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Where are efforts on harmonisation needed?

10-YEAR EXPERIENCE OF EUROPEAN NUCLEAR EDUCATION NETWORK	Ambrosini, W. (1); De Regge, P. P. (2) 1 - Universita' di Pisa, Italy 2 - European Nuclear Education Network Association, France
SPECIFIC APPROACHES USED FOR DEVELOPMENT OF TRAINING SCHEMES WITHIN THE FRAMEWORK OF PROJECT CORONA - ESTABLISHMENT OF A REGIONAL CENTER OF COMPETENCE FOR VVER TECHNOLOGY AND NUCLEAR APPLICATIONS	Krivoshieva, N. (1) 1 - Kozloduy NPP.Plc., Bulgaria
THE CMET WORKING GROUP ACTIONS WITHIN IGD-TP. FEASIBILITY OF VOLUNTARY ACCREDITATION IN GEOLOGICAL DISPOSAL USING ECVET APPROACH.	Palmu, M. (1); Cantone, M. C. (2); Paiva, I. (3); Vivalda, C. (4) 1 - Posiva Oy, Finland 2 - University of Milan, Italy 3 - Instituto Superior Técnico/Nuclear and Technological Centre, Portugal 4 - Vivalda Scientific Services, Italy

Where are efforts on harmonisation needed?

10-YEAR EXPERIENCE
OF EUROPEAN NUCLEAR EDUCATION NETWORK

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ABSTRACT

The European Nuclear Education Network (ENEN) Association, a non-profit organization established in 2003 under the French law, has as its main objective the preservation and further development of expertise in the nuclear fields by higher education and training. In the last September, the Association celebrated its 10th Birthday, coming at the end of a very active decade in which major achievements were reached and ENEN grew from the initial number of 22 Members to the present 64.

The paper summarises these achievements, obtained by efforts spent in order to harmonise and promote mutual recognition of MSc courses, PhD activities and training in nuclear matters throughout Europe. The establishment of the European Master of Science in Nuclear Engineering certification, the yearly PhD Events, the promotion of courses in nuclear matters at different levels, the extension of the range of action of the Association beyond the European borders represent some of the relevant results achieved so far, in the frame of the several EU Projects in which ENEN participated and as autonomous developments. General conclusions about the present status of the Association and its future perspectives are finally drawn.

1 INTRODUCTION

The European Nuclear Education Network (ENEN) [1] was founded in 2003 at the end of an effort focused on education in nuclear engineering which was the subject of an Euratom FP5 Project having the name of European Nuclear *Engineering* Network. Among the objectives of the project, establishing the basis for preserving nuclear knowledge and expertise, creating a European Higher Education Area for nuclear disciplines and facilitating the implementation of the Bologna declaration [2] in the nuclear disciplines can be mentioned.

A the root of these efforts there was the awareness of the difficult situation of nuclear education in Europe at the time, when many high level courses were at risk of extinction for discontinuity in the preparation of the necessary human resources and when the attractiveness of careers in the nuclear fields was starting declining. The effort spent in this regard was then justified by the attempts to put repair to this situation, trying to restore conditions that could assure the necessary workforce in the nuclear field.

A decade later, in the aftermath of the Fukushima accident, the motivations for the existence of ENEN are quite similar. Notwithstanding the short period of nuclear renaissance experienced in the last years, again the volatility in energy policies and the lack of popularity of nuclear energy are threatening the capability to maintain and develop knowledge in the nuclear field as required by the future needs for plant operation, maintenance, decommissioning and for new builds. Research in the nuclear fields, related to power and non-power applications, also needs qualified manpower, to be obtained by a well-designed education process, enabling the new developments needed for the design of new generations of nuclear power plants, for waste management and geological disposal and for radiation protection and the new emerging medical applications of ionising radiations.

In this situation, ENEN is continuing to pay its service to European citizens in contributing to maintain high level education and training schemes in the nuclear field. Recently, in the frame of a new effort [3], the Association also undertook activities in ETI (i.e., Education, Training and Information), responding to a precise call by two European Commissioners for establishing training schemes specifically related to "nuclear safety culture", as the necessary ingredient to assure the high levels of safety of the European nuclear plants.

This paper summarises the relevant achievements that ENEN obtained in the last decade and shortly discusses the present and future challenges in front of the Association.

2 MISSION AND STRUCTURE OF ENEN

The Statutes of the ENEN Association [4] establish that:

"The main objective of the ENEN Association is the preservation and the further development of expertise in the nuclear fields by higher education and training. This objective should be realized through the co-operation between universities, research organisations, regulatory bodies, the industry and any other organisations involved in the application of nuclear science and ionising radiation."

Indeed, the Association presently includes 64 Members or institutions connected to it by MoUs, including Universities, Industries, Research and Training Centers (Table 1). Though a more extended presence of non-academic members in ENEN is an objective to be further pursued in the future, the cooperation achieved up to now is satisfactory enough and allowed to perform common actions in the field of training, as it was recently in the ENEN-III Project [5] (see below).

The structure of the Association is represented in Figure 1, showing that the General Assembly and the Board of Governors are the major bodies charged of deciding the lines of general policy of the Association, while the Secretary General has the role to implement these decisions in the day-to-day life of ENEN. Working groups, stimulated and coordinated by the Secretary General, provide the necessary elaboration at the basis of the actions of the Association, acting within the Teaching and Academic Affairs Area, the Advanced Courses and Research Area, the Training and Industrial Projects Area, with Knowledge Management and Quality Assurance being cross-cutting areas of activity.

List of ENEN Members

LIST OF ENEN MEMBERS (55 + 9 = 64 MEMBERS AS OF 1 MARCH 2013)

Atominstitut der Oesterreichischen Universitaeten	ATI	Vienna, Austria
Katholieke Universiteit Leuven	KUL	Leuven, Belgium
Université Catholique de Louvain	UCL	Louvain-la-Neuve, Belgium
Ghent University	UG	Ghent, Belgium
Université de Liège	ULG	Liege, Belgium
Université Libre de Bruxelles	ULB	Brussels, Belgium
Vrije Universiteit Brussel	VUB	Brussels, Belgium
Belgian Nuclear Research Centre	SCK•CEN	Mol, Belgium
Westinghouse Electric Company	WES	Brussels, Belgium
Czech Technical University in Prague	CTU	Prague, Czech
CV Rez, a.s.	CVR	Prague, Czech
Aalto University School of Science and Technology	AALTO	Helsinki, Finland
Lappeenranta University of Technology	LUT	Lappeenranta, Finland
CEA/INSTN Centre d'Etudes de Saclay	CEA/INSTN	Saclay, France
Institut National Polytechnique de Grenoble	INPG	Grenoble, France
Ecole des Mines de Nantes	EMN	Nantes, France
AREVA	AREVA	Paris, France
Centre National de la Recherche Scientifique	CNRS	Paris, France
Institut Régional Universitaire Polytechnique	IRUP	Saint Etienne, France
Institut Supérieur des Techniques de la Performance	ISTP	Saint Etienne, France
Technische Universitaet Muenchen	TUM	Muenchen, Germany
Universitaet Stuttgart	IKE	Stuttgart, Germany
Institute of Nuclear Fuel Cycle, RWT Aachen University	INBK	Aachen, Germany
Karlsruhe Institute of Technology	KIT	Karlsruhe, Germany
J. W. Goethe Universität	IAPFU	Frankfurt, Germany
Ruhr Universität Bochum	RUBLEE	Bochum, Germany
Institute for Safety and Reliability	ISAR	Munich, Germany
Aristoteles University	AUTH	Thessaloniki, Greece
Budapest University of Technology and Economics	BME	Budapest, Hungary
Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare	CIRTEN	Pisa, Italy
SOGIN	SOGIN	Rome, Italy
Delft University of Technology	DUT	Delft, The Netherlands
AGH-University of Science and Technology	AGH	Krakow, Poland
University Politechnica Bucharest	UPB	Bucharest, Romania
National Institute "Horia Hulubei"	IFIN-HH	Bucharest, Romania
Slovak University of Technology in Bratislava	STU	Bratislava, Slovakia
University of Ljubljana	UL	Ljubljana, Slovenia
Jozef Stefan Institute	JSI	Ljubljana, Slovenia
Universidad Politecnica de Madrid	UPM	Madrid, Spain
Technical University of Catalonia - Barcelona Tech	UPC	Barcelona, Spain
Universidad Nacional de Educacion a Distancia	UNED	Madrid, Spain
ETS Institute Quic de Sarriá	IQS	Barcelona, Spain
Universidad de Sevilla	USE	Sevilla, Spain
Universidad Politechnica Valencia	UPV	Valencia, Spain
TECNATOM	TECNATOM	San Sebastián de los Reyes-Madrid, Spain
Uppsala Universitet	UU	Uppsala, Sweden
Royal Institute of Technology	KTH	Stockholm, Sweden
Chalmers University of Technology	CUT	Goteborg, Sweden
Swiss Federal Institute of Technology Zurich	ETH	Zurich, Switzerland
Swiss Federal Institute of Technology Lausanne	EPFL	Lausanne, Switzerland
University of Manchester	UM	Manchester, UK
University of Birmingham	UB	Birmingham, UK
Imperial College London	ICL	London, UK
Univesity of Hertfordshire	UH	Hatfield, UK
University of Central Lancashire	UCLAN	Preston, UK

By concluding a Memorandum of understanding, the following Partners are considered as an ENEN Member, without a Voting right at the General Assembly.

Joint Research Centre of the European Commission	JRC	
North West University	NWU	Potchefstroom, South Africa
Moscow Engineering Physics Institute (State University)	MEPhI	Moscow, Russia
Central Institute for Continuing Education and Training	CICET	Obninsk, Russia
Tokyo Institute of Technology	TokyoTech	Tokyo, Japan
University of Fukui	FUKUI	Fukui, Japan
Japan Atomic Energy Agency	JAEA	Tokai, Japan
V. N. Karazin Kharkiv National University	KKNU	Kharkiv, Ukraine
Odessa National Polytechnic University	ONPU	Odessa, Ukraine

LIST OF MOU PARTNERS (4 PARTNERS AS OF 1 MARCH 2013)

European Nuclear Society	ENS	Brussels, Belgium
International Atomic Energy Agency	IAEA	Vienna, Austria
University Network of Excellence in Nuclear Engineering	UNENE	Canada
World Nuclear University	WNU	UK

Table 1. List of ENEN Members

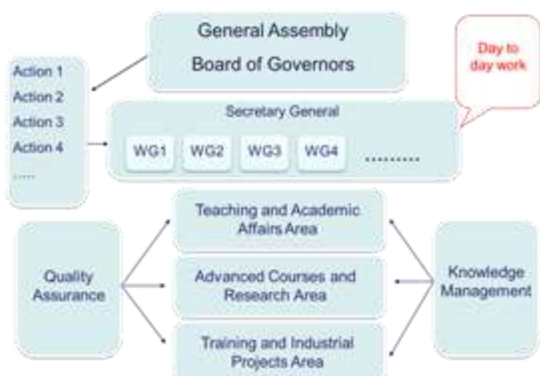

Figure 1. Functional structure of the ENEN Association

3 OBJECTIVES REACHED IN THE PAST DECADE

3.1 The European Master of Science in Nuclear Engineering

ENEN developed the European Master of Science in Nuclear Engineering as a “quality label” (or certification) released by the Association to those engineers whose studies satisfy the following requirements:

- *“the total load of the study programme of the applicant leading to the degree of Master in Nuclear Engineering, or equivalent, is at least 300 ECTS credits at university level (...);*
- *of which at least 60 ECTS credits (which may include the master thesis project) are in nuclear sciences and technology, preferably engineering, at master level;*
- *of which at least 20 ECTS credits (which may include the master thesis project) are taken at one or more academic institutions or clusters of such academic institutions, that are effective members of the ENEN-A, other than the home institution and in a different country than the home institution;*
- *the applicant has successfully defended a nuclear engineering master thesis project” [6].*

The mentioned 60 ECTS in nuclear sciences and technology must cover at least the following areas: Nuclear Power Plant Technology & Reactor Engineering; Reactor Physics; Nuclear Thermal Hydraulics; Safety and Reliability of Nuclear Facilities; Reactor Engineering Materials; Radiology and Radiation Protection; Nuclear Fuel Cycle and applied radiochemistry. Laboratory work on some of the above fields of study should be also included, to provide a minimum of additional practical skills. Every year a Ceremony is held for assigning the certifications to EMSNE students.

3.2 International Exchange and Advanced E&T Courses

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

A typical example is the Eugene Wigner course, a three-week course on nuclear reactor physics including lectures and practical exercises at three different reactors, which has been organized five times since 2003 by a group of universities and research centres in central Europe, addressing nuclear engineers and young professionals. Joint courses have also been organised on Neutronics for LWRs, Principles of Operation of Nuclear Reactors, and Dismantling Experience of Nuclear Facilities. Advanced courses at PhD level have been organized by ENEN in the framework of the Integrated Project EUROTRANS (http://www.enen-assoc.org/en/activities/for-universities/eurotrans.html). Many international training seminars addressing students and professionals have been organised on a regular basis since 2003 in France, Germany, Romania, Finland, etc..

3.3. PhD EVENTS

At PhD level, starting with 2007 a “PhD event” is being organised yearly for stimulating young researchers to discuss and share their ideas in a public occasion. Its objectives are:

- to provide a forum for PhD students to present their research work to their fellows and colleagues in a friendly but competitive spirit;

- to promote the research work of PhD students in the nuclear filed;
- to set up a bridge between PhD students and professionals in the nuclear field.

The event generally consists of 8-12 PhD presentations nominated by ENEN Members and selected by the ENEN PhD Event Jury. The participants are requested to make a presentation of their research work in a reasonable time span, with allowance for questions and comments. The presentations are finally judged by the Jury members, considering the submitted paper as well as the quality of the presentation and the clarity in the discussion while answering the questions and discussions. The best presentations are awarded by the ENEN Prize in a specific ceremony at the end of the event.

At present, the ENEN PhD Events are co-sponsored by the European Nuclear Education Network Association (ENEN), the European Commission Joint Research Centre (JRC) and the organizer of the international conference hosting the event.

3.4 FP6 ENEN II and NEPTUNO Projects

The implementation of the EMSNE concept was achieved under NEPTUNO FP6 project. The project developed ENEN activities related to education in Nuclear Engineering and its extension to include training courses for professionals and knowledge management by the establishment of the “ENEN Database”, as a valuable resource for disseminating information on available courses at any level and on job opportunities. In addition, textbooks and multimedia resources with the brand name of ENEN were also developed.

The ENEN-II Coordination Action consolidated and expanded the achievements of the ENEN and the NEPTUNO projects attained by the European Nuclear Education Network Association in the 5^{th} and 6^{th} Framework Programme of the European Commission. The objective of the ENEN-II project was to develop the ENEN Association in the areas of nuclear engineering, radiation protection and radwaste management, including underground disposal. The interaction between the different communities, engineering, radiation protection and waste management, has been considerably strengthened. Although the training projects ENEN-III, PETRUS-II and ENETRAP-II, run under the 7^{th} Framework Program, were distinct activities, they have been prepared in mutual consultation by the three communities.

3.5 Nuclear European Fission Training Schemes (EFTS)

In the seventh framework programme of Euratom, ENEN took part in or coordinated projects aimed at setting up training schemes for different target groups of learners. In particular, the following projects were (or are still) addressed (see the ENEN website [1]):

ENETRAP II on Radiation Protection (2009-2012)

The overall objective of ENETRAP-II, coordinated by SCK-CEN, has been to develop European high-quality "reference standards" and good practices for education and training (E&T) in radiation protection (RP). The introduction of a radiation protection training passport as a means to facilitate efficient and transparent European mutual recognition was an objective of this project. ENEN took part in it cooperating in some actions of the project.

PETRUS II on Waste Management and Disposal (2009-2012)

The aim of the PETRUS II project, coordinated by the Institut National Polytechnique de Lorraine, has been to enable present and future professionals on radioactive waste management in Europe, whatever their initial disciplinary background, to follow a training programme on geological disposal which would be widely recognized across Europe. Also in this case ENEN participated in project actions, together with some of its Members. The continuation of the project, named PETRUS-III, is presently starting with the participation of ENEN.

TRASNUSAFE on Nuclear Safety Culture (2011-)

This project, coordinated by the Université Catholique de Louvain, aims at designing, developing and validating two training schemes on nuclear safety culture for professionals operating at a high level of managerial responsibilities in nuclear installations. One of the training schemes is related to the nuclear industry, while the other is related to the other installations making use of ionizing radiation based technology, mainly in the medical sector. ENEN cooperates in this project, also acting as an umbrella for some of its members, working as third parties.

ENEN III on Nuclear Engineering (2009-2013)

The ENEN Association directly coordinated this project, aimed at setting up training schemes for four different profiles of engineers, having different needs in terms of Education and Training:

Type A: Basic training in selected nuclear topics of non-nuclear engineers and personnel of nuclear facilities contractors and subcontractors;

Type B: Technical training for the design challenges of GEN III plants;

Type C: Technical training for the construction challenges of GEN III plants;

Type D: Technical training for the design of GEN IV plants.

The Project involved 19 Partners from 12 countries: ENEN, SCKCEN, UCL, AALTO, LUT, INSTN, AREVA, ISAR, BME, CIRTEN, DUT, UPB, UL, JSI, TECNATOM, UPM, UPC.

4 RECENT EFFORTS

4.1 NUSHARE EFTS on Nuclear Safety Culture (2013 - 2016)

The NUSHARE project (Project for Sharing & Growing Nuclear Safety) [3] originated as a Euratom education and training (E&T) initiative proposed by Commissioner Ms. Máire Geoghegan Quinn after the Great East Japan Earthquake on 11 March 2011. The objective of NUSHARE is to develop and implement training and information activities with the aim to share and grow, across EU Member States, the *safety culture* in nuclear installations.

This project, presently running, represents a very challenging effort, characterised by a high visibility for the Association, which is called to pay a service to the European Union in taking the lead in a process of education, training and also *information* at very high level, including three target groups:

- TG1: Policy and decision makers at the level of governments, emergency management teams, including international organizations;
- TG2: Staff of Nuclear Regulatory Authorities and Technical Safety Organisations;

- TG3: Managers and operators in the nuclear industry, system suppliers and energy providers.

4.2 Other Projects

In some projects, ENEN is presently involved in different coordination or advisory roles. A list of these projects is reported hereafter, referring the reader to the ENEN website [1] for further information.

- *FP7 CORONA Establishment of Regional Center of Competence for VVER Technology and Nuclear Applications (2011 – 2014)*
- *FP7 CINCH-II - Cooperation in education and training In Nuclear Chemistry: focus on the European master's degree in nuclear and radiochemistry (June 2013 – May 2016)*
- *FP7 EUTEMPE-RX - EUropean Training and Education for Medical Physics Experts in Radiology: (September 2013 – August 2016)*
- *FP7 GENTLE - Graduate and Executive Nuclear Training and Lifelong Education (January 2013 – December 2017)*
- *FP7 PELGRIMM: PELlets versus GRanulates: Irradiation, Manufacturing & Modelling (2012 – 2015)*

5 INTERNATIONAL COOPERATION

In the framework of the Sustainable Nuclear Energy Technology Platform (SNE-TP) launched in 2007 with the aim of coordinating Research, Development, Demonstration and Deployment (RDD&D) activities in the field of nuclear fission energy, ENEN co-chaired with the industry the Working Group on Education, Training and Knowledge Management (ETKM).

The Association was also engaged in projects aiming at broadening the cooperation in education and training to other areas of the world in which nuclear energy is being developed. The projects run in this frame were ENEN-RU, with Russian Federation, and ECNET, with China.

The EUJEP project, instead, involved the mobility of students at the Master level of Nuclear Engineering and other nuclear disciplines related to the application of nuclear technologies and radiation sciences. The project included exchanges of students and faculty members between the participating European and Japanese institutions.

In 2009 and in 2013 the ENEN Association signed Practical Arrangements with International Atomic Energy Agency (IAEA) for cooperating with the regional networks operating in Asia (ANENT), Latin America (LANENT) and Africa (AFRA-NEST).

6 CONCLUSION

The European Nuclear Education Network Association has recently celebrated its 10th Birthday, being strongly engaged in pursuing its mission. The past decade has seen several important achievements and made the Association to grow and to become a reference institution in the field of nuclear education and training.

The momentum acquired by ENEN in performing education and training actions in Europe and abroad is now directed also towards the field of information, through the NUSHARE Project, aimed at performing the service to set up training schemes focused on nuclear safety culture. This represents a new challenge that requires making full use of ENEN's potential by deploying the resources available through its many members.

Indeed, the recent growth in the number of members and of links that the Association was able to establish within Europe and abroad gives to ENEN a key role in nuclear education and training. In this respect, the existence of ENEN now represents a resource that may be deployed in support to different efforts aiming at the construction of the European educational system in the nuclear sector.

REFERENCES

[1] ENEN Website, http://www.enen-assoc.org/

[2] Bologna Declaration:

http://ec.europa.eu/education/policies/educ/bologna/bologna.pdf

[3] Page of the NUSHARE Project on the ENEN website, http://www.enen-assoc.org/en/training/for-nuclear-community/nushare.html

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

[5] ENEN-III Project Page on the ENEN Website,

http://www.enen-assoc.org/en/training/for-nuclear-community/efts-fp7/enen-iii.html

[6] By-laws of EMSNE,

http://www.enen-assoc.org/en/activities/for-students/master.html

APPROACHES USED FOR DEVELOPMENT OF TRAINING SCHEMES WITHIN THE FRAMEWORK OF PROJECT CORONA - ESTABLISHMENT OF A REGIONAL CENTER OF COMPETENCE FOR VVER TECHNOLOGY AND NUCLEAR APPLICATIONS

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ABSTRACT

The major objective of the CORONA project is to facilitate the transfer of higher-level knowledge and technology between disciplines, sectors and countries. The ultimate goal is to develop a European passport for Continuous Professional Development, which relies on the principles of common qualification criteria, a common mutual recognition system, and the facilitation of teacher, student and worker mobility across the EU.

The aim of this paper is to describe the characteristics of the process of development of the following training schemes:

- Basic training on VVER technology specifics for non-nuclear professionals and subcontractors;
- Specialized technical training on VVER technology for students studying of nuclear professions;
- Specialized training on specific VVER technology aspects for nuclear professionals and researchers.

The safety culture and soft skill training are incorporated as an integral part of training schemes of all the above groups. The objectives of the safety culture training for the personnel are to understand better the involvement of each one in nuclear safety; to identify areas for improvement in nuclear safety when carrying out the activities; to exchange experience based on real-life situations (operation and engineering). Practical aspects like development of questioning attitude, elaboration and use of procedures, providing and use of feedback, development of efficient communication shall be achieved through investigation of real situations (incidents in operation, design errors) occurred in their company.

The training schemes are developed according to the SAT (systematic approach to training) and include the following five phases: Analysis, Design, Development, Implementation and Evaluation.

The paper considers the specifics during the implementation of SAT methodology regarding the defined groups including various specialists. The paper presents results from the activities during the analysis, design and development phases, as the results from pilot training delivered to selected specialists.

It is planed to be performed a verification of the technical content and pedagogical value of the components of the training scheme and the logical sequence of the different modules, as an assessing the qualifications acquired and the skills developed during the training.

1. Introduction

CORONA project (Seventh Euratom Framework Programme for Nuclear Research and Training Activities) promotes a special purpose structure for training and qualification of personnel for serving VVER technology (VVER - Russian specification of pressurized light water reactor) as one of nuclear power options used in the European Union (EU). Such approach should allow unifying existing VVER related training schemes according to International atomic energy agency (IAEA) standards and commonly accepted criteria recognized in the EU.

The major objective of the schemes is to facilitate the transfer of higher-level knowledge and technology between disciplines, sectors and countries. The ultimate goal is to develop a European passport for continuous professional development, which relies on the principles of

common qualification criteria, a common mutual recognition system, and the facilitation of teacher, student and worker mobility across the EU.
CORONA training schemes are dedicated to nuclear engineering and are focused to specifics of VVER technology implementation and operation. The schemes cover complete range of subject related specialists from students to experienced nuclear professionals.

2. Description of general framework for the training schemes

The training scheme presents training programmes, set of courses, training materials, training aids and various forms of training activities designed to meet the requirements regarding necessary professional knowledge and skills. The training schemes cover the necessity of certain knowledge, the methods and forms to be presented that provide its good understanding, the approaches to attract the trainees in nuclear activities.

2.1. Target groups' description

The training schemes included in the CORONA project concept are aimed at three target groups:

- Group A - Nuclear professionals and researchers;
- Group B - Non-nuclear professionals and subcontractors;
- Group C - Students on power and non-power nuclear study.

Specialists of the following categories are included within the scope of group A: nuclear power plant (NPP) personnel employed in the management, maintenance, operations, technical support and safety control; nuclear professionals from research and engineering organizations, surveillance and regulatory bodies performing activities in the areas of design, technical support and decommissioning of nuclear facilities, radioactive wastes and spent nuclear fuel management, nuclear safety and radiation protection surveillance/control; specialists involved in nuclear training related activities.
Group B covers: personnel of nuclear facility serving systems and facilities outside the nuclear island; research, engineering, design and civil construction organizations performing NPP lifetime related activities – construction, start-up, operation, decommissioning; employees involved in nuclear technology matters (government, municipality, branch, ecological, public, trade union, etc.); all suppliers and contractors involved in design, engineering, manufacturing, construction, operation, maintenance or other safety related activities.
Group C covers students who have acquired higher education at the level at least of Bachelor of Science (BS) degree in engineering and techniques in designing, manufacturing, operation and maintenance of nuclear plant facilities (NPF), as well as students who are only indirectly connected with NPF operation but NPF cannot exist as a nuclear object without their activities.
Safety culture is a significant topic of importance and requires continuous consideration. The training programmes shall emphasize the necessity of understanding the safety issues, shall include consideration of the possible safety consequences caused by errors and shall deal with the ways to avoid or correct these errors. For this reason the group D is defined and named "Safety culture and soft skills training for nuclear professionals and personnel of nuclear facilities suppliers and contractors". [1]
The graphical presentation of the CORONA components (work packages) and their interdependencies are shown in Figure 1.

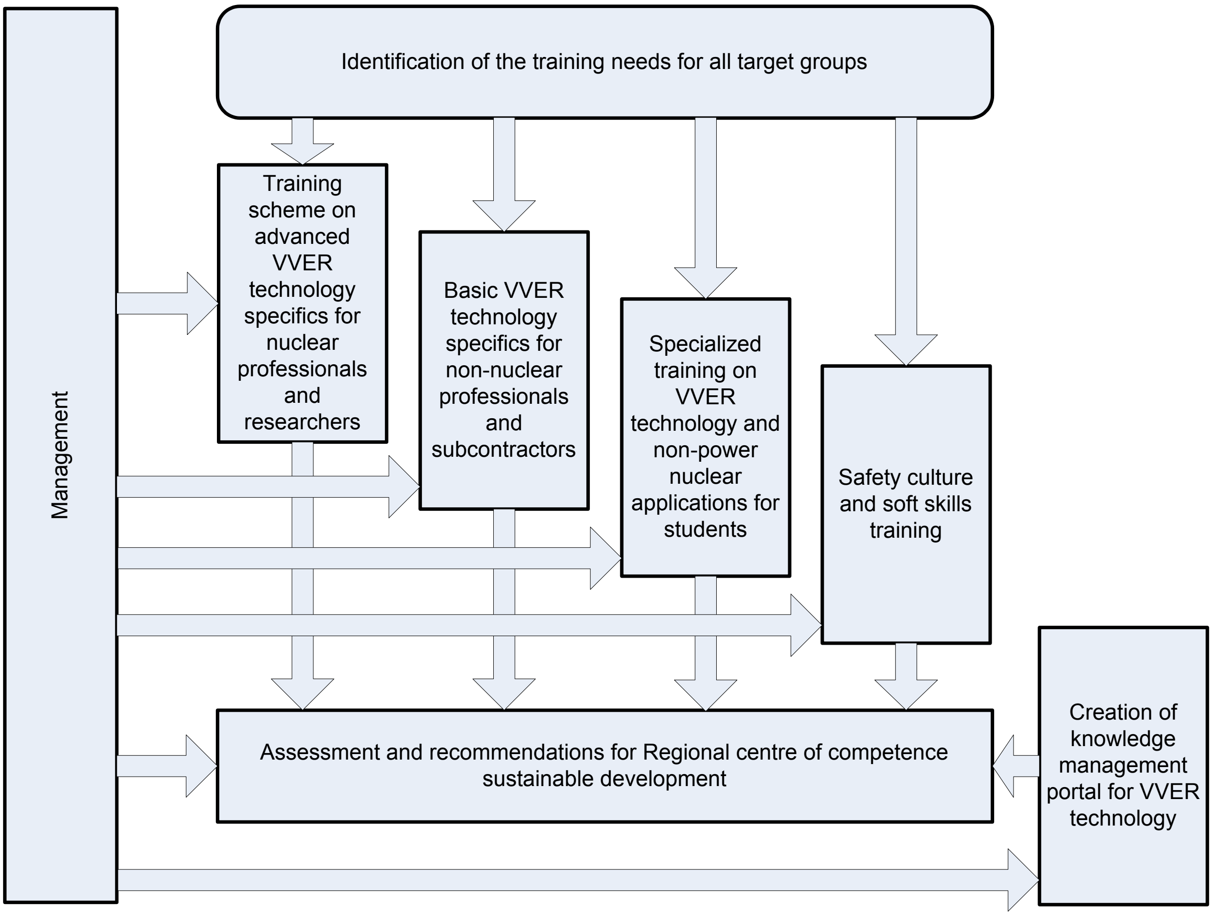

Figure 1 Graphical presentation of the CORONA components and their interdependencies

2.2. Application of European qualifications framework

European Qualifications Framework (EQF) is an EU initiative to create a translating facility for referencing academic degrees and other learning qualifications among EU member states. The EQF is a common European reference framework which links countries' qualifications systems together, acting as a translation device to make qualifications more readable and understandable across different countries and systems in Europe. This European reference framework consists of eight levels that are defined according to so-called "learning outcomes" – that is to say with reference to the knowledge, skills and competences acquired. [2]

2.3. Lifelong learning – initial and continuous training

Lifelong learning is defined as "All learning activity undertaken throughout life with the aim of improving knowledge, skills and competence, within a personal, civic, social and/or employment-related perspective".

Lifelong learning is therefore about acquiring and updating all kinds of abilities, interests, knowledge and qualifications from the pre-school years to postretirement. It promotes the development of knowledge and competences that will enable each citizen to adapt to the knowledge-based society and actively participate in all spheres of social and economic life, taking more control of his or her future.

Comprehensive training comprises initial training and continuing training or retraining.

Initial training is provided to persons before they are assigned to a job or a position within the operating organization.

Continuing training is provided to all persons throughout their working life, as it is necessary to ensure that their knowledge, skills and attitudes are maintained current in both theory and practice. Continuing training is also directed to the permanent improvement of skills and attitudes which is necessary for safety related activities.

3. Methodology used for development of the training schemes

3.1. Systematic approach to training

The training schemes were developed according to the systematic approach to training (SAT).

The SAT provides a logical progression from identification of the competences required for performing a job to the development and implementation of training towards achieving these competences, and to the subsequent evaluation of this training. The use of a systematic approach to training offers significant advantages over more conventional, curricula driven training in terms of consistency, efficiency and management control, leading to greater reliability of training results and enhanced safety and efficiency of the plant.

A systematic approach to training includes the following phases (see Figure 2):

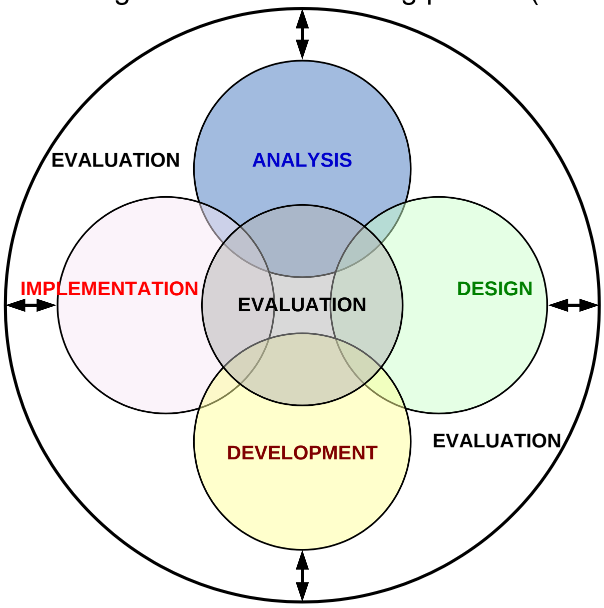

Figure 2 Phases of the systematic approach to training

- Analysis – The phase comprises the identification of training needs and the competences required to perform a particular job;
- Design - In this phase competences are converted into training objectives and the objectives are organized into training plans;
- Development - In this phase training materials are prepared so that the training objectives can be achieved;
- Implementation - In this phase training is conducted by using the training materials developed;
- Evaluation - In this phase all aspects of the training programmes are evaluated on the basis of data collected in each of the other phases. This is followed by feedback leading to improvements in the training programmes and to plant improvements.

This approach is in compliance with the European strategy for vocational training.

The activities for implementation of each of the phases within this approach are described below. [3][4][5]

3.2. Analysis

The activities during the analysis phase are carried out for definition of the required qualification of the specialists included in the defined groups of personnel.

The analysis performed was based on past experience, lessons learned and recommendations of the stakeholders, e.g. regulatory bodies, utilities, and international organisations. The main sources of information were experience of experts involved in the analysis; outcomes of the analysis of other projects (both national and international); documentation describing functions or possible areas of work, etc.

The method JCA (job competency analysis) was applied [6]. The method includes definition of the required competences, presented as combination of knowledge, skills and attitudes

(KSA). The typical JCA method involves identification of generally stated tasks. Job competency statements are then determined and analyzed to identify the related knowledge, skills, and attitudes that support the competency. These knowledge, skills, and attitudes are then generally grouped together and sequenced.
According to JCA method lists of topics/training units can be used which are already available and applied in the personnel training. The results of the analysis phase include description of the groups, brief description of the job areas or/and functions of job positions related to respective groups and list of competencies.
To facilitate the analysis process the personnel of different target groups were divided in the sub-groups in accordance with their responsibilities and functions.
As a result the personnel of Group A were distributed to eight sub-groups – Management, Operation, Maintenance, Engineering and technical support, Radiation protection, Design, Research & development and Training/Instructors. Group B was divided into four sub-groups (Non-nuclear professionals for works at NPP, Non-nuclear professionals for works related to NPP and nuclear applications, Non-professional technical staff, Contractor's personnel) and Group C – into three sub-groups (Nuclear students, Non-power nuclear students and Non-nuclear students).
In the analysis process the available information concerning competencies was collected in areas, for example, safety principles of nuclear facility, nuclear facility theory/technology, nuclear facility components/equipment, nuclear facility systems, safety culture and soft skills etc.
The competencies for each of the above defined target groups were selected from lists of the competencies defined as topics/training units. EQF was used for definition of expected level of competencies. The respective lists of competencies for each target group include competencies selected from available lists, as well as new competencies defined during the analysis phase.
For the development of training schemes in the case of safety culture and soft skills, the SAT method of "Expert panel" was used to define the units and competences of each course. This is because many of the tasks are introspective to the people and it is not possible to observe them.

3.3. Design

The purpose of the analysis phase is particularly to produce sufficient data to allow measurable training objectives to be derived from this data and developed in the design phase of SAT. The same personnel were used to develop the training objectives as to analyse the tasks or competencies. By combining these steps better assurance is provided that the training objectives adequately reflect the analysis data. Combining the steps also ensures that there is a direct and logical link between the tasks or competencies, the training objectives, and job performance.
Based on the competencies defined for each of the groups of personnel the respective training programmes were elaborated during the design phase. Each programme includes a couple of elements including learning outcomes and list of courses and training units.
The lists of training courses were prepared based on the list of competencies defined during the previous phase of the approach and the defined entry level of the trainees. Duration of the training, training objectives/learning outcomes, types of training used (theoretical, practical/on-the-job training, simulator), evaluation methods and forms, and training aids were determined for each topic.
All training programmes for specific plant activities make reference to safety culture. The knowledge and skills referring to safety culture and soft skills are common for all participants.
Although safety culture and soft skill training topics are covered by a specific training programme, the training programmes for different groups contain references on safety culture and soft skills courses.
For integration of safety culture in the training schemes were used the following:

- Integration in the beginning of each course of a safety culture baseline as an introduction;

- Development of several business cases based on real situations regarding how safety culture is affected by each process of VVER technology as a part of personnel practical training;
- Inclusion of tools and methodologies such as “power questions” (what, how, when, who, where, which) at the end of each training course in order to evaluate and enhance the safety culture awareness of the participants.

To describe the training scheme on safety culture and soft skills training, and to develop a list of competencies on the “soft” skills for all target groups, a re-grouping has been made of all the categories, defined above. Group D1 includes personnel of management, operation and training/instructors “A” sub-groups. The required EQF level is above level 3, up to level 6, depending on the job position. Group D2 includes the rest “A” sub-groups, as well as contractors and non-nuclear professionals for works at NPP. The required EQF level is up to 4. The third group D3 covers the rest sub-groups and required EQF level is up to level 3. [7]

According to EQF the entry level requirement to reach any competence regarding safety culture and soft skills is the level 1 (basic general knowledge) to each target group. This is justified because to improve in those competences is not necessary to have a previous knowledge about the issues. In fact, in many cases it is better not to have such because the participants have less assumptions and expectations about those issues and is easier for them to enter in deeper levels of knowledge. The aim of the training is that the target groups build their new knowledge on the assumptions that enhance a strong safety culture.

Further, lists of training courses, training units and their duration in training hours (max hours) including different forms of training for sub-groups D1, D2 and D3 were developed. [7]

The overall purpose of the training is to ensure enough competences to develop a strong safety culture and to improve the awareness about the impact that each employee has on safety with his work and to acquire the necessary skills and correct attitudes to develop the organizational culture which improve the safety culture.

3.4. Development

This phase consists of elaboration of training materials to cover the training programme. The tasks within the phase were:

- Select and collect training courses, training sessions and training events to obtain the competencies;
- Develop additional training materials for selected courses (if necessary);
- Develop new courses.

The developed materials include:

- For theoretical training – lesson plan, trainee’ handbook, PowerPoint presentation, test questions bank, supporting material (if necessary);
- For practical training - instructor guide, check lists or job performance measures (JPM), exercise description for defined task (if applicable);
- For simulator training - simulator scenario.

3.5. Implementation

During the phase, implementation of theoretical, practical, and simulator training forms, as well as visits to introduce the experience and participation while performing specific tasks and activities are arranged. Pilot training is delivered for specialists selected. It is decided that during the pilot training each training scheme will offer 4 different courses.

After the completion of the specialized training under a programme, the trainees undergo examinations to review the compliance of the knowledge and skills acquired with the requirements established. The expected method of assessment is a test. The overall objective is to check that the information provided during the development of the courses is understood and internalized, while the participants can see that use of these new tools is something useful to their performance and help to enhance safety.

After the course completion the participants have to complete a test (one of each course). The test is conformed by a questions bank regarding the key concepts of the different units of the course. The trainees have to choose between several answers.

In addition to the test, it is possible that the facilitator uses business cases, role playing or group games. This practical methodology could be a part of the examination used after the training course completion.
The criterion for success in a test is 80% correct answers. During the practical training the facilitator must observe an appropriate predisposition to participate to the developed dynamics and put in practice the new concepts during the exercises by the participants.
In the frame of the project two pilot trainings were organised and conducted:

- In Sofia and Kozloduy NPP, Bulgaria during the period 27-31 May 2013 with a goal to evaluate the training programme of Group B [7]. The training was addressed to non-nuclear specialists that have to be trained in nuclear field. Interest in the training course was demonstrated by 19 specialists from physical protection employees, government employees, secondary school teachers, journalists etc. Nine observers attended the presentations of lectures and visited the Kozloduy NPP. The trainers selected for the pilot training were experienced in the corresponding field of knowledge;
- Second pilot course was organised in the period July 1 – 5 2013 in Moscow, Russia to evaluate the training programme of Group C - Nuclear and non-nuclear students. The course included lectures and practical sessions (training on simulator and technical tour to special laboratories) (see Figure 3).


Figure 3 Participants in the pilot courses

3.6. Evaluation

The evaluation phase has two components. The first evaluation is carried out by project management bodies. The purpose is to verify the technical content and pedagogical value of the components of the training scheme and the logical sequence of the different modules.
The second evaluation is carried out after running the training schemes/pilot course and assessing the qualifications acquired and the skills developed during the training. This evaluation includes recommendations for optimising and improving the training scheme. The evaluation is performed through special evaluation forms.
The results from the performed pilot trainings assessed the training programmes ability to provide specialized knowledge, skills and attitudes. The recommendations are considered as initial recommendations. Further feedback from employers could give additional information on the area of knowledge and skills needed as well as on the matter to increase the effectiveness of the training programme.
The feedback from the pilot training showed that the activities to be carried out within the CORONA project are necessary, beneficial and efficiently implemented.

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THE CMET WORKING GROUP ACTIONS WITHIN IGD-TP. FEASIBILITY OF VOLUNTARY ACCREDITATION IN GEOLOGICAL DISPOSAL USING ECVET APPROACH

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ABSTRACT

The Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP) community according to its vision (Vision 2025) aims to proceed to obtaining licenses to construct and to operate deep geological repositories for spent fuel, high-level waste, and other long-lived radioactive waste in their respective Member States. Their commitment to the Vision 2025 includes developing joint means to facilitate access to expertise and technology and maintain competences in the field of geological disposal for the benefit of the European Member States. In the Strategic Research Agenda (SRA 2011) a need for the Cross-cutting Activity Competence Maintenance, Education and Training (CMET) was identified. Preliminary work towards setting up a permanent Organisational Working Group to address this area has begun. In 2013, the CMET Working Group convened for its first meeting with the support of the IGD-TP Secretariat (FP7 project: SecIGD2). The CMET group has several objectives and one of their objectives is to carry out a feasibility study about the use of the ECVET instrument in voluntary accreditation of learning outcomes within the field of geological disposal.

1. Introduction to the Implementing Geological Disposal of Radioactive Waste and its Competence Maintenance, Education and Training Working Group

1.1 Implementing Geological Disposal of Radioactive Waste (IGD-TP)

In 2009 a technological platform was launched in Europe to promote the sharing and pooling of resources to carry out jointly research, development and demonstration activities that are needed to address the remaining scientific, technological and societal challenges in deep geological disposal. This European wide cooperation was established by producing a common shared vision for the technology platform stating that the IGD-TP's vision (Vision 2025) is that by 2025, the first geological disposal facilities for spent fuel, high-level waste, and other long-lived radioactive waste will be operating safely in Europe (1). The vision was supported by three commitments. This vision led to the formulation of a Strategic Research

Agenda (2) and its Deployment Plan (3). In alignment with the platform's' commitment to facilitate access to expertise and technology and maintain competences in the field of geological disposal for the benefit of European Member States a Joint Activity was started and a permanent IGD-TP Working Group on "Competence Maintenance, Education and Training" was set up.

1.2 Competence Maintenance, Education and Training Working Group (CMET)

The CMET Working Group provides a forum for discussing the education and training matters in nuclear waste management and especially in geological disposal. Interaction within the CMET group is seen as a source for innovation beyond the current activities, too. The group has four main objectives as defined in its Terms of Reference (4):

1. To carry out transfer of the state of the art of strategies and activities for Competence Maintenance, Education and Training related to the implementation of Vision 2025. This requires identifying what the specific CMET needs are for implementing the SRA 2011 and the IGD-TP's first Deployment Plan until 2016 (DP 2012 in ref. 3).
2. To develop quality assurance of training aimed at new and experienced professionals in the field of geological disposal. This is done by developing quality assurance procedures and criteria for the voluntary accreditation of training (and education) for the sector. The work starts with carrying out a feasibility study for an accreditation scheme for informal learning that will be undertaken and that can also be applied to the formal setting. The background of the scheme is derived from the European Credit system for Vocational Education and Training (ECVET) approach (5)&(6) initiated by the Copenhagen process[1].
3. To compile the content of training i.e. a type of "curriculum or curricula" for professionals in geological disposal for pooling joint training efforts or alternatively engaging educators and trainers to address the IGD-TP's RD&D work's education and training (E&T) needs. Identifying the current state of curricula that have already been developed for geological disposal is required. Mapping their content in relation to the generic stages of repository development identified in the SRA 2011 (2) is a starting point of the CMET work towards this objective.
4. To ensure indirectly the sustainability of providers and the necessary infrastructures/facilities for CMET, and the new personnel and their development in the future. The first three objectives and the voluntary pooling of resources for the development and implementation of CMET action plan are also foreseen to strengthen the sustainability of supply of expertise.

The CMET Strategy and Action plan ("StrAP") are in the formulation process by the CMET Working Group volunteers from 13 European countries. The CMET working group aims to promote new type of approaches to meet the future human resources needs and to maintain the knowledge, skills and competence already achieved in the geological disposal community with the help of the new instruments. And this is done in cooperation with various stakeholders and in interaction with other complementary initiatives in the European Union.

1.3 Complementary European Initiatives to CMET

The aim of this paper is to discuss the prerequisites related to the feasibility of a voluntary accreditation scheme for geological disposal using the ECVET approach. This task is related to the second main objective of the CMET working group. During the past years, several

[1] European policy efforts within education and training carried out include e.g. the Bologna process (http://ec.europa.eu/education/higher-education/bologna_en.htm), Copenhagen process (http://ec.europa.eu/education/vocational-education/copenhagen_en.htm) and European law governing the recognition of professional qualifications (http://ec.europa.eu/internal_market/qualifications/index_en.htm)

European initiatives have addressed the different issues in quality assurance and mutual recognition of the professional competence.

ECVET instrument was introduced as a voluntary approach in the European Vocational Training context as part of the Copenhagen process. One emphasis in ECVET is that a person is able to reached defined learning outcomes independent of the means one has acquired the learning. Drivers to ECVET have not only been the mutual recognitions of vocational knowledge, skills and competence (KSC), but also to promote life-long learning of individuals in accumulating and recognising the learning that has been acquired either by education, training, on the job learning, at free-time activities or as in the context of geological disposal in research and project activities. During the recent years, the ECVET has also provided a good basis for piloting its use also on higher levels of qualifications in the European Qualification Framework (EQF) and especially on the EQF levels starting from level 5 to even to level 8 (Doctoral level) of KSC.

Pilot activities that provide input also to the CMET work towards the voluntary accreditation are the European Fission Training Schemes (EFTS) like PETRUS II and its continuation PETRUS III (9), ENEN III and several training schemes in radiation protection and radiochemistry[2]. The European Human Resources Observatory for the Nuclear Energy Sector[3] has initiated ECVET workshops (6) that have produced complete sets of Learning Outcomes for various nuclear new build job profiles and EHRO-N has also worked together with the ECVET team in DG-Education and Culture to train various stakeholders in the implementation of the ECVET principles (8, pp. 10-12). The on-going work in EHRO-N is also expected to provide further generic approaches and tools for the implementation of the ECVET approach in the sector.

The 2013 study by OECD on adult skills (16-64 years of age), the PIAAC[4] study , also indicates that the skills and competences levels (in literacy, numeracy and problem-solving in technology-rich environments) have a positive correlation with the overall educational level but also participation in both formal and non-formal training activities independent of their context (job related or extra curriculum activities) has a favourable impact on the studied skills and competences (see ref. 9 for PIAAC, pp. 37-39 & 45-46). ECVET as an instrument can thus also contribute to making such non-formal and even informal learning activities more attractive to the European labour force and especially to the professionals already having a high basic education.

The main impetus for the CMET feasibility study are the foreseen benefits for the geological disposal community and also for the wider nuclear and other industry sectors from having individual's learning outcomes recognised by the use of such a voluntary system. The main ambition in the use of ECVET' is to help in the development of a common understanding on standard job requirements to promote the mutual recognition of qualifications (6). Such benefits were identified in terms of the labour market, mobility and for flexible career pathways also in the 2012 ECVET Seminar for the Nuclear Energy Sector, see Tab 1 (8 & 10) that was initiated by EHRO-N[3], too:

[2] http://www.enen-assoc.org for more information on the different EFTS
[3] http://ehron.jrc.ec.europa.eu/
[4] Programme for the International Assessment of Adult Competencies (PIAAC) http://www.oecd.org/site/piaac/

Benefits of ECVET

For the labour market in general	
	Competence gap analysis Training including on-the-job learning and mobility Mobility - higher safety culture Planning for the future needs
For the employer:	
	Enlargement of the recruitment area Broadening the Human Resources Management (internal flexibility) Mixed careers for young professionals (combining training and job)
For the individuals:	
	Enhanced career opportunities Intersectoral mobility Upward mobility and job rotation
For the education and training providers:	
	Fostering faster and improved employability of graduates and trainees
For mobility	
	Mobility of personnel at all levels Streamlining of human resources allocation to where needed Knowledge preservation about the needed KSC Tool for transparency, quality improvement and excellence Mutual recognition of KSC and qualifications Common assessment standards
For flexible pathways	
	Flexible pathways to qualifications Less overlapping training Faster way to qualification NIFL[5] can be assessed Harmonized terminology in use New perspectives on how to increase competence Recognition of learning (outcomes) acquired in various schemes Opportunity to be exposed to different cultures Access to different technical approaches

Tab 1: Identified benefits from the adoption of the ECVET instrument (10).

The group sees that these benefits can also help the geological disposal community to overcome some of the main challenges (the Euradwaste2013 paper by the authors (11) outlines a more detailed discussion on the challenges) related to the competence maintenance over the long timeframes inherent in the management of radioactive wastes. The role of the IGD-TP as a forum with authority on expertise can have also a significant role in the quality assurance of learning outcomes and their mutual recognition when provided with a developed implementation framework for such validation. This is a challenge for the CMET Working Group to address in its work that is supported by the EURATOM FP7 project grant no 323260 SecIGD2[6].

[5] NIFL = Non-formal and Informal Learning

[6] Secretariat of the Implementing Geological Disposal of Radioactive Waste, phase 2, e.g. www.igdtp.eu

1.4 Units of Learning and KSC and their development for geological disposal

The ECVET objectives (Fig 1) are both about transnational mobility and lifelong learning for all labour force in Europe independent of their status on the labour market or of their sector of work. In the core of ECVET is the recognition of learning outcomes in view of achieving qualifications. The ECVET contributes to these objectives by making the qualifications transparent, enabling the accumulation of learning outcomes and providing for a transfer and communication mechanism for the learning outcomes from one organisation to another and further from one context to another (12, p. 7).

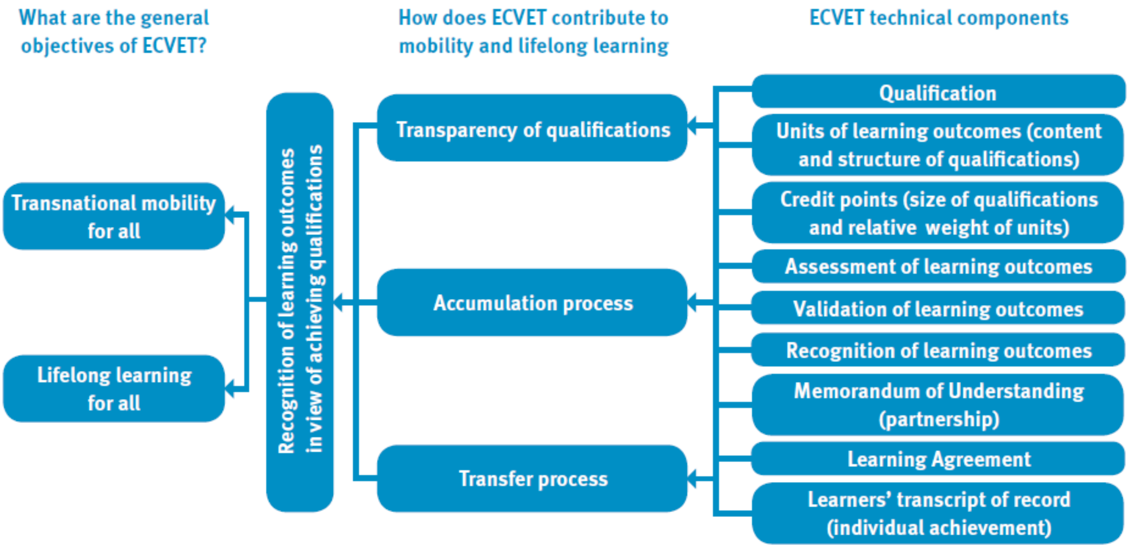

Fig 1: The ECVET Objectives and technical components (12, p. 7). Copied from original source as produced and published by ECVET User's Group.

The CMET feasibility study on a voluntary accreditation aims at addressing also this gap with regards the validation and mutual recognition of the professional's learning outcomes using the ECVET as an approach. Since the implementation of ECVET instrument is still voluntary within the European Union, the main piloting of the system has been carried out within the educational system and apprenticeships and student exchange related to these. This is partly influenced also by the subsidiarity of the Member States regarding professional qualification. Any bodies, national, sector specific or professional that could validate the learning outcomes of an individual that is not attached to a training or education provider does not exist. The approach and prerequisites of defining Units of Learning and the Knowledge, Skills and Competence in geological disposal following from the ECVET are discussed in the following and in Fig 2.

Under the ECVET, a Unit of Learning Outcomes (or unit) is defined as a component of a qualification, consisting of a coherent set of knowledge, skills and competence, which can be assessed and validated. Before any knowledge, skills and competence (KSC) related to the unit can be defined, one needs to define the qualification level aimed at as an outcome. Under the European Qualification Framework, qualifications are divided into 8 different levels. EQF levels 5-6 related to higher education qualifications like engineers at Bachelor level, the EQF level 7 relates to Masters and EQF level 8 relates to Doctoral Degrees. This is a simplified explanation of the levels and one should note that the levels are defined in terms of levels of learning mastered, not by a given degree even though in the national qualification framework context a specific level is often linked with a specific formal degree. The recent developments have also harmonised the EQF and the new ISCED 2011 (International Standard Classification of Education) levels used in the education statistics collection to correspond to each other (13).

After the qualification level for the units are defined, then the knowledge, skills and competences related to this specific learning outcome is broken down using a suitable taxonomy. Within the nuclear sector ECVET pilots, first a specific job profile is described, which is an accumulation of the units of learning outcomes. The definition for the Knowledge is: Cognitive competence (occupational-conceptual), for Skill: Functional competence (occupational-operational) and for Competence: Personal competence (conceptual and operational), for more detailed definitions see e.g. ref (6).

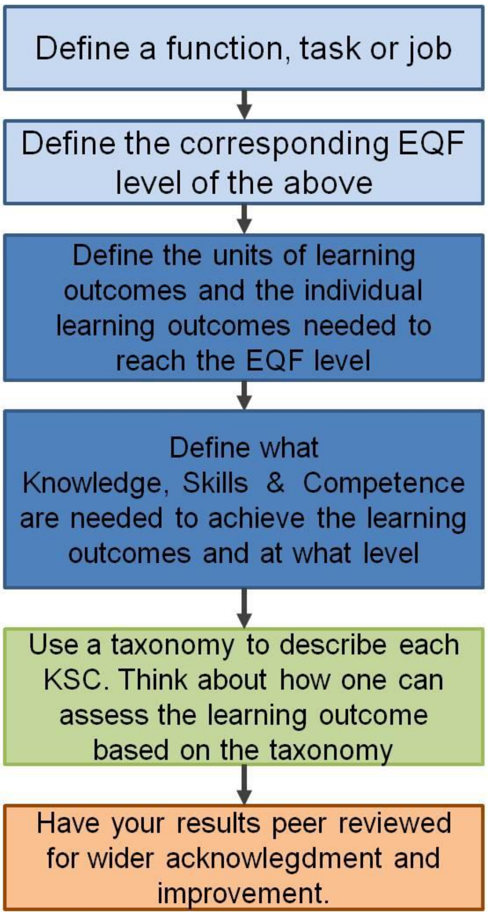

Fig 2: Schematic process of defining the content of an ECVET based curriculum ultimately leading to e.g. to a certificate or portfolio of KSC like the EuroPass.

In geological disposal, the number of job profiles is more challenging as at least prior the deep repositories are in operation, the personnel's job profiles consist of many different functions, which include often also knowledge and skills from different technical or scientific or cross-cutting disciplines. This makes a focus on the units of learning more attractive in the geological disposal compared with the wider requirements of a specific job profile. The needed job profiles can then be put together by each organisation needing them by accumulating the units into a full profile.

2. Definition of the required qualifications and expertise and their development

The development of the required qualifications in geological disposal starts by defining a basic educational level of a job. These qualifications are based on the degrees defined by the national legislation regarding education and degrees (by the national qualification framework). Depending on the maturity of the programme and national requirements further competence requirements are set either due to regulatory guides that in general state that according to the graded approach stricter requirements for competence are set for personnel dealing with tasks having a more significant impact on the nuclear safety than on tasks that do not influence nuclear safety. Meeting such requirements may also include taking training and passing the authorities exams. In addition, specific professions have requirements based on other national legislation than nuclear acts. For such positions, there are legal qualification requirements that need to be met by the job holder. Further professional associations and groupings qualify professionals according to certain criteria and state them competent within the national setting or among their peers. This is the type of voluntary accreditation of individuals and curricula that are based on the ECVET principles that is aimed at as an important action of the CMET. Taking the competence requirement definition even further down the line, each nuclear energy organisation is able and often obliged by the authorities to set their own requirements for competence and training. Often it is easier to set the training requirements (14), as the methods of assessing the learning outcomes require more development work. Finally each individual staff member should address one's own development needs merely just from the point of view of the safety culture and to be able to contribute to the continuous improvement of safety and security. ECVET brings now a new perspective also to the Human Resource Management practices related to competence management.

3. Addressing changing and evolving KSC needs during the different stages of a geological repository development

The CMET group is in the process of preparing its Strategy and Action Plan (StrAP). In the first discussion about the content of this plan, it was clear to the group that as the repository development from the initial concept development to the full operating repository have various stages (Fig 3), the units of learning defined for geological disposal also need to take the different needs of the stages into account. One can also consider the different stages of repository development to correspond also to the different technological readiness levels (TRLs) towards implementing geological disposal.

Stages of repository development

	Generic studies and concept development	Selection of host rock and site	Technology development and repository design	Technology development and repository construction	Industrial -scale manufacturing and repository operation
Safety strategy and methodology	Development of safety assessment methodology	Application of methodology in safety case and improvement of methods	Application of methodology in safety case and improvement of methods	Application of methodology in safety case	Application of methodology in safety case
Long-term safety: Scientific and technical basis	Broad-based research	Research narrowed to deal with host rock-specific aspects and specific aspects associated with the selected EBS	In situ experiments and improvement of data bases and understanding	Scientific work sharply focused on small number of residual issues, large-scale in situ experiments and component tests	Confirmation studies on components under site conditions incl. monitoring
Facility and component design	Concept variant studies	Repository design concepts adapted to specific rock type	Component design and layout design Operational safety studies	Full-scale prototypes constructed Industrial scheme developed	Full-scale production and operation
Site-related characteristics	Surveys of potential host rocks and their characteristics based on available information	Host rock characterization and site-specific studies	Detailed site characterization Excavation	Construction of main underground facilities Confirmation of rock properties for final design	Construction, confirmation, monitoring

Fig 3: Different generic stages of repository development and examples of actions and related functional and task needs at the different stages from IGD-TP SRA 2011 (2, p. 16).

For example, conducting the work for a safety case has the same elements at all of the stages of the development, but the level of knowledge, skills and even competences changes from a more general/generic view to specialist work related to a specific technical or scientific discipline. And at the same time as the waste management programme advances, the need for interaction and the understanding of the complex couplings between the different components of the safety case increases.

Other functions or jobs are, on the contrary, specifically related to one stage of the geological repository development, such as “component design and layout design” in the technology development and repository design. In this case, the units of learning should provide the individual knowledge, skills and competences that are relevant to different projects and organisations and can be transferred cross border, contributing in this way to the mobility of skilled professionals. The two examples show as the units of learning need to be thoroughly defined in the broad perspective of the repository life cycle and to respond to the needs and work practices of different organisations.

As a starting point for any pilot under the CMET in using the ECVET principles, the most feasible target would be to focus on units of learning that have been used already extensively in some Member States who wish to preserve the KSC and at the same time these units of learning could be applied in a Member State, which is taking its first steps towards the same stage of development. The process of formulating the KSC would provide for an ideal knowledge transfer, too.

The feasibility study for the voluntary accreditation looks at two points related to the ECVET objectives. First, how to provide for a voluntary accreditation of an individual's learning outcomes resulting in recognised and certified learning outcomes. Second, how to provide, following the ECVET principles, a quality enhancing voluntary accreditation system addressing the non-formal learning outcomes of education and training providers. In order to advance in developing a voluntary accreditation scheme within the IGD-TP, the several issues related to the ECVET technical components as listed in Tab 2 need to be addressed with practical solutions by the CMET.

In addition to the ECVET technical components, several other solutions are needed like the actual accreditation body, the width of such a body's authority within the geological disposal community (starting with the IGD-TP) and the funding structure for the accreditation and the related certificates especially when the learning outcomes are acquired through informal learning and assessment of the learning outcomes against the set criteria need to be carried out by an accreditation body.

ECVET TECHNICAL COMPONENTS need for:	Voluntary Accreditation of an individual's LOs	Voluntary Accreditation of an ECVET training provider
Qualification	Yes. Recognition of mastery, but not a formal qualification. No requirement to have a home institution.	Not applicable. [Formal qualification of a legally recognized provider is outside the scope of voluntary accreditation.]
Units of learning outcomes (LO)	Yes, need to define tasks or functions in terms of EQF-level sand KSC for the LO, for which the accreditation is sought. These definitions need to be approved by the geological disposal community.	Yes, production of units of learning corresponding to predefined KSC. Definitions should be universal for a unit of learning corresponding to an EQF-level. [Formal: For a degree full range of units of LOs is required for the desired EQF level.]
Size of qualifications	No	Yes. Weight of units or credit points for transfer between different provider parties are needed if included into the training provider's scope.
Assessment of LOs	Yes. Assessment criteria and demonstration of LOs needed See also validation.	Yes. Assessment criteria and demonstration of LOs needed.
Validation of LOs	Yes. An accreditation body needs to be set up or approved by the partners.	Yes. Done by an internal process, by MoU partners, or by an accreditation body.
Recognition of LOs	Yes. By the industry and institutions in the community and/or by training providers by signing an MoU.	Yes (see MoU).
Partnerships (MoU)	Yes. Wide coverage of partners to engage themselves in a MoU for voluntary approval of the recognised LOs.	Yes. Basis for transfer of the recognized LOs between various providers (a criteria for voluntary accreditation, too).
Learning Agreement	No	Yes, needed for exchange in the formal exchange between training providers or between a provider and a workplace.
Learner's transcript of record (e.g. Europass)	Yes. A certificate needs to be provided of recognition of LO/s resulting from assessment => e.g. inclusion into Europass.	Yes, provided by the training provider to the home institute and later into the Learner's transcript (achievements). One example, the ENEN supplement to a diploma.

Legend: LO = Learning outcome, MoU = Memorandum of Understanding, KSC = Knowledge, Skills and Competence

Tab 2: ECVET technical components to be addressed in developing voluntary accreditation adopted from (12, p. 7)

4. Conclusions

The work is in its initial stage. The expected benefits encourage tackling this ambitious task. Fortunately, there are several complementary initiatives on-going, so all the challenges need not to be faced alone. The commitment of all stakeholders to the application of the ECVET is needed and more communication is needed about the different initiatives around it and the practitioners themselves need more training and piloting of different approaches and interaction to meet the ambitious goal.

Other sectors in Europe are more advanced in such voluntary accreditation approaches. The CMET group also intends to learn from these experiences, so that a feasible scheme can be developed for acknowledging knowledge, skills and competence in geological disposal irrespective of the means by which an individual has acquired them. At the same time support will be provided to acknowledge training schemes that use similar principles for producing the needed learning outcomes.

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