. For this reason, the creation of awareness of radiation protection (ALARA culture) would reduce the unnecessary radiation exposure in all areas of life and may offer us the opportunity to obtain maximum benefit from the beneficial effects of radiation. Education about radiation will increase this awareness.

Acknowledgement

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References

[1] UNSCEAR, (2010). Sources and Effects of Ionizing Radiation, Annex A: Medical Radiation Exposures, UNSCEAR 2008 Report Vol. I Annex A, New York.

[2] NCRP, (2009). Ionizing Radiation Exposure of the Population of the United States, NCRP Report No. 160, Bethesda.

[3] Mettler, F.A., Thomadsen, B.R., Bhargavan, M., Gilley, D.B., Gray, J.E., Lipoti, J.A., McCrohan, J., Yoshizumi T.T. and Mahesh M., (2008). "Medical Radiation Exposure in the U.S. in 2006: Preliminary Results", Health Physics Society, 95(5):502–507.

[4] Schauer, D.A. and Linton O.W., (2009). "National Council on Radiation Protection and Measurements Report Shows Substantial Medical Exposure Increase", Radiology, 253(2):293-296.

[5] Mettler, F.A., Bhargavan, M., Faulkner, K., Gilley, D.B., Gray, J.E., Ibbott, G.S., Lipoti, J.A., Mahesh, J.A., McCrohan, J., Stabin, M.G., Thomadsen, B.R., Yoshizumi T.T., (2009). "Radiologic and Nuclear Medicine Studies in the United States and Worldwide: Frequency, Radiation Dose, and Comparison with Other Radiation Sources – 1950 – 2007", Radiology, 253(2): 520–531.

[6] Etard, C., Sinno-Tellier, S. and Aubert, B., (2010). "Exposure of French Population by Ionizing Radiation due to Medical Diagnostic Examinations in 2007", Third European IRPA Congress, 14-18 June 2010, Helsinki.

[7] IRSN, Exposure of the French Population to Ionizing Radiation Related to Medical Diagnosis in 2012, http://www.irsn.fr/en/newsroom/news/pages/20150119_exposure-french-population-ionizing-radiation-medical-diagnosis.aspx , 12.04.2017

[8] Etard, C. ve Aubert, B., (2015). Exposure of the French Population to Ionizing Radiation Related to Medical Diagnosis in 2012, http://www.eurosafeimaging.org/wp/wp-content/uploads/2015/03/IRSN_Eurosafe2015.pdf , 12.04.2017

[9] Le Coultre, R., Bize, J., Champendal, M., Wittwer, D., Trueb and P., Verdun, F. R. (2015). "Exposure of the Swiss Population to Ionizing Radiation in Medical Radiology in 2013 Final Report" (July 2015).

[10] Parkin, D.M. and Darby, S.C., (2011). "Cancers in 2010 Attributable to Ionising Radiation Exposure in the UK", British Journal of Cancer 105:57–65.

[11] 15th EAN Workshop on "Improving ALARA Culture through Education and Training", Rovinj, Croatia, 7 – 9 May 2014

[12] European ALARA Network Workshop 'ALARA and the Medical Sector", Oscarborg Fortress, Norway, 7 – 10 June 2011.

[13] Yıldız Yarar, Y., Kara, Ö. E. (2013). "A Survey on the Awareness of the Radiation Protection in Medical Sector in İstanbul, Turkey". 5th International Conference on Education and Training in Radiological Protection, European Nuclear Society. ETRAP 12-15 March 2013 Vienna- Austria.Transactions Page No: 387-398.

[14] ICRP, (2007). "The 2007 Recommendations of the International Commission on Radiological Protection, ICRP publication 103", Annals of the ICRP 37(2-4):1-332

DEVELOPMENT OF RADIATION RESEARCH CAPACITY IN IRELAND

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ABSTRACT

Ireland's Environmental Protection Agency (EPA) is the national competent authority for the protection of workers, members of the public and the environment against the hazards associated with ionising radiation and has a role in maintaining, growing and building national capacity in radiation science. Evidence indicates that the current capacity nationally in terms of the availability of skilled radiation scientists is insufficient to meet future staffing requirements for EPA in this field. It is acknowledged that a programme to build radiation research in Ireland is a strategic priority for the EPA in its 2016 – 2020 Strategic Plan under the heading "Implement the EPA Research Strategy and leverage national co-funding and EU funding opportunities to help build environmental and radiological protection research capacity in Ireland and improve the dissemination of research outputs". This paper presents a vision and approach towards reinvigoration of radiation research in Ireland to attract the next generation into this field of science.

1. Introduction

Recent efforts by the Environmental Protection Agency (EPA) to recruit new staff for positions relating to radiation protection have shown that the current capacity nationally in terms of the availability of skilled radiation scientists is insufficient to meet future staffing requirements. This concern was acknowledged during the development of the EPA's 2016 – 2020 Strategic Plan and a programme to build radiation research in Ireland was identified as a strategic priority in the plan. In particular the plan includes an action to "implement the EPA Research Strategy and leverage national co-funding and EU funding opportunities to help build environmental and radiological protection research capacity in Ireland and improve the dissemination of research outputs".

This paper presents a vision and approach towards development of radiation research in EPA and to achieve the following objectives:

1. To stimulate the Irish radiation research community so as to develop national radiation research capacity
2. To support high standards and broad horizons in radiation research by facilitating engagement with national and international research groups.
3. To address knowledge gaps on radiation matters relevant in Ireland and internationally and aligned with the EPA Corporate Strategy.
4. To build expertise and facilitate knowledge sharing by engaging with a network of stakeholders.
5. To inform EPA and national policy by addressing the knowledge needs of governmental and non-governmental stakeholders, both nationally and internationally and providing evidence based solutions with an emphasis on continually improving nuclear safety and radiation protection.

2. Background to EPA participation in research

2.1 Historical Perspective

The Environmental Protection Agency (EPA) has been assigned a statutory role to co-ordinate and support national environmental and radiation research following its merger with the Radiological Protection Institute of Ireland (RPII). As a result of the merger the EPA is mandated under the Radiological Protection Act, 1991(1) 'to carry out or to arrange for the carrying out of and to co-ordinate or assist in arrangements for the carrying out of research into any matter' relating to its functions or activities.

The fulfilment of these functions points towards the need to be involved in radiation research. In particular, following the Chernobyl accident in 1986, there was a desire by Government for the then RPII to be involved in international research into agricultural countermeasures and also to be involved in projects that supported the development of technical expertise in radiation monitoring and assessment. This involvement in research has been clearly beneficial in many ways. For example, in the years following the Chernobyl accident, the RPII participated in a number of international collaborative research projects. These were hugely important in expanding and developing Ireland's skills base in the areas of environmental behaviour of radionuclides and transfer through food systems, a key area of interest for Ireland given the emphasis on the agricultural sector. The RPII's, and more recently the EPA's, involvement in research to underpin its environmental monitoring and assessment roles has also allowed it to establish the capability to undertake nationally important projects such as the assessment of new nuclear build in the UK , and to provide credible and high quality advice to Government in this area. It has also provided a solid base to allow it to fulfil its role in relation to Ireland's preparedness for a nuclear emergency and its capacity to respond to such an event.

In addition the RPII/EPA's work on radon established the scale and nature of the problem in Ireland and developed expertise that was crucial to formulating the advice to Government and the public on this issue.

Collaborative radiation research is particularly important to EPA due to the fact that Ireland is a non-nuclear country and the pool of radiation expertise and the radiation research community is quite small. Participation in research opened up staff access to the wider research community, and allowed EPA to maintain and develop links with colleagues in other agencies and third level institutes both within Ireland and abroad.

With the passage of time since Chernobyl the radiation research community in Ireland, particularly in environmental aspects of radiation research, has dwindled. The impact of this decline is seen when experienced recruits are sought; this has been the EPA's experience and more recently succession was identified as an issue by the reviewers in the IAEA International Regulatory Review Service (2). This decline was also illustrated in a recent EPA call for radiation research tenders where only one tender was received for each project.

2.2 Future radiation research programme in EPA

The current EPA corporate strategy recognises the importance to the future of radiation protection in Ireland of maintaining a commitment to radiation research. Being able to attract the next generation of talent is crucial to the future success of any organisation.

Research provides a means of keeping abreast of latest developments, provides a basis for providing up to date and sound advice to Government, and sustains capacity to respond as needed in the event of a nuclear emergency. Supporting radiation research in Ireland will nurture a pool of scientists as a national resource in radiation protection.

Looking forward it is clear that research will continue to play an important role in underpinning delivery of the EPA's mandate.

3. Vision for radiation research in Ireland

That Ireland will have a vibrant, well-resourced and sustainable radiation research community, with high quality outputs actively addressing knowledge gaps and working towards enhanced radiation safety, and understanding of environmental and health aspects of radiation science.

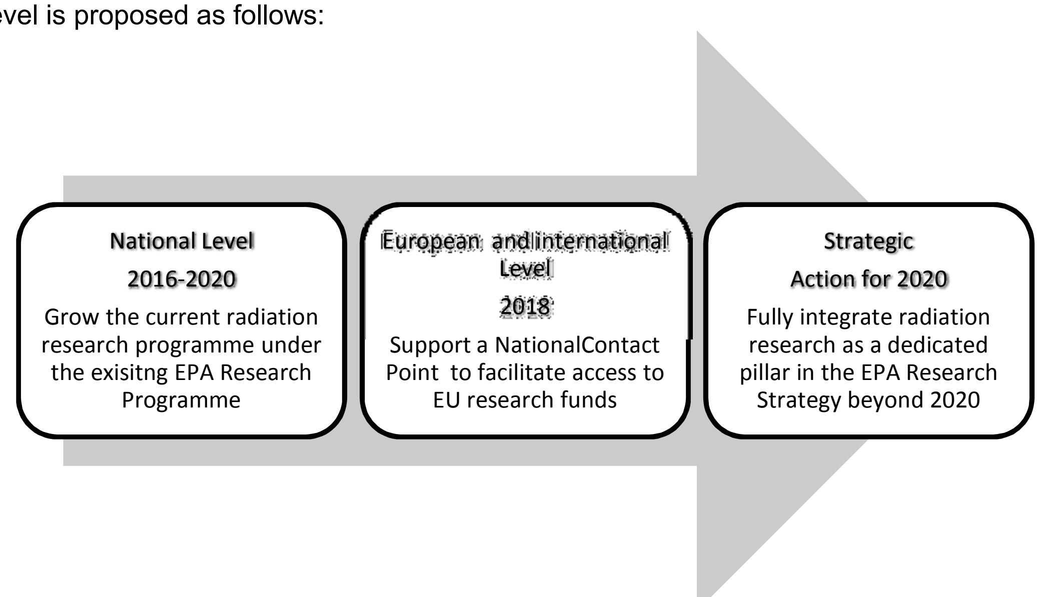
It is proposed that the EPA will be a key player in delivering on this vision. The EPA will stimulate, facilitate and support the development of radiation research in Ireland:

1. through engagement with the research community and funding authorities nationally and internationally,
2. by supporting the co-ordination of access to EU funds and
3. by directly funding a research programme.

3.1 Approach to realising the vision

Research capacity can be understood as a country's ability to produce, debate and use research knowledge and products relevant to their needs. Research capacity strengthening (also known as capacity building or capacity development) is thus the long-term, complex processes aiming to enhance these abilities. A wide variety of approaches and interventions can be employed to build capacity.

A three stranded approach to realising the vision at national and European/International level is proposed as follows:



3.1.1 Strand 1: National Level

The objective under this strand is to build on the current suite of radiation research EPA funded projects between 2016 and 2020 in order to grow the current radiation research programme under the EPA Research Programmes Sustainability Pillar (3). This will involve a modest incremental allocation of resources to radiation research.

In order to deliver this objective an EPA-based Radiation Research Co-ordinator will be nominated to work with the EPA Research Team to:

- Be a point of contact on radiation research and integrate radiation in existing EPA research activities e.g. dissemination of information, information days, research conferences, updating EPA website.
- As identifying synergies and enhanced collaboration with other national funders is a key objective of the EPA Research Programme, liaise with other national funding agencies to ensure a coordinated approach
- Consult with colleagues in EPA radiation teams to identify knowledge gaps as a basis for future research calls and work with the EPA Research Team to encourage research calls
- Support the EPA Research Team in budget negotiations to secure additional radiation research funding
- Work with others. The EPA recognises the value of engagement and networking with other sectors and organisations involved in research. The research programme has formed strong linkages with national and international partners over the past number of years and the research we fund is of significant value to other government departments and state agencies.

3.1.2 Strand 2: EU & international level

Under this strand the ambition is to have the necessary arrangements in place by 2018 to support the Horizon 2020 National Contact Point (Euratom) to facilitate access by Irish researchers to EU research funds

The EPA Radiation Research Coordinator will work closely with the Irish National Contact Point (Euratom) for European research funding to:

- Identify actions needed to open access to Euratom funding for Irish radiation researchers
- Develop a collaborative work programme to deliver on these actions
- Continue participation as a National Delegate to the Euratom Programme Committee - Fission (complementing the Horizon 2020 – The Framework Programme for Research and Innovation) representing Irish views at Programme Committee meetings.

A number of international linkages have been established to promote Irish radiation research in the European research area. By ensuring that Ireland is represented in significant European initiatives such as Horizon 2020, working towards participation Joint Programming Initiatives e.g CONCERT, the EPA will aim to increase the critical mass, reach and impact of Irish radiation research.

3.1.3 Strand 3: Strategic

The actions under the *Strand 1: national level* and *Strand 2: EU & international level* will be delivered within the framework of the existing EPA research strategy which currently does not have a dedicated radiation pillar. However, in 2018 the EPA intends to commence work on the development of a new research strategy for 2020 and beyond. As part of this development work it is intended to fully integrate radiation research in the new strategy by providing for a dedicated radiation research pillar.

As part of this work the EPA Radiation Research Coordinator will:

- Work with the EPA research team to develop an appropriate pillar position for EPA radiation research within the next EPA Research Strategy.
- Consult with research community on strategic direction for radiation research

4. Conclusions

As the national competent authority EPA has a role in maintaining, growing and building national capacity in radiation science. Evidence indicates that the current capacity nationally in terms of the availability of skilled radiation scientists is insufficient to meet future staffing requirements for EPA. To address this concern the EPAs current corporate strategy contains an action to implement the EPA Research Strategy and leverage national co-funding and EU funding opportunities. It is further intended to help build environmental and radiological protection research capacity in Ireland and improve the dissemination of research outputs. It is believed that this approach will go some way in enriching the pool of knowledge and expertise available for addressing Ireland's current and future radiation protection capacity requirements.

5. References

(1)Radiological Protection Act, Number 9 of 1991. Ireland,1991. Dublin: Stationery Office.

(2)Integrated Regulatory Review Service (IRRS) mission to Ireland. IAEA, 2016. https://www.epa.ie/pubs/conferencesandevents/2016-02-12_brn_irrs%20declg%20mission%20report%20final_ks.pdf

(3)EPA Research Strategy 2014-2020 Published: 2014 http://www.epa.ie/pubs/reports/research/eparesearchstrategy2014-2020/eparesearchstrategy2014-2020.html

MALAYSIA STRATEGY TOWARDS ESTABLISHING NATIONAL POLICY FOR E&T IN RADIATION, TRANSPORT AND WASTE SAFETY

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ABSTRACT

The usage of ionising radiation in Malaysia encompasses of diverse usage such as medical, industry, agriculture, research and others for national well-being. Education and training in Radiation, Transport and Waste Safety is a vital component to maintain sustainability and to ensure the safety of radiation workers, members of the public and the environment from radiation hazards.This paper present the initiatives taken for the establishment of the nuclear education & training strategy and policy in Malaysia. It analyzed current status of Human Resource Development (HRD) and nuclear education and training framework of Malaysia and conducting TNA (Training Need Analysis) and benchmarking exercises. The features of the current nuclear education & training in Malaysia are independent, dispersed and unintegrated within stakeholders. Linkages and cooperation systematically integrated between institutions are not visible. As a result, duplicated programs and resource allocation, and inefficiency have been identified. Therefore, this paper proposed the national nuclear education & training system model as a policy initiatives and establishment of national steering committee to oversees that manages and centralise overall nuclear education & training.

1. Introduction

IAEA has introduces the concept of a national strategy for building competence in protection and safety in Member States in order to address educational and training needs in the field of radiation protection and the safety of radiation sources in IAEA Strategic Approach to Education and Training in Radiation, Transport and Waste Safety, 2011–2020.[1].

In line with IAEA statute and commitment as Member States, Malaysia has taken steps towards building competences and establishing strategy for education and training RTWS. The introduction of the Atomic Energy Licensing Act, followed by the establishment of the Atomic Energy Licensing Board (AELB) in 1984 were serious initiatives taken by the Malaysian Government to regulate, safeguard and monitor the ionizing radiation activities in Malaysia. In addition, AELB is to complement the functions of Malaysian Nuclear Agency (Nuclear Malaysia) that focuses on the application and promoting the peaceful uses of nuclear and related technologies for national development. Its follows with steps of participating in EDUTA mission in 2005 and 2015 and ETRES mission in 2014. Nuclear Malaysia has been running a very detailed and comprehensive annual programme for education and training in radiation protection in collaboration with AELB and other relevant institutions. A formal national strategy for building competence in radiation protection has not been formally finalised. However, some elements of this strategy are believed to be available, e.g. a well-designed annual training programme with a realistic time frame has been developed and it has been successfully implemented.[1].

The overall aim of establishing the strategy is to develop a human capital development programme required to sustain an adequate level of national capability and competency on RTWS for sustainable development and societal wellbeing.

2. Current Status of E&T in RTWS in Malaysia

Nuclear Malaysia has been providing training courses on radiological protection for more than 30 years and has extensive experience in the development of training materials. A wide range of training courses in radiological protection are currently provided by training organizations, both nationally and internationally, and significant effort has been devoted in determining appropriate levels of training, methods of training provision, course content and training infrastructure. The occupational level training courses currently vary from one-day courses for operators of straightforward equipment such as X-ray baggage inspection cabinets, to week-long courses for radiation protection supervisors in a wide range of practices. The number of participants increases each year, and in 2016 around 2845 participants from several sectors, i.e. Radiation Safety and Health (64.5%), Medical X-ray (16.5%), NDT (10.1%) and Environmental Safety and Health (8.9%) were trained [2]. Through this courses, radiation workers will able to understand and apply the concept of radiation protection at workplace. This will certainly benefit an organization with ultimate goals of continuously striving for a healthy, accident-free and environmentally sound workplace and community, while providing the technical support needed to meet the national mission. Beside Nuclear Malaysia, there is 7 other training centre accredited by regulators to conduct training in radiation protection [3].

Since 1970s, there are nuclear-related subjects being taught at local universities . Table 1 show that eight universities conduct programmes related to non-power applications of nuclear science and technology; four of them offer such programmes at postgraduate level. These are results of progress and development in the non-power sector of the application of nuclear science and technology in the country. As can be seen, the courses are largely concentrated in the medical applications, which is consistent with the growing number of nuclear medicine centers in the country.

INSTITUTES	LEVEL OF STUDY	PROGRAMME
UKM	Undergraduate	Bachelor in Nuclear Science
	Postgraduate	Diagnostic Imaging and Radiotherapy Master of Medicine (Radiology) Master of Science (Radiation Safety)
	Postgraduate	Master of Science (Safety, Security and Safeguard)*
UM	Undergraduate	Bachelor of Biomedical Technology (Nuclear Medicine)
	Postgraduate	Master in Medical Physics (coursework)
USM	Undergraduate	Bachelor of Applied Science in Medical Physic Bachelor in Medical Radiation
	Postgraduate	Master of Science in Medical Physic (coursework) Master of Medicine (Radiology)
UPM	Undergraduate	Bachelor in Applied Radiation (research subject in Radiation Synthesis and Medical Physics)
UTM	Undergraduate	Bachelor in Health Physics Bachelor in Nuclear and Energy Engineering
UiTM	Undergraduate	Bachelor in Basic Nuclear Technology and Application of Radioisotope and Radiation (major subject in 3th year)
UNITEN	Undergraduate	Bachelor in Mechanical Engineering with elective courses (i) Introduction to Nuclear Engineering, (ii) Radiation Detection and Nuclear Instrumentation, (iii) Introduction to Reactor Physics, (iv) Reactor Thermal-hydraulics, (v) Radiation Safety and Nuclear Waste Management, and (vi) Nuclear Policy, Security and Safeguard
UNIMAS	Postgraduate	Condition Monitoring and Non-Destructive Testing (PhD)

Table 1: University Offering Nuclear Related Courses

Since 1980s, nuclear education outreach for secondary schools was successfully implemented in Malaysia. The programme is well collaborated between Malaysian Nuclear Agency (Nuclear Malaysia), Ministry of Education (MOE) and Ministry of Science, Technology and Innovation (MOSTI). The nuclear education outreach are known as Nuclear Science and Technology (NST) Talk and Exhibition for Secondary Schools, Nuclear Camp *Veni Vidi Vici* and Scientist Icon Roadshow and IAEA Technical Cooperation Program in Compendium of NST for Secondary Schools Pilot Programme [4]. By participating in this programme, Malaysia has enriched the new method in outreach activities so that the students become more engaging with science. Besides all the programmes mentioned, Nuclear Malaysia has also organised few programmes which indirectly promoting NST to students; nuclear facilities visit, public exhibitions and nuclear talk.

2.1 Policy Framework

The legal and regulatory framework for atomic energy in Malaysia is provided through the Act 304, which provides for the regulation and control of atomic energy, for the establishment of standards on liability for nuclear damage and for matters connected therewith or related thereto. The regulatory body, Atomic Energy Licensing Board (AELB) within the Ministry of Science, Technology and Innovation (MOSTI), is responsible for regulation in the area of radiation and nuclear safety, nuclear security, safeguards and liability except for medical applications which are regulated by the Ministry of Health on behalf of AELB.

Requirements and provisions are established calling for all persons associated with work with ionizing radiation to be suitably trained and qualified. Sub-Regulations 15(8), of the Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010 require that *"the licensee or the employer to provide appropriate training, retraining and facilities for updating the skills and knowledge of their workers"*.[5] The regulatory body has established guidance specifying which persons should have particular qualifications and the process to be employed for the recognition of such qualifications. Such requirements and guidance are enforced by the regulatory body.

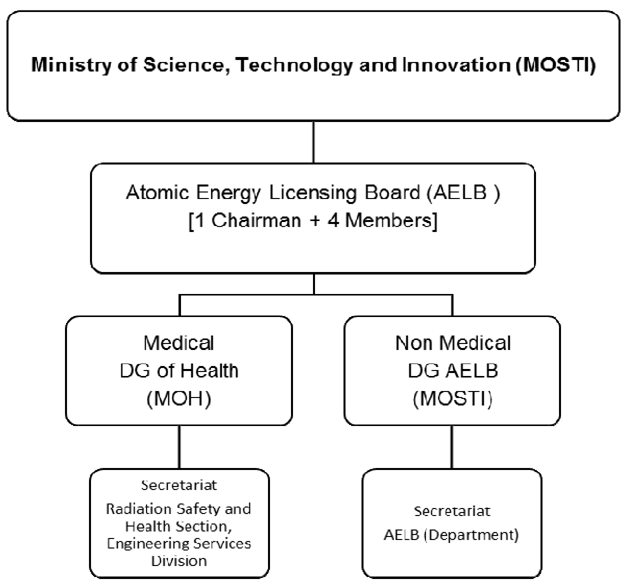

Fig 1: Regulatory Function

2.2 Nuclear Infrastructure and Stakeholders

For a successful education and training strategy, all relevant stakeholders must be identified and involved. Stakeholders' identified are regulatory body, research agency, utilities, education institution i.e. universities and training center, certification body and scientific/professional organization and government. However, needs of leading organization to spearhead and coordinate the strategy is very importance.

The establishment of a national nuclear research institute in 1972, now known as the Malaysian Nuclear Agency, catalyzed the development of nuclear science and technology in Malaysia. The institute was set-up as a research and training facility to develop the manpower and technical capability for the introduction of nuclear power program in Malaysia. A 1 megawatt thermal nuclear research reactor was built and commissioned in 1984. However the discovery of oil fields and subsequent development of petroleum industry in Malaysia in the middle of 1980s set the program back. The diversity of nuclear science and technology enables the institute to instead focus in its non-power applications. Currently, Nuclear Malaysia has a total of 815 personnel, of which 313 are researchers having tertiary degrees. The figure comprises of 64 with PhD and 90 with Master Degree (MSc) representing 21% and 27% respectively. The remaining 159 personnel with bachelor's degree (BSc) qualification are mainly the newly recruited personnel [6]. Hence, Nuclear Malaysia involvement in setting up the E&T landscape in Malaysia are undeniable.

The administrative infrastructure for further growth of the technology in Malaysia was completed with the setting-up of the Atomic Energy Licensing Board (AELB) in 1985. The board is the regulatory agency that implements the Atomic Energy Licensing Act which was enacted in late 1984.

For nuclear safety training, stakeholders identified includes Malaysia Nuclear Power Corporation (MNPC) and Tenaga Nasional Berhad (TNB). On January 2011, (MNPC) in its capacity as the country's Nuclear Energy Program Implementing Organization (NEPIO) was established to spearhead Malaysia's nuclear power program. The government is studying the possibility of deploying nuclear energy to meet future demand and diversify the energy mix for Peninsular Malaysia

TNB is the largest electricity utility in Malaysia with RM117.1 billion in assets and capital expenditure of RM10.8 billion in power plants and system improvements [6]. Its core businesses are generation, transmission and distribution of electricity throughout Peninsular Malaysia, the state of Sabah and the Federal Territory of Labuan. TNB owns and operates a total 10,818 MW of installed capacity comprising of thermal generation facilities and major hydro-generation schemes in Peninsular Malaysia. Other TNB businesses include operation and maintenance services, manufacturing of electrical equipment such as switchgears, transformers and cables, and higher education and research services. TNB employs approximately 36,000 staff group-wide to serve an estimated 8.9 million customers nationwide [7]. TNB also owns its education and training infrastructures which is ILSAS and UNITEN.

3. Strategy Initiatives for Building Competence in RTWS

3.1 Dissemination of Information

The first action taken by Malaysia Nuclear Agency is to conduct Special Meeting & Briefing on the Establishment of Steering Committee for the Preparation of National Strategy on Education and Training in Radiation, Waste and Transport Safety. This meeting was conduct in 2013 at Nuclear Malaysia with targets to disseminate information to stakeholders, gained support and established linkage.

Stakeholders invited were Atomic Energy Licensing Board Ministry of Health, Ministry Of Education, USM and UKM. Mr John S. Wheatley, Head, Technical Assistance and Information Management Unit, IAEA Division of Radiation, Transport & Waste Safety was invited to conduct the briefing.

However, the commitment from the stakeholders to the next steps was very slow due to issue of responsible lead agency, source of mandate and availability of current committee for RPO certification (JKPPPS).

3.2 Commitment and Support from Stakeholders

In 2015, IAEA has conducted Regional Workshop addressing on Establishing National Policy in Education and Training at Kuala Lumpur Malaysia. This workshop has trigger the importance of needs assessment and national strategy by sharing other countries experience. Therefore Nuclear Malaysia has taken the initiatives to lead the interim committee and conduct national workshop.

The workshop has been conducted on 19-21 October 2015 with attendance of several key person from regulatory body, certification body and public university. Participants conduct needs assessments about the capacity, skills and responsibilities of regulators and radiation workers in RTWS. Acquisition of information on facilities and activities related to RTWS was available from regulatory body database. Analysis on education and training requirements specified in the legal and regulatory framework and defining the skills and levels of education and training required for RTWS stake holders was carried during the workshop. Information necessary for the analysis of training needs including feedback on implementation is described in the Safety Guide on Building Competence in Radiation Protection and the Safe Use of Radiation Sources (RS.G-1.4) para [4.11]. However, without information sharing within stakeholders, the task will be not accomplished as the data is confidential and only can be access by subjected officer.

From the TNA results, there has been a significant increase in the industrial applications of radiation sources in Malaysia. In 2015 there were about 4444 workplaces involved with ionizing radiation from 3 categories of job activities, namely medical, industrial and non-destructive testing, NDT. As results, the number of workers in this field is steadily increasing, with around 18,820 radiation workers in 2008 and 21,113 in 2015. Approximately 40.9% of the total workers are from the industrial, 52% from medical and 7.1% from NDT sectors. Below is the latest data of number of radiation facilities and radiation workers in Malaysia.

NO	TYPE OF CERTIFICATION	TOTAL
1	Radiation Protection Officer	1043
2	Supervisor	635
3	Workers	16335
4	Trainee	465
5	Radiation Protection Consultant	511
6	Qualified Expert	10
	TOTAL	**21,113**

Table 2. No. of Radiation Workers in Malaysia

PRACTICES USING RADIATION SOURCES	NUMBER OF FACILITIES		
	EXISTING	**FORESEEN (< 5YRS)**	**TOTAL**
Industrial Radiography	83	15	98
Irradiating Facilities including Research Reactor	5	1	6
Gauging	778	60	838
R&D	46	5	51
Mineral	23	5	28
Nuclear Medicine	30	8	38
Radiotherapy	34	9	43
Dental	1598	400	1998
Radiology	1851	463	2314
Veterinary	82	21	103
Laboratory	2	1	3
TOTAL	**4444**	**988**	**5520**

Table 3. License Radiation Application in Malaysia

Source: AELB Database until October 2015

3.3 Policy Suggestion

Draft of the policy/strategy has been prepared during the National Workshop on 19-21 October 2015. Strengthening collaborations among the stakeholders and establishing working committee to support the steering committee were taken to formalise the national strategy. Commitment and support from relevant authorities to establish the policy/strategy to formalize/endorse the related documents were needed. Members of the WG including all stakeholders i.e Atomic Energy Licensing Board (AELB), Ministry of Health, Department of Skill, USM and Nuclear Malaysia. The visions of the policy are transforming education and training in radiation, transport and waste safety (RTWS) for national well-being and sustainable development. The strategies includes Development of a National RTWS Education and Training Programme, Continuous Training Programme, Development of a National RTWS Competency and Certification Scheme and Development of Educational Institution. The policy also suggested for establishing a network of training provider for coordinated and integrated nuclear education and training programme. The policy still under review before submitting to the relevant authorities for endorsement.

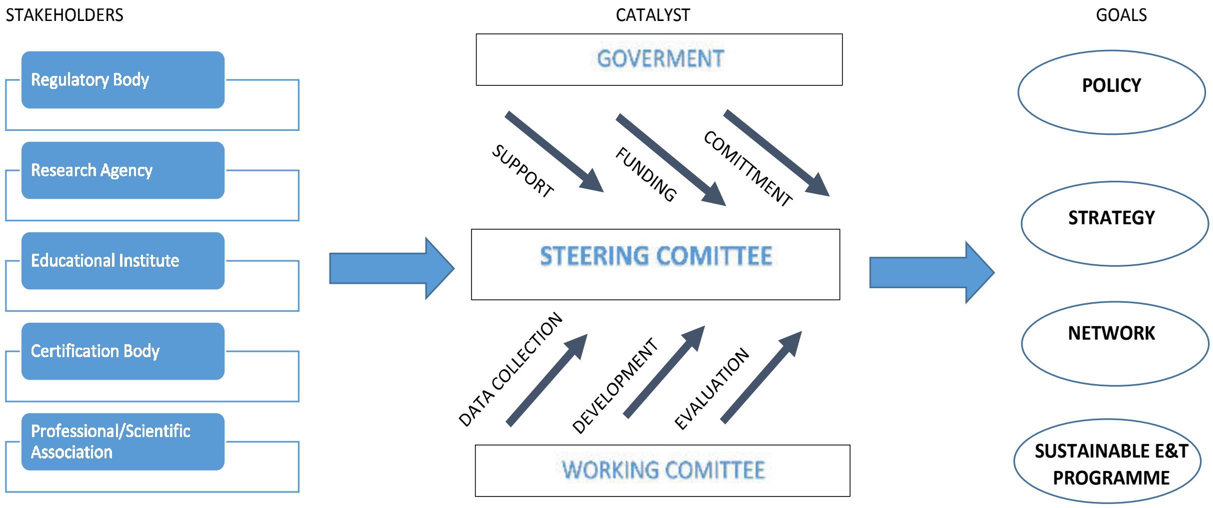

Figure 2: Strategy Model for Establishing National Policy

4. Conclusion

Comprehensive and integrated planning and implementation to develop national strategy on E&T in RTWS shall involve all relevant stakeholders within the HRD framework of Malaysia (industry, educational institutions, etc.). Cooperative partnership and collaborative efforts can assist in strengthening the national E&T programme on RTWS and must be expanded beyond borders to enable sharing of expertise and experiences for a better and balanced global development. The needs of formalized E&T policy/strategy deem fits to Malaysia E&T objectives for sustainable societal well-being.

Having discussed about the status of nuclear education and training in Malaysia, it is concluded that Nuclear education and training in Malaysia has contributed importantly to the country's self-reliance on nuclear technology for peaceful use; it is expected to take a more innovative role to meet the need of attracting young scientists to the nuclear field, preserving nuclear knowledge as well as advanced nuclear energy technology development. The community of nuclear education and training in Malaysia is making an extensive efforts to strengthen its capability at national level including established linkage, networking and sharing information and resources.

5. References

INTERNATIONAL ATOMIC ENERGY AGENCY, Building Competence in Radiation Protection and the Safe Use of Radiation Sources, IAEA Safety Standards Series No. RS-G-1.4, IAEA, Vienna (2001)

EDUCATION AND TRAINING APPRAISAL MISSION IN MALAYSIA REPORT, 26-30 September 2011.

List of Agencies Accredited by AELB - Consultant Radiation Protection (JPS), Leak Test and Training Agency, 2017.

FNCA Workshop on Human Resources Development, Country Reports 2016

INTERNATIONAL ATOMIC ENERGY AGENCY, Regulatory Authority Information System — RAIS, (2014), http://www-ns.iaea.org/tech-areas/regulatoryinfrastructure/rais.asp

Tenaga Nasional Berhad, Annual Report 2015 (TNB, Kuala Lumpur, 2015).

PRACTICAL LEARNING FOR EXTERNAL BEAM RADIOTHERAPY TREATMENT PLANNING USING OPEN SOURCE PLANNERS

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ABSTRACT

The therapeutic use of ionizing radiation in medicine is one of the main forms of treatment for patients with cancer and related diseases. In radiotherapy, a potentially lethal dose of radiation is administrated to patients. Thus, well-designed radiotherapy procedures must be adopted to avoid misadministration and exposure of non-patient individuals (medical staff, visitors or general public). One of the most important issues in radiation safety in radiotherapy is the optimization of the treatments, so one obtains the desired level of accuracy between the medical prescribed doses and the real doses during the treatment. The present work is focused on the practical learning of the treatment planning for External Beam Radiotherapy (EBRT) using open source and free planners. The learning methodology has been developed to teach future professionals in radioprotection in the medical field. The students learn the protocol and techniques with tools very similar to the real ones. They also learn basic concepts as isodose curves and the dose volume histogram, always from the point of view of the ALARA approach.

1. Introduction

The present work is focused on the practical learning of the treatment planning for External Beam Radiotherapy (EBRT) using open source and free planners. The learning methodology has been developed to teach future professionals in radioprotection in the medical field. The students learn the protocol and techniques with tools that are currently used in hospitals. They also learn basic concepts as isodose curves and the dose volume histogram, always from the point of view of the ALARA approach. This learning methodology is based in the case studies.

Case studies have long been used in business schools, law schools, medical schools and the social sciences, but they can be used in any discipline when instructors want students to explore how what they have learned applies to real world. Problems or cases come in many formats, from a simple “What would you do in this situation?” question to a detailed description of a situation with accompanying data to analyse. Whether to use a simple scenario-type case or a complex detailed one depends on the course objectives (1).

Using this methodology in teaching can provide opportunities for deep learning, as they:

- allow the application of theoretical concepts to be demonstrated, thus bridging the gap between theory and practice,
- encourage active learning,
- provides opportunities for the development of key skills such as communication, group working and problem solving.
- increase students' enjoyment of the topic and hence their desire to learn.

Case studies can be used not only to teach concepts and content, but also process skills and critical thinking.

In this frame, the present work is focused on the practical learning of the treatment planning for External Beam Radiotherapy (EBRT) using open source and free planners. In particular, the case studies considered in this work is a prostate cancer patient.

The most crucial step in any form of radiation treatment planning is the accurate registration of the tumor volume. If this step is not correctly done, the radiation portals may include too much normal tissue, miss part of the tumor, or both. And once this error has been committed, no amount of treatment-planning sophistication can make up for it. This registration can be aided in various ways, for example, by placing opaque markers either internally, or on the patient's surface so as to identify areas of concern. Nevertheless, experience suggests that manual definition of the tumor on the simulation film is prone to error. For example, a review of an important national cooperative trial for the treatment of lung cancer revealed that the target volume was incompletely covered more than 20% of the time even though all of these patients had had preplanning diagnostic CT scans (2). Similar, or even higher error rates may occur in other anatomic locations.

2. Radiation Protection

The therapeutic use of ionizing radiation in medicine is one of the main forms of treatment for patients with cancer and related diseases. In radiotherapy, a potentially lethal dose of radiation is administrated to patients. Thus, it is fundamental to apply radiation protection principles to radiotherapy environment. There are two aims of radiation protection, one consists in the prevention of deterministic effects (not including those that are intentionally produced, but doing so with those which are not intended) and on the other hand, the reduction of the probability of stochastic effects.
According to the ICRP recommendations, the system of radiation protection is based upon 3 fundamental principles: Justification of practices, limitations of doses and optimization of protection and safety (3). Regarding to the first one, there is a basic need of evaluation of the benefits of the radiation, this is due to the fact that even the smallest exposure is potentially harmful, so the risk must be offset by the benefit. This fact is linked to the second principle; the dose must be limited.
The optimization in the context of the radiotherapy is focused in two main points of view, the optimization of the dose (in the sense of optimization) and the optimization of the protection of all the public (staff, patients and rest of public). The optimization of the protection is based on the ALARA (As Low As Reasonably Achievable) principle, and this concept links the optimization principle with the rest of the radiation protection system.
ALARA is an acronym used in radiation safety for "As Low As Reasonably Achievable." The ALARA radiation safety principle is based on the minimization of radiation doses and limiting the release of radioactive materials into the environment by employing all "reasonable methods. The ALARA concept is an integral part of all activities that involve the use of radiation or radioactive materials and can help prevent unnecessary exposure as well as overexposure.
The three major principles to assist with maintaining doses "As Low As Reasonably Achievable" are:

- Time: Reducing the time of exposure can directly reduce radiation dose. Dose rate is the total amount of radiation absorbed relative to its biological effect. Dose rate is the rate at which the radiation is absorbed. Limiting the time of radiation exposure will reduce the radiation dose.
- Distance: Increasing the distance with the radiation source the exposure will be reduced by the square of the distance
- Shielding: Lead or lead equivalent shielding for X-rays and gamma rays is an effective way to reduce radiation exposure. There are various types of shielding used in the

reduction of radiation exposure including lead aprons, mobile lead shields, lead glasses, and lead barriers. When working in radiation areas it is important to use shielding.

3. PLanUNC

Three-dimensional (3D) treatment planning is an integral step in the treatment of various cancers when radiation is prescribed as either the primary or adjunctive modality, especially when the gross tumor volume lies in a difficult to reach area or is near to critical bodily structures. Today, 3D systems have made it possible to more precisely localize tumors in order to treat a higher ratio of cancer cells to normal tissue. Over the past 15 years, these systems have evolved into complex tools that utilize powerful computational algorithms that offer diverse functional capabilities, while simultaneously attempting to maintain a user-friendly quality. A major disadvantage of commercial systems is that users do not have access to the programming source code, resulting in significantly limited clinical and technological flexibility. As an alternative, in-house systems such as Plan-UNC (PLUNC) (4) offer optimal flexibility that is vital to research institutions and important to treatment facilities. Despite this weakness, commercially available systems have become the norm because their commissioning time is significantly less and because many facilities do not have computer experts on-site.

PLanUNC, or PLUNC as it is known familiarly, is a portable, adaptable, and extensible set of software tools for 3D Radiotherapy Treatment Planning (RTP) that has been under active development in the Department of Radiation Oncology at the University of North Carolina (UNC) since 1985.

PLUNC, is an adaptable and extensible software system for RPT. Its features include graphical tools for contouring anatomical structures, virtual simulation, dose calculation and analysis, and Intensity Modulated Radiation Treatment (IMRT) planning. It is suitable for External Beam Photon/Electron therapy, but currently contains no LDL/HDL or Proton code (easy to add). PLUNC is built on the principles of fast, light programming -- complex solutions done simply by specific (non-general) but extensible code. In Figure 1 a screenshot from the treatment planning system is shown.

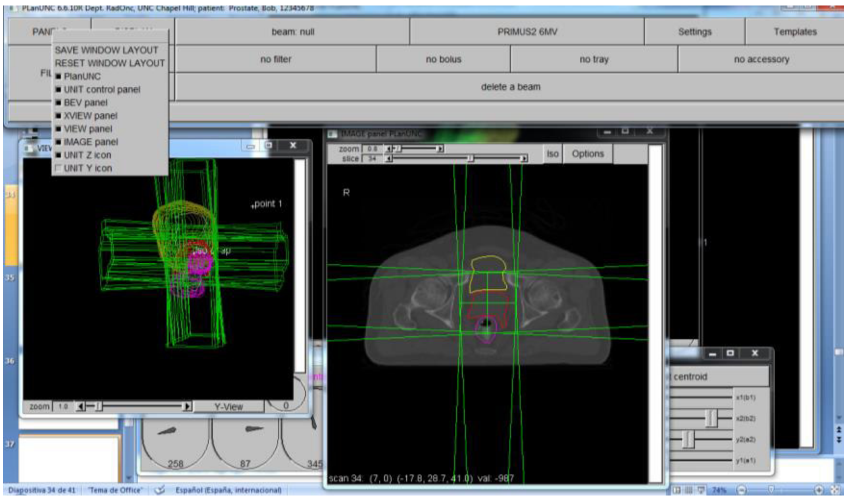

Fig 1. PLUNC screenshot from treatment planning system

The current UNC tools encompass the full range of RTP External Beam functions including image importing and processing, virtual simulation, dose calculation, plan evaluation, and planning for intensity modulated radiotherapy. PLUNC source code and related software are

licensed without fee to qualified facilities to support research involving new methods for planning and delivering radiation therapy, and to support RTP training for dosimetrists, physicists, radiation therapists, and radiation oncology residents.
Today there are several commercialized planning system competitors used for extern beam radiotherapy. However, PLUNC is successfully used for the education and training purposes.

4. PRIMO

PRIMO is a computer software that simulates clinical linear accelerators (LinAc's) and estimates absorbed dose distributions in water phantoms and computerized tomographies (5).
PRIMO is an adequate software to work with for students due to different reasons: First, it is a free software, so the students can install it in their computers and perform different simulations. Then, this engine is based on the Monte Carlo code PENELOPE (2), which is a software distributed by the OECD Nuclear Energy Agency (NEA). Thus, they work with a software based on an official code, using accurate physics but with a significantly computation time reduction due to variance-reduction techniques.
PRIMO can simulate Varian and Elekta linacs including multileaf simulations, and one can get absorbed dose distributions from a water phantoms or this can be provided in computerized tomographies in DICOM format. The user can store different fields in intermediate phase-space, and one can go through the set up case steps by working in a graphical interphase.

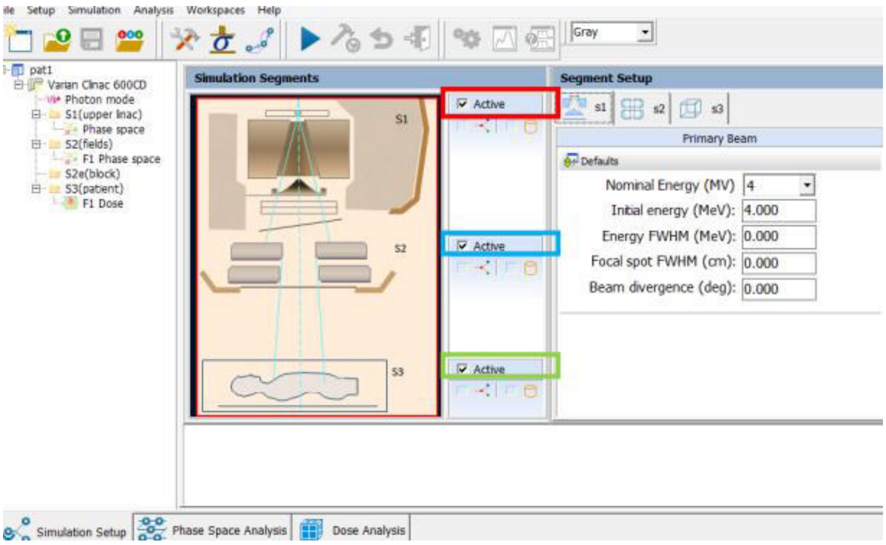

Fig 2: PRIMO software main window

By using these both codes, the students are working with a deterministic code and with a code based on Monte Carlo, learning also advantages and disadvantages of each code.

6 RESULTS

The treatment planning process consists of:

1. CT scans, volume definitions, localization of tumour and Organs-At-Risk (OARs) (critical structures).
2. Optimization of beam size effect, energy and placement.

3. Dose calculation/ treatment plan evaluation.
4. Preparation of treatment data.

Following sections present this process for both software. First, planning process simulated with PlunC is presented. In this section, a detailed description of the procedure followed by the students is presented. Hereafter, a brief presentation of the same performance but made with PRIMO is shown.

6.1 PLUNC

6.1.1. CT scans, volume definitions, localization of tumour and OARs

The definition of tumour and target volumes for radiotherapy is vital to its successful execution. This requires the best possible characterisation of the location and extent of tumour. Diagnostic imaging, including help and advice from diagnostic specialists, is therefore essential for radiotherapy planning. There are three main volumes in radiotherapy planning. The first is the position and extent of gross tumour, i.e. what can be seen, palpated or imaged; this is known as the gross tumour volume (GTV). Developments in imaging have contributed to the definition of the GTV. The second volume contains the GTV, plus a margin for sub-clinical disease spread which therefore cannot be fully imaged; this is known as the clinical target volume (CTV). It is the most difficult because it cannot be accurately defined for an individual patient, but future developments in imaging, especially towards the molecular level, should allow more specific delineation of the CTV. The CTV is important because this volume must be adequately treated to achieve cure. The third volume, the planning target volume (PTV), allows for uncertainties in planning or treatment delivery. It is a geometric concept designed to ensure that the radiotherapy dose is actually delivered to the CTV. The PTV depends on the precision of such tools as: immobilization devices and patient positioning lasers. Figure 3 shows the principal volumes related to 3D RPT, defined by the International Commission on Radiation Units (ICRU).

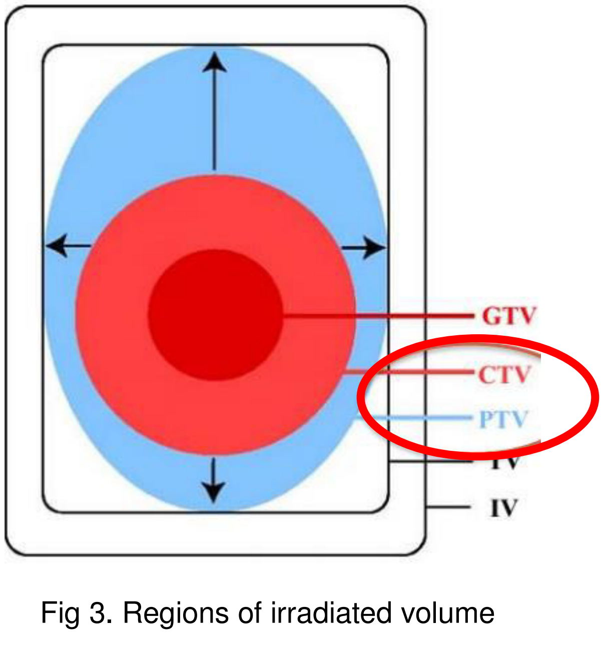

Fig 3. Regions of irradiated volume

Radiotherapy planning must always consider critical normal tissue structures, known as OAR. It is an organ whose sensitivity to radiation is such that the dose received forma a treatment plan may be significant compared to its tolerance, possibly requiring a change in the beam arrangement or a change in the dose. Figure 3 shows a 2D view of computed tomography image for prostate cancer patient: the main anatomical structures are: bladder, tumour (PTV), rectum.

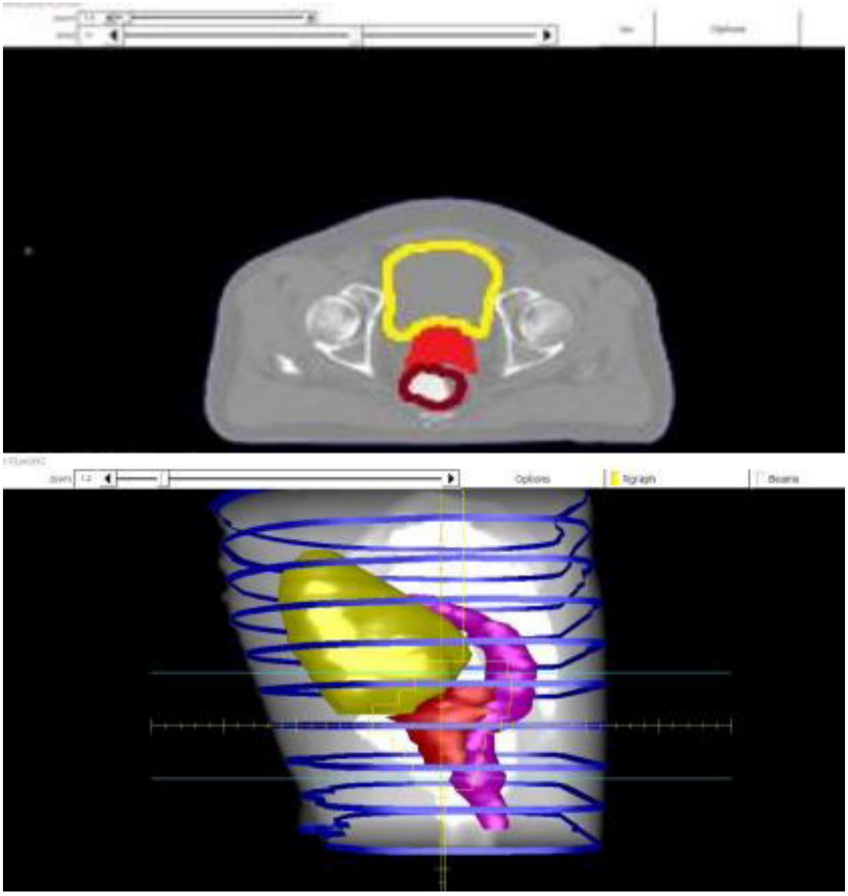

Fig 4. 2D view of computed tomography image for prostate cancer patient.

6.1.2 Optimization of beam size effect, energy and placement.

External photon beam radiotherapy is usually carried out with multiple radiation beams in order to achieve a uniform dose distribution inside the target volume (PTV) and a dose as low as possible in healthy tissues surrounding the target.

Recommendations regarding dose uniformity, prescribing, recording, and reporting photon beam therapy are set forth by the International Commission on Radiation Units and Measurements (ICRU). The ICRU report 50 recommends a target dose uniformity within +7% and -5% relative to the dose delivered to a well defined prescription point within the target.

For deeper lesions, a combination of two or more photon beams is usually required, if it is needed to concentrate the dose in the target volume and spare the tissues surrounding the target as much as possible. The Figure 5 shows the geometry of the fields and the wedges selected by the student.

Weighting and normalization: Dose distributions for multiple beams can be normalized to 100 % at z_{max} for each beam or at isocenter for each beam. It allows that each beam can be equally weighted.

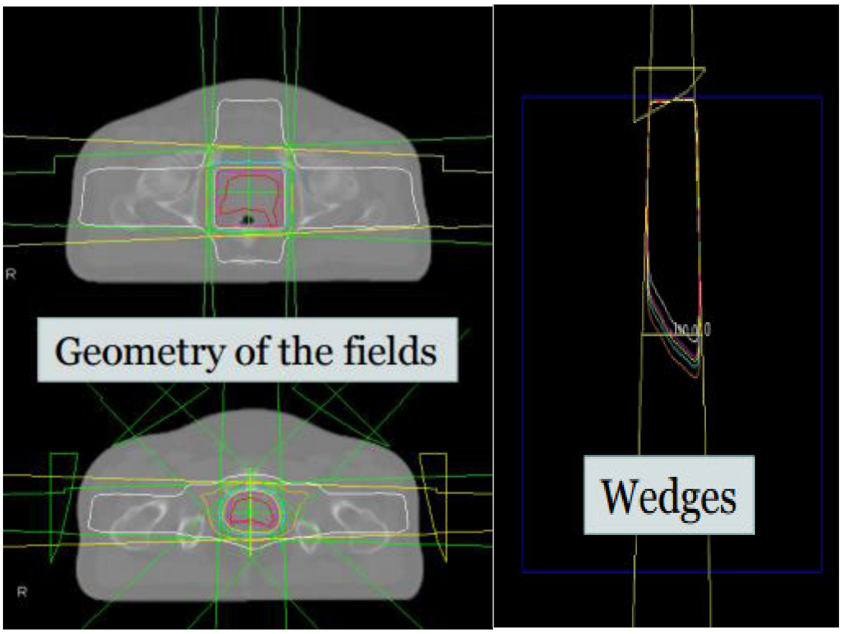

Fig 5. Geometry of the fields and the wedges selected by the student

6.1.3 Dose calculation/ treatment plan evaluation.

When the dose to a given volume is prescribed, the corresponding delivered dose should be as homogeneous as possible. Due to technical or anatomical reasons, some heterogeneity in the PTV has to be accepted. Parameters to characterize the dose distribution within a volume and to specify the dose are: Minimum target dose; Maximum target dose; Mean target dose; Reference dose at a representative point within the volume.

Evaluating the radiation treatment planning results the students also learn to use a plot of a cumulative dose-volume frequency distribution, known as a Dose-Volume Histogram (DVH). DVH results for the students shows graphically summarized the simulated radiation distribution within a volume of interest (PTV or OAR) of a patient, which would result planned radiation treatment plan. Also using DVH students have a possibility to compare treatment plans for the same patient by clearly presenting the possible uniformity of the dose distribution in the target volume and any hot spots for normal organs or healthy tissues (5).

The DVH data can be analysed with a TPS for the same "patient", with evaluation of the single plan or even comparative dose distributions for few different plans (Figure 6).

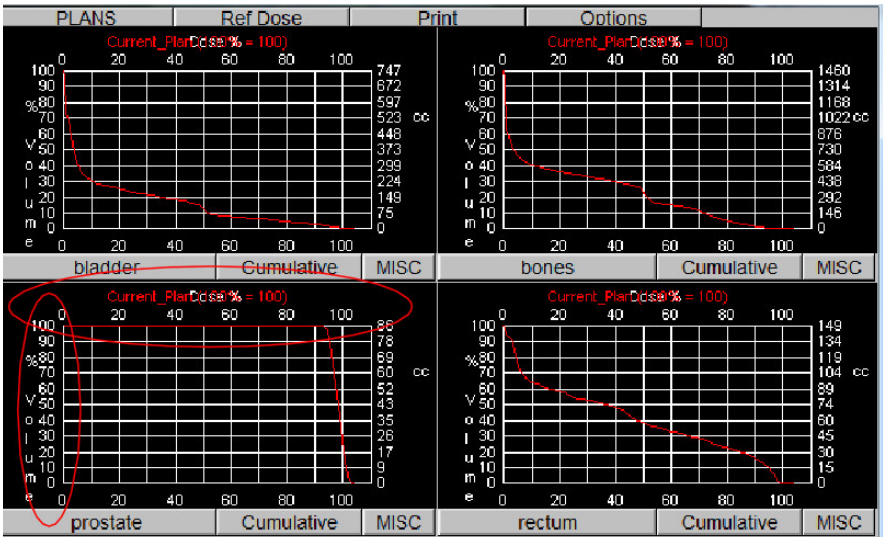

Fig 6. Results obtained by the students.

The DVH is an important tool that specifies each dose value, the fraction of a structure that receives a certain amount of the dose, dose distribution of irradiated volumes, ensuring the better protection of critical structures.

6.1 PRIMO

6.1.1. CT scans, volume definitions, localization of tumour and OARs

First, they need to import the CTA images. Then, they will be able to see a reconstructed voxelized geometry for the estimation of the dose. It is also necessary to convert to mass densities from Hounsfield number calibration curve and to associate each voxel to one material.

In order to define the planning target volume (PTV), the students can delineate in the 2-D views, reproducing the same process explained in the previous section.

Fig 7: 2D views of computed tomography image for prostate cancer patient in PRIMO

6.1.2 Optimization of beam size effect, energy and placement.

Once the students know the main volumes taken into account in radiotherapy planning and they know how to define the critical tissues (OAR's), now they also have to set up the accelerator, the beam and the collimator.

This software allows the students to define different accelerators from Varian and Elekta. Then, they have to select also the operation mode, where they can choose between photon or electron. Once the linac has been selected, the nominal energy has to be specified, along with the positioning of the jaws, multileaf collimators or electron applications.

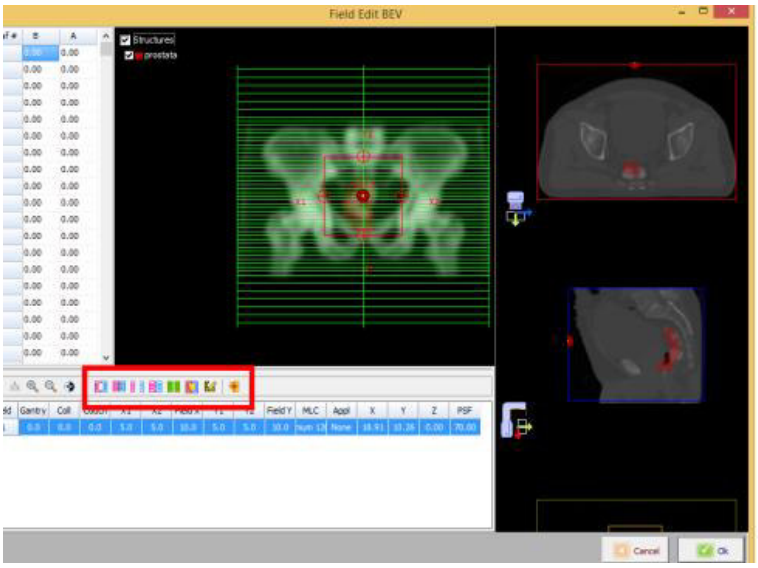

Fig 8: Selection of the collimator in PRIMO

6.1.3 Dose calculation/ treatment plan evaluation.

One of the advantages of PRIMO is that it allows to analyse not only dose distributions but also the spatial distribution of particles of the energy spectrum in 2-D planes called phase—space planes. In this work a phase-space has been defined immediately at the exit of the collimator. Dose distributions are seen by superimposing the results to the computerized tomography. The DVH is also plotted so that the students can check if their treatment plan.

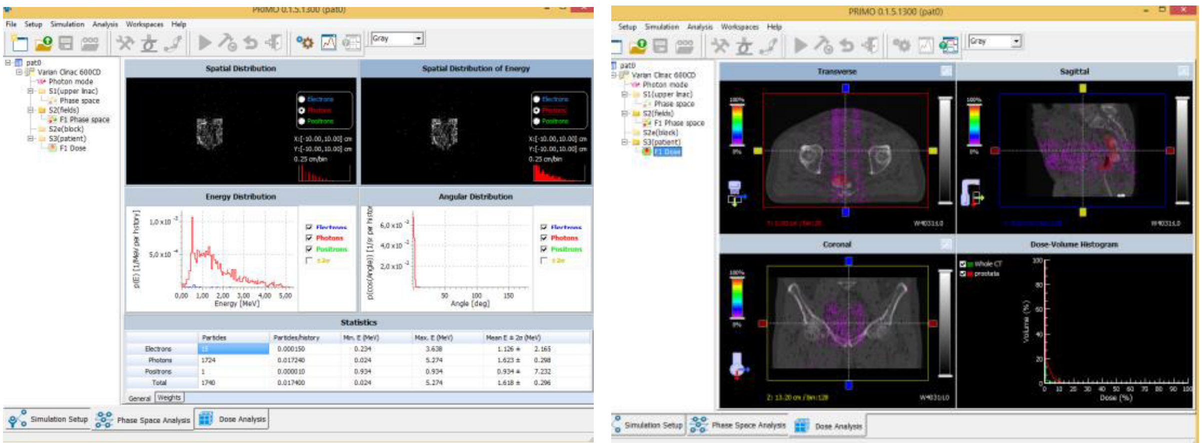

Fig 9: Phase –space view (left) and dose distribution view (right)

The main advantages using PLUNC and PRIMO with students are:

- Safe, and realistic education process;
- The clinical equipment, which is used in a daily clinical environment, is not necessary;
- Before starting work in a hospital it helps for future professionals and demo "patients" to find and discuss the most proper and optimized radiation treatment plan and irradiation method/technique.
- With such knowledge and practice it is easier to integrate the new practitioner in real clinical environment after graduation;
- it is needed less time to spent learning clinical skills like standard radiotherapy techniques used for patient radiation treatment planning.

7. CONCLUSSIONS

- ✓ Students get an understanding about planning process.
- ✓ However, compared to the commercialized planning systems, PLUNC today is useful for students' education and training, for its flexibility, this system does not require any annual contracts, it means that PLUNC treatment planning software is available to other institutions as mentioned for research and educational purposes.
- ✓ Advantages for having a non-commercialized treatment planning system for education purposes means safe, and realistic education process; also you do not need to use clinical equipment used in a daily clinical environment; it is needed less time to spent learning daily clinical skills after graduation starting to work in real clinical environment.

8. References

1. Boston University, Centre for Excellence and Innovation in Teaching
2. 2 R.O Dillman, S.L Seagren, K.J Propert, J Guerra, W.L Eaton, M.C Perry, R.W Carey, E.F Frei, M.R Green. "A randomized trial of induction chemotherapy plus high-dose radiation versus radiation alone in stage III non-small lung cancer N", Engl. J. Med., 323 (1990), pp. 940–945
3. ICRP, 1991. 1990 Recommendations of the International Commission on Radiological Protection. ICRP Publication 60. Ann. ICRP 21 (1-3)
4. https://sites.google.com/site/planunc/home
5. M. Rodriguez, J. Sempau and L. Brualla, PRIMO: A graphical environment for the Monte Carlo simulation of Varian and Elekta linacs, Strahlenther. Onkol. 189 (2013) 881-886.
6. Reid F. Thompson. RadOnc: An R Package for Analysis of Dose-Volume Histogram and Three-Dimensional Structural Data. J. Radiat. Oncol. Inform. no. 6(1), (2014), p. 98-110.

TRAINING IN EXTERNAL DOSIMETRY CALCULATIONS WITH COMPUTATIONAL CODES

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ABSTRACT

A typical radiological protection education program should include: radiation physics, biological effects of ionising radiation, detection and measuring of ionising radiation, radiation dosimetry, and regulations. Theoretical learning is required in all these subjects, but only two of them involve practical learning: detection and measuring of ionising radiation, and radiation dosimetry. For the practical learning of detection and measuring of ionising radiation, one should have access to different equipment, such as sources and detectors. This equipment may be expensive or difficult of obtaining it, because of regulations. Thus, students might not practice frequently with them. In contrast, practical learning of dosimetry calculation only requires a computer, because radiation dosimetry calculation is based on the calculation of the flux distribution and the dose-to-flux conversion factors. On the one hand, dose-to-flux conversion factors are obtained from databases, such as that of the National Institute of Standards and Technology. However, the flux distribution calculation could be a difficult task, because one should solve the transport equation. Although there are some practical approaches that calculate easily the flux distribution, like the isotropic point source approach, this calculation might be also a hard task for complex geometries. Fortunately, there a lot of codes that can calculate the flux distribution with different methods. The state of the art of these codes are those based on Monte Carlo method. However, these codes are not user-friendly and may require high computational times. On the other hand, there are several user-friendly codes based on the isotropic point source approach, which can calculate faster the flux distribution, even for complex geometries. These codes are accurate enough for obtaining an approximate flux distribution and calculate an appropriate shielding. In this work, the authors describe the use and applications of two codes of this kind: MicroShield and EasyQAD. In particular, several examples will be given in the full paper, such as the dosimetry calculation due to radioactive wastes and shielding calculation.

1. Introduction

A typical radiological protection education program should include: radiation physics, biological effects of ionising radiation, detection and measuring of ionising radiation, radiation dosimetry, and regulations. Theoretical learning is required in all these subjects, but only two of them involve practical learning: detection and measuring of ionising radiation, and radiation dosimetry.

For the practical learning of detection and measuring of ionising radiation, one should have access to different equipment, such as sources and detectors. This equipment may be expensive or difficult of obtaining it, because of regulations. Thus, students might not practice frequently with them.

Radiation dosimetry requires various specifications of the radiation field at the point of interest and deals with methods for a quantitative determination of energy deposited in a given medium by directly or indirectly ionizing radiations [1]. This energy deposited as radiation interacts with atoms of the material, is responsible for the effects that radiation causes in matter, for instance, a rise in temperature, or chemical or physical changes in the material properties [2]. Several quantities related to the radiation field and this energy have been used for quantifying the effects of radiation with matter. Nowadays, one uses the absorbed dose for quantifying the effects of ionising radiation with matter.

Absorbed dose calculation is based on the calculation of the flux distribution and the dose-to-flux conversion factors. On the one hand, dose-to-flux conversion factors are obtained from databases, such as that of the National Institute of Standards and Technology. On the other hand, one can calculate the flux distribution calculation by solving the transport equation. This calculation might be a hard and complex task, but there are several codes that can calculate the flux distribution with different methods.

The state of the art of these codes are those based on Monte Carlo method, such as: MCNP [3], PENELOPE [4], GEANT [5], etc. However, these codes are not user-friendly and may require high computational times. On the other hand, there are several user-friendly codes based on the isotropic point source approach, which can calculate faster the flux distribution, even for complex geometries. These codes are accurate enough for obtaining an approximate flux distribution and calculate an appropriate shielding.

Summarising, practical learning of dosimetry is accessible to students, because it only requires a computer. In this work, the authors describe the use and applications of two codes for calculating the external dose: MicroShield [6] and EasyQAD [7], which are based on the isotropic point source approach. The outline of this paper is as follows. Sections 2 and 3 describes the codes MicroShield and EasyQAD respectively. Section 4 describes the learning method. Section 5 summarises the conclusions.

2. MicroShield

MicroShield [6] is a comprehensive photon/gamma ray shielding and dose assessment program that is widely used for designing shields, estimating source strength from radiation measurements, minimizing exposure to people, and teaching shielding principles.

It is fully interactive and utilizes extensive input error checking. Integrated tools provide graphing of results, material and source file creation, source inference with decay (dose-to-Ci calculations accounting for decay and daughter buildup), projection of exposure rate versus time as a result of decay, access to material and nuclide data, and decay heat calculations.

MicroShield can define sixteen different geometries, such as: point, lines, disks, cylinders, rectangular volumes, etc. It also contains updated library data (radionuclides, attenuation, buildup, and dose conversion), which reflect standard data from ICRP 38 and 107 as well as ANSI/ANS standards and RSICC publications including (ICRP) Publication 116 absorbed dose rates and dose conversion factors from ANSI/ANS-6.1.1-1977. In addition, it includes custom materials based on ANSI/ANS-6.4.2-2006.

3. EasyQAD

EASYQAD [7] was built at Hanyang University, Seoul, Korea as a visualization code system based on the commonly used QAD-CGGP-A point-kernel code in order to perform conveniently gamma and neutron shielding calculations. Its Graphical User Interfaces (GUI) were constructed by MATLAB GUI and compiled in C++ programming language by using MATLAB Compiler Toolbox to form a stand-alone code system that can be run on Windows XP or Windows 7 environment without any MATLAB installation.

Its user-friendly interfaces allow complex items to be easily defined and presented without expert knowledge or special training. One enters geometrical, chemical and nuclear properties through templates and computer aided sequences to build the view to be measured. In these sequences the operator enters the dimensions of 3D-shapes, their chemical compositions, their densities, the type of radioactive sources, the locations of the sources, the type and positions of detectors.

It also contains a material library including about 180 materials, but the user can also build a complete new material and store in this library. Multi-group energy and source spectrum can be defined in which gamma spectrum energy can be determined from the selection of energy gap, minimum energy and the number of energy groups. It is also possible to load the spectrum data from available files. Finally, one can calculate the dose for multiple points at the same time using point, line and grid detectors.

4. Methods

The methodology is focused on the use of two different dose calculation software (MicroShield and EasyQAD) to solve two simple problems. In the first problem, one should obtain the maximum number of trips that a truck driver can make, with a cargo of Cs-137 and without exceeding the dose limit of 1 mSv per year. In the second problem, one calculates the optimal containment for a Co-60 and I-131 source and the thickness of the room wall where the source will be stored to protect people working in the contiguous rooms.

Firstly, a brief theory lesson is given. The purpose of this is to explain basic concepts of dosimetry, such as radiation interaction with the matter (photo electric, Compton and pair production), the concept of mass coefficient, mass thickness, half value-layer or build-up factor. In addition, the instructors explains the basic law of attenuation:

$$I(x) = I_0 \cdot e^{-\mu \cdot x}$$

Where I is the radiation intensity in the point considered, I_0 is initial intensity and μ is a proportionality constant called attenuation coefficient with L^{-1} dimension, and this coefficient depends on the material considered and the incident photon energy.

Secondly, the instructors highlight the three criteria to take into account considering the ALARA (As Low As Reasonably Achievable) concept. These three criteria (Distance, time and shielding) are clearly applied in the problems.

4.1 Driver Truck Problem

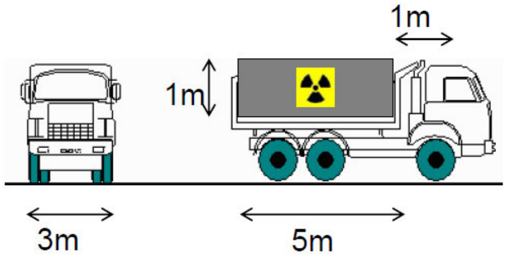

Fig 1. Dimensions used in the Driver Truck Problem.

Problem: *A truck whose dimensions are 5 meters long by 3 meters wide and with a height of 1 meter, has to transport 2000 Tm of radioactive ashes (Cs-137) of 100 Bq / cm3. Taking into account that the truck driver is located 1 meter, obtain with MicroShield and EasyQAD the equivalent dose rate in mSv / h (Deep dose parallel) with and without Buildup. It is known that each trip lasts 2 hours and that the maximum allowable dose is 1 mSv. Calculate how many trips you can make and the dose you receive, considering the dose rate with and without Buildup.*

In this exercise, the instructors point out four special issues. First, the source calculation from the radioactive isotope Cs-137. Second, the difference between the dose calculation with and without build-up factor. Third, dose limit depending on the category of the worker. Fourth, time limit, so the driver does not exceed the dose limit. This time limit is expressed in terms of number of trips.

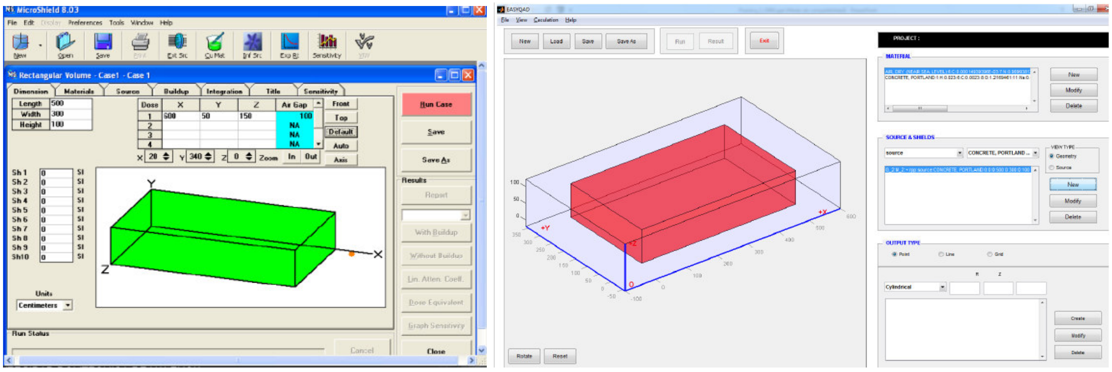

Fig 2. Screen captures of MicroShield (on the left) and EasyQAD (on the right) for the Driver Truck Problem

4.2 Drum problem

Problem: *A cylindrical Pb drum with a thickness of 0.1cm, 1 meter in diameter and 1.5 meters in height is used to store Co-60 and I-131 from medical applications that have been previously compacted into concrete. The activities of each nuclide are: 50 Bq / cm3 for Co-60 and 100 Bq / cm3 for I-131. The drum is stored temporarily in a room of the hospital, one meter away from a concrete wall that separates this room from a visitor's room. Considering that there is a person working in the visitor's room, one meter away from the wall, one should obtain with EasyQAD and Microshield the dose rate in mSv / h with and without Buildup. Considering that the annual work hours for this person are 1900, determine if they will exceed the annual limit,* *which is 1 mSv (consider the dose rate with Buildup). Determine the minimum thickness of the wall so that the annual limit is not exceeded.*

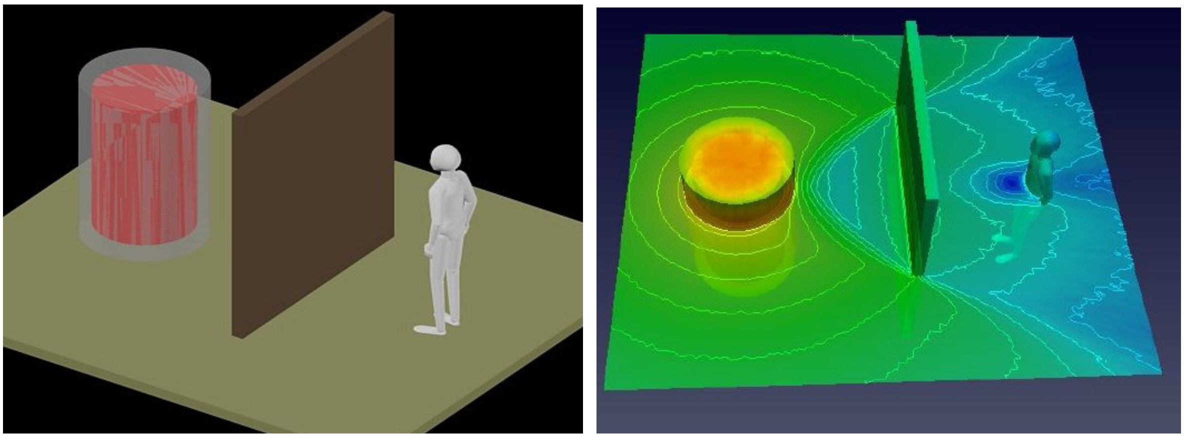

Fig 3. Geometric Example of the problem

The main objective of this problem is to provide a real calculation of a shielding, third ALARA criterion. As in the previous exercise, the instructors highlight several issues. First, the source calculation from radioactive isotopes Co-60 and I-131. Second, the difference between the dose calculation with and without build-up factor. Third, the attenuation of radiation due to thickness and different materials (lead and concrete). Forth, dose limit depending on the category of the worker. Fifth, increasing the shielding, so the worker does not exceed the dose limit.

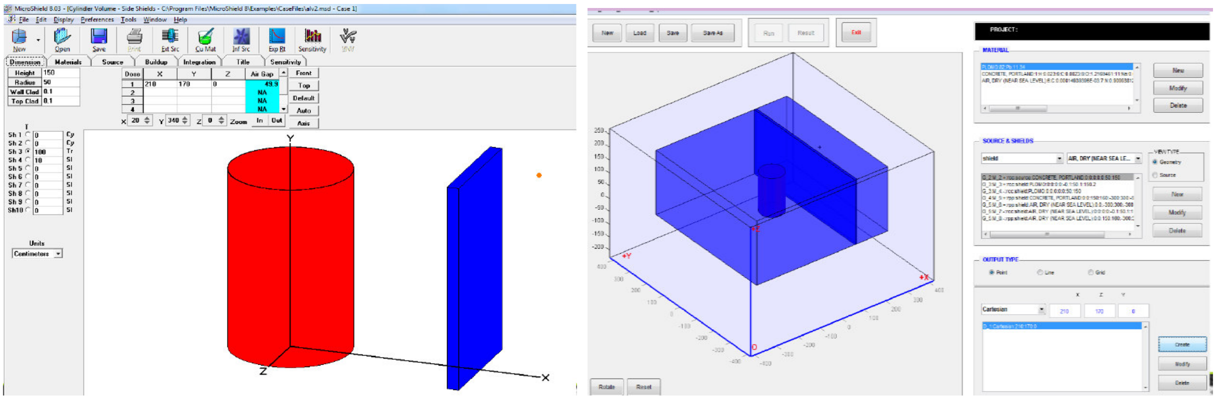

Fig 4. Screen captures of MicroShield (on the left) and EasyQAD (on the right) for the Drum Problem

An analysis of the wall thickness is required, so that the worker does not exceed the annual dose limit. The results are displayed as a flux-thickness curve that simplifies the determination of the optimal thickness. MicroShield can automatically obtains this curve without changing the input, but EasyQAD needs to change the input for each thickness.

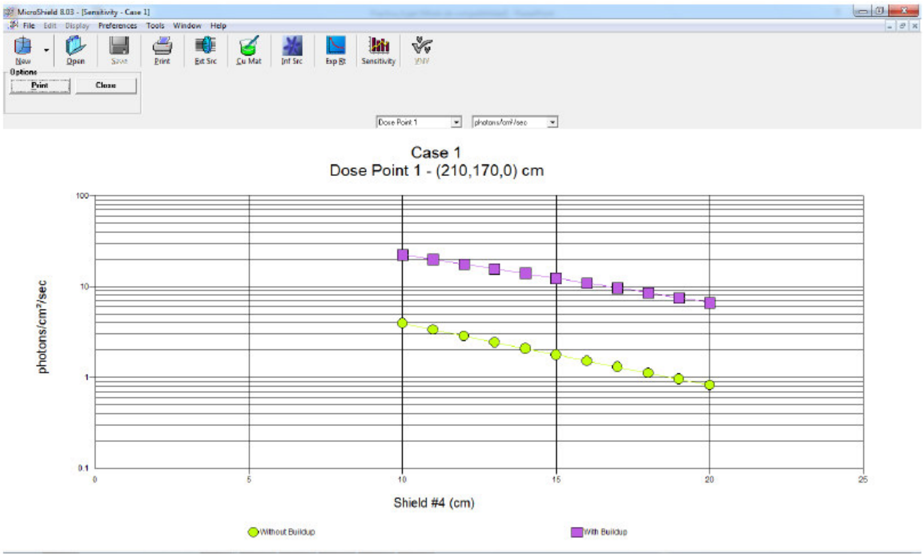

Fig 5. Graph sensitivity (Microshield).

5. Conclusions

This work emphasises two advantages of the training of external dosimetry calculation. First, it only requires a computer and software. Second, it includes both theoretical and practical learning.

Exact external dosimetry calculation might be a hard task, because one should solve the transport equation to determine the flux. However, there are several codes than can calculate the external dose with simplified methods, like those based on the isotropic point source approach.

In this work, the authors used two codes for dose and shielding calculations: MicroShield and EasyQAD. These codes are based on the point source approach, but the results obtained with them are accepted by the Spanish Nuclear Safety Council (CSN).

These codes are a good educational and training tool for practical lessons, without needing expensive devices or large facilities. Their use is very easy and an exhaustive knowledge about the different options of the programs is not necessary to perform real simulations.

Realistic problems were solved in the practical sessions. The practical sessions allow apply the theory to practical learning, which is more dynamic and entertaining than the theoretical learning.

Learners can compare both codes, which is useful for checking that the models and the simulations are correctly executed.

6. References

[1] *Radiation Oncology Physics: A Handbook for Teachers and Students*, International Atomic Energy Agency, Vienna, Austria, 2005.

[2] *Diagnostic Radiology Physics: A Handbook for Teachers and Students*, International Atomic Energy Agency, Vienna, Austria, 2014.

[3] X-5 Monte Carlo Team, *MCNP – A General Monte Carlo N-particle Transport Code, Version 5 – Vol. I: Overview and Theory*, Report LA-UR-03-1987, Los Alamos National Laboratory, Las Alamos, NM, 2003.

[4] J. Baró, J. Sempau , J.M. Fernández-Varea and F. Salvat, *PENELOPE: an algorithm for Monte Carlo simulation of the penetration and energy loss of electrons and positrons in matter*, Nucl. Instrum. Methods B, **100**, pp. 31-46, (1995).

[5] S. Agostinelli, J. Allison, K. Amako, et al. *Geant4 – a simulation toolkit*, Nucl. Instrum. Methods Phys. Res. Sect. A: Accel. Spectrom. Detect. Assoc. Equip., **506**, pp. 250-303, (2003).

[6] MicroShield and Grove Software, *MicroShield*, Grove Software, http://radiationsoftware.com/microshield/.

[7] J.K. Kim, *EASYQAD Version 2.0.1: A Visualization Code System for Gamma and Neutron Shielding Calculations*, iTRS at Hanyang University, Seoul, Korea.

TEACHING COMPUTATIONAL CAPABILITY FOR RADIATION PROTECTION AND SHIELDING IN SCALE

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ABSTRACT

This paper presents the work carried out within a training course in computational capability for Radiation Protection and Shielding, applied to criticality calculation, deep penetration problems, radiation transport, and neutron flux calculation. The course was offered in July 2016 by the Polytechnic University of Valencia (UPV) and was sponsored by The Spanish Nuclear Safety Council (CSN) within the Vicente Serradell Chair of Nuclear Safety to foster the education of highly qualified nuclear safety and radiation protection professionals. It was designed for workers of the nuclear sector as well as for graduate and postgraduate students. The proposed approach was focused on theoretical lectures and practical exercises in order to simulate real problems like nuclear reactors fuel assemblies, spent fuel pools, deep penetration transport simulations and shielding design. To solve the proposed problems, the authors employed two sequences of SCALE code: KENO-VI and MAVRIC, both based on Monte Carlo method for solving criticality and radiation transport problems. The main feature of these SCALE sequences is that they calculate accurately real radiation transport problems in reasonable computation times. This work presents an overview of the course, a brief explanation of the teaching method and the practical exercises.

1. Introduction

This paper presents the work carried out within a training course in computational capability for Radiation Protection and Shielding, applied to criticality calculation, deep penetration problems, radiation transport, and neutron flux calculation. The course was offered in July 2016 by the Polytechnic University of Valencia (UPV) and was sponsored by The Spanish Nuclear Safety Council (CSN) within the Vicente Serradell Chair of Nuclear Safety to foster the education of highly qualified nuclear safety and radiation protection professionals. It was designed for workers of the nuclear sector as well as graduate and postgraduate students. The total number of trainees was 27 and they evaluated positively the course.

Shielding and radiation protection are of concern to many areas, such as: medical facilities, outer space, accelerators, fission and fusion reactors, and nuclear waste management. All these areas involve criticality safety and radiation transport calculation. Criticality safety attempts to prevent nuclear accidents by analysing all possible conditions in fissile material operation, studying the most important parameters affecting the criticality of the system. Radiation transport calculation determines the flux distribution and the dose rate.

Criticality and dose rate calculations are very important for professionals working in shielding and radiation protection areas. Consequently, these workers need theoretical and practical knowledge in methods and codes for performing these calculations.

In a training course of shielding and radiation protection, there are two main objectives. First, to teach the trainees to simulate practical situations as realistic as possible. Second, teach the trainees to calculate fluxes and dose rates with low uncertainties in reasonable times, even for deep penetration problems.

The best method for performing criticality and dose rate calculations in real problems is the Monte Carlo method. One should learn several theoretical concepts for applying this method, like: Theory of probability, Cross Section Libraries, Continuous-energy and Multi-group library, and Material Information Processor. Fortunately, there are several codes for solving radiation transport problems with the Monte Carlo method, which simplify the calculation. Consequently, the trainees should also acquire computational skills to create the input files and analyse the output data.

Among these codes, the authors highlight the SCALE code, in particular the version 6.2, because of two reasons. First, SCALE is an important code for the U.S. Nuclear Regulatory Commission. Second, it includes the state-of-the-art algorithms for criticality safety and radiation shielding.

The teaching methodology applied in the course follows the simulation-based learning methodologies. It combines master classes about theory contents with the application of the theoretical concepts to real cases using computational codes. In lecture classes the teacher creates an environment that propitiates the participation of the trainees. The good understanding of the theory basis is very important to be able to follow the practical classes and to tackle other problems that trainees can find in their professional work.

The outline of this paper is as follows. Section 2 includes a brief description of SCALE. This section includes two subsections describing the major modules for criticality and radiation shielding calculation: KENO-VI and MAVRIC. Section 3 explains the learning method. Section 4 summarises the conclusions.

2. SCALE

The SCALE code system [1] is a widely used modelling and simulation suite for nuclear safety analysis and design, which is developed by the Reactor and Nuclear Systems Division (RNSD) of the Oak Ridge National Laboratory (ORNL) [2]. SCALE provides a comprehensive, verified and validated, user-friendly tool set for criticality safety, reactor physics, radiation shielding, radioactive source term characterization, and sensitivity and uncertainty analysis. SCALE includes nuclear data libraries for continuous energy, multigroup neutronics and coupled neutron-gamma calculations, as well activation, depletion, and decay calculations. Moreover, SCALE includes unique capabilities for automated variance reduction for shielding calculations, as well as sensitivity and uncertainty analysis.

2.1. KENO-VI

The KENO-VI [3] is a 3D multigroup and continuous energy eigenvalue Monte Carlo analysis sequence with criticality search capability. KENO-VI uses the SCALE Generalized Geometry Package, which provides a quadratic based geometry system with much greater flexibility in modelling with slower runtimes. KENO-VI performs eigenvalue calculations for neutron transport to calculate multiplication factors (k_{eff}), fluxes and energy distributions of a criticality problem, useful as a source in shielding problems. On the other hand, this sequence calculates angular fluxes and flux momentums useful to the sensitivity analysis.

The geometry package in KENO-VI is capable of modelling any volume that can be constructed using quadratic equations. Special features include simplified data input, supergrouping of energy-dependent data, and the use of quadratic equations to represent geometry input, a P_n scattering treatment, extended use of differential albedo reflection, and an improved restart capability [4]. Other calculated quantities are neutron lifetime, generation time, energy-dependent leakages, energy- and region-dependent absorptions, fissions, fluxed, and fission densities.

The principal applications of the KENO-VI sequence are listed below.

For criticality calculations:

- Nuclear reactors.
- Spent fuel/refuelling pools
- Spent fuel dry storage casks.
- Research reactors.

With the purpose of calculating the fission source term:

- Depth penetration transport simulations.
- Shielding design.
- Critically accident alarm systems (CAAS).

2.2. MAVRIC

MAVRIC is a 3D sequence for continuous energy and multigroup fixed-source Monte Carlo analysis with automated variance reduction [5, 6]. MAVRIC is based on the Consistent Adjoint Driven Importance Sampling (CADIS) methodology [7], which uses an importance map and a biased source that are derived to work together. Its primary feature is the capability to calculate fluxes and dose rates with low uncertainties in reasonable times, even for deep penetration problems. This sequence automatically performs a coarse mesh 3D discrete ordinates transport calculation using Denovo [8] to determine the adjoint flux as a function of position and energy. This adjoint flux is used for applying variance reduction techniques in the shielding calculation, which is performed by Monaco sequence [9, 10].

The principal applications of the MAVRIC sequence are listed below.

- Perform radiation transport on problems that are too challenging for standard, unbiased Monte Carlo methods.
- Calculate fluxes and dose rates with low uncertainties in reasonable times even for deep penetration problems.
- Shielding calculations in low times.
- Calculation of deep penetration problems in reasonable times.
- Dose rate analysis in a high capacity nuclear spent fuel storage system.
- Dose analysis in pools of spent fuel.
- Gamma ray litho-density logging tools in well-logging studies.
- Radiation transport in ex-core calculations.
- Neutron flux calculation in the pressure vessel.

3. Method

The learning method is based on a theoretical explanation of the calculation method and its application to real problems. As mentioned before, the calculation method is the Monte Carlo Method with variance reduction techniques and is applied to fixed-source radiation transport problems. In case of criticality sources, the source is calculated in the first place by solving an eigenvalue problem.

The major concepts that are explained are the following ones: transport equation, continuous energy and multigroup approach, eigenvalue problem, deterministic method, Monte Carlo method, random number generation, distribution functions and sampling, variance reduction techniques. The instructors highlight the importance of the variance reduction techniques and explained those used in MAVRIC. These techniques are the source biasing and the weight windows; these weight windows are based on the adjoint flux calculated with a deterministic method.

The instructors point out the advantages and drawbacks of the method. In particular, the Monte Carlo method is the most accurate method for solving radiation transport problems in complex geometries, but it might require long run times for obtaining low uncertainties. Thus, variance reduction techniques are applied to the Monte Carlo method to solve accurately the problem in reasonable computation times.

The major applications of this method are shielding calculations and deep penetration problems. Therefore, the theoretical learning was combined with three different practical problems. First, a dose rate analysis in nuclear spent fuel storage system. Second, application of gamma ray litho-density logging tools in well-logging studies. Third, neutron transport in ex-core calculations.

In each of these three problems, the instructors define accurately the problem. Then, instructors and learners make the input for the code together. Next, the cases are run. Finally, instructors and learners discuss the results. The following subsections describe each problem.

3.1. Dose rate analysis in nuclear spent fuel storage system

This example was chosen because it uses several capabilities of MAVRIC code, such as: multiple sources, user-defined distributions for these sources, macro-materials for improved S_N calculations and the automated variance reduction technique.

This model contains PWR spent fuel assemblies, each with specified neutron and photon sources, which are placed inside a shielding cask. Fig 1 shows the geometry of the model. The goal of this example is to calculate the total dose rate within two meters of the cask surface.

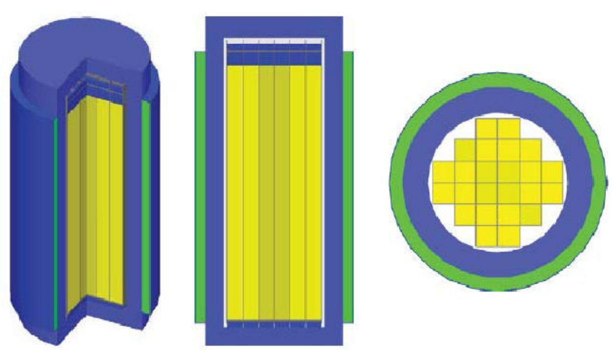

Fig 1. Geometry of the nuclear spent fuel storage system.

The detailed definition of the input includes the following issues: cross sections, materials, geometry, distributions, sources, responses, parameters for the Monte Carlo simulation and parameters for the variance reduction techniques.

Two cases were simulated: one with variance reduction technique and other without it. The comparison of these simulations is used to point out that the variance reduction techniques reduce the uncertainties of the results. The dose rates are also analysed to check the shielding of the cask.

3.2. Gamma ray litho-density logging tools in well-logging studies

The authors chose this example because it is a different application of radiation transport problems. The model of this problem is simpler than the previous one: the source is punctual and with a discrete spectrum and the geometry contains few cylinders as shown in Fig 2.

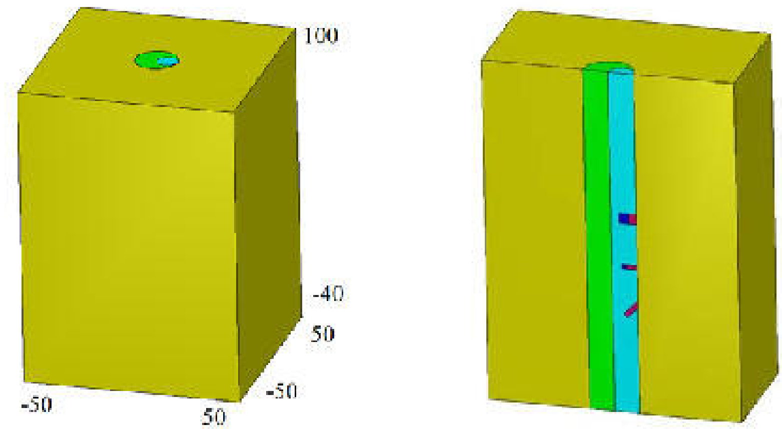

Fig 2. Geometry of the well-logging problem.

As in the first problem, a detailed definition of the input is performed. By contrast, five cases were simulated, which differ in the variance reduction technique. Thus, the instructors and learners discuss the results to find out the optimal technique in terms of computational time and low uncertainty.

3.3. Neutron transport in ex-core calculations

This example consists in calculating the dose in 16 ex-core detectors of a reactor. The example was chosen because of three reasons. First, the complexity of the geometry. Second, one should solve the criticality problem to determine the source, because the neutron source is the fissions from the reactor. Third, the variance reduction technique is crucial to obtain low uncertainties.

A detailed definition of the input is also performed for this case. Figs 3 and 4 show different cross sections of the reactor. As regards the simulations, 19 cases were simulated varying parameters of the variance reduction technique.

Finally, the power of this problem is the analysis of the results. This problem is a fantastic example to show the capability of the variance reduction techniques in both computational time and uncertainties.

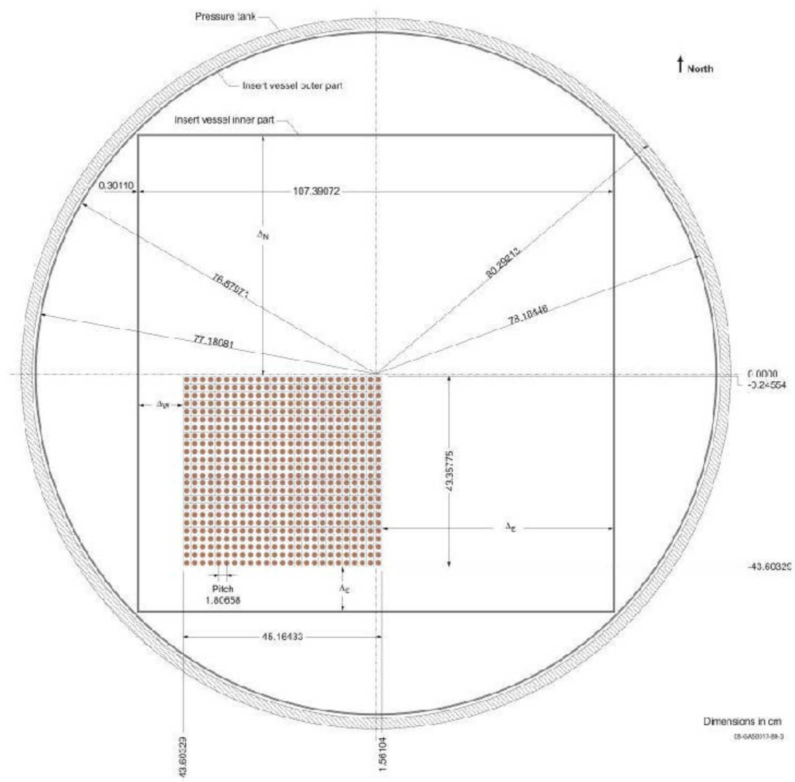

Fig 3. Axial cross section of the reactor.

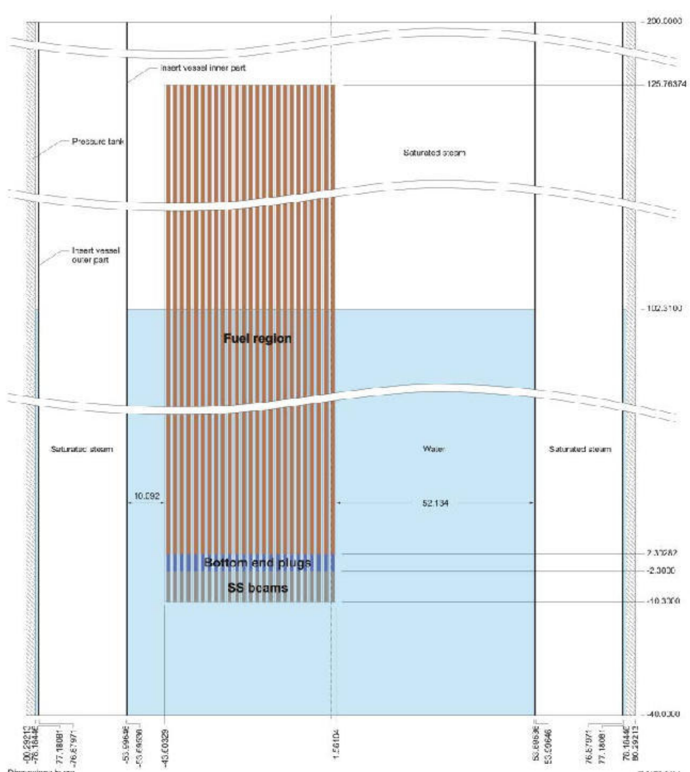

Fig 4. Frontal cross section of the reactor.

4. Conclusions

This work describes the learning method to calculate radiation protection and shielding problem with SCALE code. This method was applied in a training course of criticality and radiation transport calculations, offered by Polytechnic University of Valencia, and sponsored by The Spanish Nuclear Safety Council (CSN) within the Vicente Serradell Chair of Nuclear Safety.

A complete explanation of KENO-VI and MAVRIC modules of SCALE code is provided, especially the input files construction and output files understanding.

The learning method is based on a theoretical explanation of the calculation method and its application to real problems. Since the calculation method is complex (Monte Carlo with variance reduction technique), the application of the theory to real problems is crucial for achieving a good level of understanding.

The instructors applied the calculation method to three real problems. First, a dose rate analysis in nuclear spent fuel storage system. Second, application of gamma ray litho-density logging tools in well-logging studies. Third, neutron transport in ex-core calculations. Each problem includes a detailed definition of the input, several simulation, and analyses of the results. It is important to highlight that the discussion of the results is the important part to test the understanding of the method.

5. References

[1] B. T. Rearden and M. A. Jessee, Editors, "*SCALE Code System*", Reactor and Nuclear Systems Division, ORNL/TM-2005/39, Version 6.2.1, 2016.

[2] SCALE - Oak Ridge National Laboratory: http://scale.ornl.gov.

[3] S. Goluoglu, S. M. Bowman and M. E. Dunn, "*KENO Monte Carlo Code Capabilities*", Trans. Am. Nucl. Soc., 97, 592-594, 2007.

[4] S. M. Bowman, "*KENO-VI Primer: A Primer for Criticality Calculations with SCALE/KENO-VI Using GeeWiz*", Nuclear Science and Technology Division, ORNL/TM-2008/069, 2008.

[5] D. E. Peplow, "*Monte Carlo Shielding Analysis Capabilities with MAVRIC*", Nucl. Technol., 174(2), 289-313, 2011.

[6] D. E. Peplow, E. D. Blakeman and J. C. Wagner, "*Advanced Variance Reduction Strategies for Optimizing Mesh Tallies in MAVRIC*", Trans. Am. Nucl. Soc. 97, 595-597, 2007.

[7] J. C. Wagner, E. D. Blakeman and D. E. Peplow, "*Forward-Weighted CADIS Method for Global Variance Reduction*", Trans. Am. Nucl. Soc., 97, 630-633, 2007.

[8] T. Evans, A. Stafford, R. Slaybaugh and K. Clarno, "*Denovo: A new three-dimensional parallel discrete ordinates code in SCALE*", Nucl. Technol., 171, 171–200, 2010.

[9] M. B. Emmett and J. C. Wagner, "*MONACO: A New 3-D Monte Carlo Shielding Code for SCALE*", Trans. Am. Nucl. Soc., 91, 701-703, 2004.

[10] D. E. Peplow, S. M. Bowman, J. E. Horwedel and J. C. Wagner, "*Monaco/MAVRIC: Computational Resources for Radiation Protection and Shielding in SCALE*", Trans. Am. Nucl. Soc., 95, 669-671, 2006.

CHALLENGES IN PRACTICAL TRAINING EVENTS AT AN ACADEMIC INSTITUTION

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ABSTRACT

Experience tells that practical training in an environment close to the real professional world and visits to installations like NPPs, accelerator centers, research facilities are extremely valuable activities to enhance learning capability and motivation of the students. This contribution reports on the past and future initiatives of AcUAS to offer these possibilities to its own students but also to students coming from universities of the CHERNE network. In view of the relatively small number of students and the increasingly difficult financial situation it is essential to share the possibilities individual partner can offer. The specialization and infrastructure of an academic institution influences the teaching at that institution and thus one has to expect a quite diverse knowledge of the participants. This and other challenges are subject of this contribution.

1. Introduction

The Jülich branch of AcUAS (Aachen University of Applied Sciences) has a long tradition in offering not only study courses in nuclear engineering, nuclear chemistry, radiation protection, and other related disciplines but also dedicated vocational training especially in radiation protection to workers from research, industry, and the medical sector. The activities started in the early sixties together with the launch of the Jülich research center (FZ-Jülich) to educate engineers in those emerging disciplines. In 1971 a new law in Germany introduced the so called “Fachhochschulen” (university of applied sciences), a type of university devoted to offer professionally oriented study courses. Many of the existing engineering schools in Aachen and also the school in Jülich where in this way joined to become the AcUAS. As in many other German institutions the number of students specializing in the nuclear sector decreased despite the fact that job opportunities did not decrease significantly. To counteract this development already in 2003 a new master program “European Master in Nuclear Applications” taught in English language was introduced. More over contacts to other European universities were intensified. Starting in 2003 with the participation in a joined intensive course (PAN-2 “Practical Approach in Nuclear techniques”) in Prague at the Czech Technical University (CVUT) together with participants from the Haute Ecole Paul-Henri SPAAK, the Universidad Politécnica de Valencia (UPV), and the University of Hasselt. Since then AcUAS either organized training events or at least participated in practically all training events offered by the partner institutions. A list of EU-funded training events organized by the CHERNE partner can be found on www.cherne.ntua.gr. Over the years quite some experience was gained on how to cope with the additional challenges due the fact that students from different countries having different background are coming together for a short period. Reports on some of these activities have been given on previous ETRAP conferences (e.g. Francois Tondeur et al. at Etrap 2005, www.euronuclear.org/events/etrap/etrap2005/Thursday-4.htm)

2. Challenges

2.1. Academic calendars in Europe

A very severe problem is the fact that even though in many publications a European learning space is advertised but obviously no one ever cared to adjust the time schedule of the European institutions of higher education in such a way that there are some time windows where all institutions can send or receive students. The fact that teaching and examination periods vary in Europe also hampers the successful student exchange. If a student arrives in the middle of a teaching period she or he will have no chance to obtain the required credits for that semester or the year.

2.2. Academic habits in Europe

Another problem in making full profit of common training events are the different regulations in the participating institutions. At least in Germany after a period where the word ‘transfer’ in the abbreviation ECTS was taken serious now more and more one is only referring to credits and is very reluctant to acknowledge or better transfer credits obtained in training events at another institution. In the EMINA – study course at AcUAS it is stated in the official study plan that credits obtained in CHERNE activities can be acknowledged as part of the electives.

2.3. Funding and Sustainability

Universities in Germany and certainly in other countries as well have very limited financial resources. State funding in general is restricted to aliment only the national programs. To obtain funding from the EU is increasingly difficult and financial rules are in part not realistic. For example there is a rule that in the framework of strategic partnerships travel costs of participating professors are only reimbursed if they stay at least five working days. This is practically unfeasible if the activity takes place during the lecturing period of the visiting professor, and as stated above, due to the different time schedules all over Europe this is the most probable case that one or more participating partners will have their lecturing or examination period right at that time. The other problem is sustainability. As state universities are financed according to the national study plans they cannot sell these activities easily. Training events in academic institutions are in general not a product like a vocational training course which can be offered on the free market. More over funding periods are very short, so that even if there would be the possibility to transform the activity into some kind of vocational training there would be not enough time to really advertise and implement the course for commercial use. Some of the partners reach sustainability in incorporating the training event into the national study plans. But then the man power to run the course has to be provided by the institutions since there will be no funding (aside from possible ERASMUS agreements) for visiting professors.

2.4. Student motivation

The Bologna process of organizing study courses in a three year bachelor plus a two year master course forces students into a very tight study plan in order to keep the schedule. Again as for the participating professors the activities may coincide with their lecturing or examination period. Thus to motivate a student to attend a course over two weeks with sometimes an uncertainty whether the credits are acknowledged or useful for the own studies is not an easy task. This is why e.g. in Jülich the former JUNCS (Jülich Nuclear Chemistry School) course was split in two courses lasting 5 working days, RADAM (Radiation Detection And Measurement) and MARC (Methods And Applications in Radio Chemistry) organized such that students with a good background in detection methods can just join the chemistry related course others not interested in nuclear chemistry are just following the RADAM part and those wishing to obtain practice in both fields may attend both courses.

2.5. Language and Knowledge related Problems

The common training events attract students from different disciplines having quite diverse knowledge in the field offered. Until recently the CHERNE members organized courses lasting 10 working days. In these courses a mixture of lectures and practical training was offered. At the best the lectures were closely related to the practical activities and in this way leveled the knowledge of the participants. But sometimes it turns out that some students just could not follow the content of the lecture or did not understand the laboratory instructions due to either missing language skills or theoretical knowledge required to perform the experiments successfully. Especially in a five day long course it is difficult to find out if a student who is very quiet has problems in language or in knowledge to follow the course. Working in groups is a big help in this context if the communication between group members is open minded and empathic. A very important role must therefore also be attributed to social events which have to be organized during the activity. In this context an activity which lasts longer than just five working days is advantageous, but funding of social events over the weekend is difficult.

2.6. E-Learning

Some CHERNE members applied successfully to be funded in the framework of an ERASMUS+ Strategic Partnership “Blended Learning in Radiation Protection and Radioecology”. In this project E-learning modules are being created to support practical training events. If this concept turns out to be effective to allow the participants individually to obtain the theoretical prerequisites to fully profit from the practical realization in the training event this might be then an incentive to further invest efforts in creating introductory e-learning modules to training events offered to students from the network and possibly even to interested parties from outside the academic world.

3. Conclusions

Despite the fact that the organization of training events for students from different countries due to limited resources poses a great challenge for the organizing institution and the people involved the positive feedback from the participants and the conviction that the experience having worked in a foreign environment is of high value for the development of soft skills the author encourages all the colleagues to get engaged in this kind of teaching. It would highly be welcome if European institutions would also look into the daily life problems of academic institutions. Helpful would be if funding would not only concentrate on short projects but in case of successful implementations also allow for follow up support. And as a final remark: A “European Learning Room” requires also identical opening hours!

EUTERP

Activities of EUTERP, the European Training and Education in Radiation Protection Foundation

Allisy P.J., Coeck M., Draaisma F.S., Hoyler F., Paynter R., Schouwenburg M., Stewart J.

Background

European Commission concerns prompted the formation of the EUTERP Foundation :

- Lack of mobility of radiation protection experts (RPEs) across the European Union
- Differing interpretations of both the knowledge and training requirements for RPEs in different member states

EUTERP aims

- A common understanding of the role of the RPE
- Consistent education and training requirements for RPEs
- Mutual recognition for RPEs
- Appropriate training for RPOs and all radiation workers
- Liaison with all stakeholders that have education and training in their activities

EUTERP activities

- Encouraging National Contact Points in all states
- Reference syllabus for training of RPEs
- Development and testing of modular training courses
- Stakeholder participation in training developments
- Liaison with HERCA on the recognition of RPEs
- Partner in the ENETRAP III project
- Development of the EUTERP website www.euterp.eu
- Newsletters and information dissemination
- Organization of workshops on RP training topics
- Collaboration with international conferences – e.g. ETRAP2017, Spain, spring 2017; European IRPA Congress, summer 2018

Main achievements

- Self-sustainable entity since June 2010 with a dynamic web site and a growing number of EUTERP Associates
- Advice to the EU on the definitions, roles and duties of the RPE and RPO for the EU BSS 2013
- 3 Workshops: Cyprus autumn 2011; Croatia, spring 2014; Greece, autumn 2015; the next is scheduled for 2019
- European RP course and opportunities database under beta-testing for the EUTERP web site

Conclusion

EUTERP provides a portal for radiation protection education and training activities in Europe. It liaises with other European organizations, participating in projects and events to develop and enhance training activities, and promote a common understanding of training requirements for all persons involved in activities using ionising radiation.

REGISTER NOW FOR OUR NEWSLETTER ON WWW.EUTERP.EU and stay informed on education and training in radiation protection throughout Europe

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