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Report on existing vocational European Fission Training Schemes and their accreditation

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Abstract

This report was produced as a deliverable in the frame of the ENEN Plus project. It provides an overview of all twenty-five projects carried out under the Euratom Fission Training Schemes (EFTS) and their main achievements. Almost all projects are completed to date except for three. The EFTS's ultimate goal is to develop a European passport for Continuous Professional Development, which relies on the principles of modularity of courses and common qualification criteria, a common mutual recognition system, and the facilitation of teacher, student and worker mobility across the EU. The conclusions of this review will be published in a separate report.

1 Introduction

There is a strong need for high level training of young specialists in the nuclear sector. An extensive survey on the supply and demand for nuclear experts to the EU-27 conducted on 2012 by EHRO-N found an alarming finding about the shortage in nuclear experts by 2020[1]. The EHRO-N survey indicates that the supply of nuclear engineering students and students that have taken energy-related subjects in their studies is estimated at 2800 graduates in the EU-27 in 2009. This covers some 70% of the demand of nuclear experts by the nuclear energy sector in the EU-27 (on average 4000 per year by 2020). This is true if we assume that all the 2800 graduates join the nuclear energy sector. Thus, the lack of nuclear engineers is fulfilled by the supply form other science, technology, engineering, and mathematics (STEM) disciplines. The needs of STEM graduates will be more and more important due to development of the renewable energy sector in the EU-27. It is critical to maintain the safety and efficiency of the existing nuclear installations, including life extension issues and to build and prepare the development of the next generations of facilities. Well-designed training is therefore necessary, allowing the handling of the technical challenges with all safety assurances. Major industrial organisations have the means, both in terms of expertise and finances, to hire young engineers and to train them for the specific duties, through a combination of in-house programmes, training courses available on the market, and on the- job training. It is much more problematic for smaller organisations and in countries where recent policies with respect to nuclear energy has led to the decrease in nuclear education and research funding. Synergies would be beneficial in all cases.

Retaining human competences and know-how in the nuclear disciplines and ensuring a high level of education and training (E&T) are essential if Europe is to maintain its exemplary record in nuclear safety and its peerless nuclear safety culture. One of the main goals of the Euratom research and training programmes is to contribute to the sustainability of nuclear energy by generating knowledge (research) and developing competencies (E&T). **Euratom training programs**, in particular, aim to continuously improve and disseminate the nuclear safety culture.

Two key structuring initiatives should be identified within Euratom Fission Training activities I) Euratom Fission Training Schemes (EFTS) and II) European Credit System for Vocational Education and Training (ECVET).

EFTS are coordination actions aimed at structuring training and career development through the instruments of the ECVET. These training schemes are ambitious programmes fostering continuous professional development based on a modular course approach, dedicated interdisciplinary E&T, and workshops. These are embedded in research and innovation fission projects open to the scientific community at large, and carried out in all Euratom research projects.

ECVET´s efforts in making lifelong learning and borderless mobility for students and the scientific community a reality are priorities or the European research and education policy. Lifelong learning requires a European-wide approach for assessing and validating the learner's qualifications by authorities. Borderless mobility implies mutual recognition of qualifications, freedom of movement and settlement. ECVET main objective is to promote transparency mutual trust and recognition of learning outcomes, which refers not only to knowledge but also to skills and competence.

ECVET and ECTS (European Credit Transfer System) are the heart of EFTS and compromise *portfolios of learning outcomes* that are needed to perform highly qualified functions identified in a specific field and of pan-European interest. The ultimate goal is to develop a *European passport for Continuous Professional Developmen*t, which relies on the principles of modularity of courses and common qualification criteria, a common mutual recognition system, and the facilitation of teacher, student and worker mobility across the EU. E&T Programmes are listed in Table 1.

[1] Simonovska, V. and von Estroff U.; Putting into perspective the supply of and demand for nuclear experts by 2020 within the EU-27 nuclear energy sector; EUR 25291 EN; ISBN 978-92-79-21276-5; ISSN 1831-9424; doi:10.2790/47738; JRC70083

Table 1. E&T Programmes

Project		Active	web
NEPTUNO	The Nuclear European Platform of Training and University Organisations	01/04-12/05	http://www.enen.eu/en/projects/for-nuclear-community/neptuno.html
ENEN II	European Nuclear Engineering Network Training Schemes		
ENEN III		05/09 - 04/12	http://www.enen-assoc.org/en/training/for-nuclear-community/enen-iii.html
ENEN+		10/17 - 09/20	
CINCH-I	Cooperation in Education in Nuclear Chemistry	02/10 - 01/13	https://www.cinch-project.eu/cinch2/index.html%3Fart=cinch_i.html
CHINCH-II		06/13 - 05/16	https://www.cinch-project.eu/cinch2/
MEET-CINCH	A Modular European Education and Training Concept In Nuclear and RadioCHemistry	06/17-05/20	https://www.cinch-project.eu/
PETRUS II	Towards an European training market and professional qualification in geological disposal	01/09 - 12/11	http://www.enen-assoc.org/en/training/for-nuclear-community/petrus-ii.html
PETRUS III		09/13 - 09/16	http://www.petrus3.eu
ELINDER	The European Learning Initiatives for Nuclear Decommissioning and Environmental Remediation	02/16 -	https://ec.europa.eu/jrc/en/training-programme/elinder
ENETRAP	European Network on Education and Training in Radiological Protection	04/05-03/07	http://enetrap.sckcen.be/
ENETRAP II		03/09 - 02/12	http://enetrap2.sckcen.be
ENETRAP III		06/14 - 05/18	http://enetrap3.sckcen.be

MEDRAPET	Medical Radiation Protection Education and Training	12/10 - 02/13	http://www.medrapet.eu
EUTEMPE-RX	EUropean Training and Education for Medical Physics Experts in Radiology	8/13-07/16	http://www.eutempe-rx.eu/
TRASNUSAFE	Training Schemes on Nuclear Safety Culture	11/10 - 10/14	http://trasnusafe.eu
NUSHARE	Sharing Nuclear Safety Culture Competence	01/13 - 12/16	http://www.nushare.eu
CORONA	Establishment of a Regional Centre of Competence for VVER Technology and Nuclear Applications		http://projectcorona.eu
CORONA II		09/15 - 09/18	http://corona2.eu
ECNET-EU-CHINA	Nuclear Education and Training Cooperation: mirror project to be financed by the Chinese Atomic Energy Authority	03/11-02/13	
ENEN-RU	Strengthening of Cooperation and Exchange for Nuclear Education and Training between the European Union and the Russian Federation	01/11 – 12/13	http://www.enen.eu/en/projects/for-nuclear-community/enenru.html
ENEN-RU II		07/14 – 06/17	http://www.enen.eu/en/projects/enenru2.html
EURECA	Cooperation between EU and Canada in Education, Training and Knowledge Management on Super-Critical Water Reactors	08/12 – 07/14	https://cordis.europa.eu/project/rcn/103595_en.html
GENTLE	Graduate and Executive Nuclear Training and Lifelong Education	01/13 – 12/16	http://gentelproject.eu
ANNETTE	Advanced Networking for Nuclear Education and Training and Transfer of Expertise	01/16 – 12/19	http://www.enen.eu/en/projects/annette.html

2 Qualifications

Qualifications – the certificate and diplomas awarded following education, training and learning are important in modern society. They influence our ability to get a job, practise a profession, pursue lifelong learning and move between countries. They also affect our general social standing and status.

European qualifications are increasingly included in *national qualification frameworks* linked to the *European Qualifications Framework* (EQF). These frameworks make understanding and comparing qualifications easier within and between countries, while they encourage countries to reform policy reform policy and practice on education, training and lifelong learning. Qualifications can also be awarded by international bodies and organisations, reflecting the internationalization of technologies and labour markets.

Engineers/professionals with higher qualifications such as Master and/or PhD and several other qualifications are assimilated into EQF that relates different national qualifications systems to a common European reference framework, for example Honours degree, Masters and PhD degrees are judged Level 6, 7 and 8 respectively. Over a lifetime, individuals can move between and across EQF levels as they undertake new learning and acquire new skills for particular contexts and circumstances. This can be achieved via the *European Credit Transfer and Accumulation System* (ECTS). This is a tool that helps to design, describe, and deliver programmes and award higher education qualifications. The use of ECTS, in conjunction with outcomes-based qualifications frameworks, makes programmes and qualifications more transparent and facilitates the recognition of qualifications. ECTS can be applied to all types of programmes, whatever their mode of delivery (school-based, work-based), the learners' status (full-time, part-time) and to all kinds of learning (formal, non-formal and informal).

One of the important concepts in *Vocational Education and Training* (VET) is the learning outcome. Learning outcomes means statements of what a learner knows, understands and is able to do on completion of a learning process and which are defined in terms of knowledge (learning to know), skills (learning to do) and competences (learning to be) that can be assessed and validated. In the latest revision of EQF, the term competence was replaced by responsibility/autonomy. In principle, learning outcomes can be achievable via a variety of E&T paths (in a formal or informal context) for individuals who are following a learning process to acquire specific competencies in a nuclear sector. Learning outcomes are gaining in importance compared to the traditional input-led evaluation, based on textbook knowledge or end of course examination.

Qualifications are increasingly being defined and written based on a *learning outcomes* (LO) approach. Learning outcomes are also the "glue" holding together the common EU tools and principles that lead to higher consistency in employment, E&T policy across Europe. The common EU tools include the following systems: ECVET, Europass, EQAVET and the validation of non-formal and formal learning (details see chapters 2.1 to 2.4). These tools and principles are designed to help people progress through E&T at any age, change careers or move abroad for work or for further education. In addition, the terminology developed through *ESCO - the European terminology on Skills, Competences, Qualifications and Occupations*, supports linking the labour market with E&T.

The framework established for the EFTS is based on the *Systematic Approach to Training* (SAT), for which experience has been shown that it is the most effective method available for preparing and producing training programmes. Through its five interrelated phases of analysis, design, development, evaluation and implementation, SAT offers significant advantages for developing and maintaining the competence of personnel.

2.1 The European Credit System for Vocational Education and Training (ECVET)

ECVET allows learners to accumulate, transfer and use their learning in units as these units are achieved. This enables building a qualification at learners' own pace from learning outcomes acquired in formal, non-formal and informal contexts, in their own country and abroad. The system is based on units of learning outcomes as part of qualifications that can be assessed and validated. It offers a framework for making learners more mobile and qualifications more portable, laying down principles and technical specifications and making use of existing national legislation and regulations. It applies to vocational E&T qualifications at all levels of the European qualifications framework. This is especially relevant in the context of borderless mobility and life-long learning, two main characteristics of the free movement of professionals. The European agency CEDEFOP in cooperation with the European Commission monitors and provides technical and analytical support for application of the ECVET recommendation at EU, national and sectoral levels. It researches and analyses qualifications and qualification systems, along with links between the European tools for E&T (ECVET, ECTS, EQF, FQ-EHEA, Europass, EQAVET).

Some Member States (e.g. Finland, Belgium, France) have mainstreamed ECVET into their VET systems, others (e.g. Poland, Portugal) have adopted many of its main concepts (for instance qualifications are composed of units of learning outcomes). Many mobility experiences throughout Europe, such as traineeships abroad or exchanges between VET schools, use ECVET documents, in particular the Memorandum of Understanding between institutions, the Learning Agreement between sending partner, host partner and the mobile learner, and the Personal Transcript of Record, which document the Knowledge, Skills, Competences (KSC) developed by the learner. The Personal Transcript of Record can also be used to record KSC developed in experiences other than mobility, such as Continuous Professional Development schemes.

2.2 Europass

The passport is configured to provide a single framework for transparency of qualifications and competences and is available across Member States and includes:

- *Applicant's Curriculum Vitae* (CV); The CV enables people to make their skills and qualifications visible and other Europass documents can be attached to the CV.
- *Language Passport*; allows people to describe their language skills, skills that are vital for learning and working in Europe.
- *Europass Mobility*; is a record of any organized period of time that a person spends in another European country for the purpose of learning or training. It is supported by the European Quality Charter for Mobility (EQCM).
- The *Europass Certificate Supplement*; is delivered to people who hold a vocational E&T certificate; it adds information to that which is already included in the official certificate, making it more easily understood, especially by employers or institutions outside the issuing country. The information is provided by the relevant certifying authorities.
- *Europass Diploma Supplement* is issued to graduates of higher education institutions along with their degree or diploma. It helps to ensure that higher education qualifications are more easily understood, especially outside the country where they were awarded.

2.3 European Quality Assurance in Vocational Education and Training (EQAVET)

Quality assurance in VET is a key priority at EU level to promote increased transparency of VET policy developments between Member States, thereby enhancing mutual trust, mobility of workers and learners, and lifelong learning.

European cooperation on quality in VET led to the definition of common principles, guidelines and tools for quality development. EQAVET is an approach to develop and improve quality assurance in European VET systems, which has been agreed by Member States, within the context of the implementation of the European Quality Assurance Reference Framework.

2.4 Validation of non-formal and formal learning

Citizens must be able to demonstrate what they have learned to use this learning in their career and for further E&T. Countries need to establish systems that allow individuals to identify, document, assess and certify (validate) all forms of learning to use this learning for advancing their career and for further E&T.

The European guidelines for validating non-formal and informal learning are written for individuals and institutions responsible for the initiation, development, implementation and operation of validation arrangements. The ambition of the guidelines is to clarify the conditions for implementation, highlighting the critical choices to be made by stakeholders at different stages of the process.

These tools and principles are designed to help people progress through E&T at any age, change careers or move abroad for work or for further education. In addition, the terminology developed through ESCO - the European terminology on Skills, Competences, Qualifications and Occupations, supports linking the labour market with E&T.

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3 Overview of EFTS initiatives

3.1 NEPTUNO – The Nuclear European Platform of Training and University Organisations

(35 partners from 18 EU countries)

NEPTUNO integrates European E&T in nuclear engineering, nuclear safety and other nuclear fields with the major objective to secure qualified curricula in the nuclear disciplines at European universities with sufficient harmonisation to ensure mutual recognition according to the Bologna declaration, and to harmonise professional training and accreditation schemes.

The main achievements:

- Established a comprehensive database on E&T in the enlarged European Union;
- Development of NEPTUNO Communication system to assist the nuclear community in making knowledge in the nuclear engineering field easily available; improving teaching methodologies and providing an infrastructure which will support exchange of information and cooperative work among the members of the European nuclear community;
- Report on E-learning and E-learning test platform providing a list of important E-learning tools;
- ENEN Exchange courses; A series of documents, guidelines and recommendations have been produced related to academic education, to the organisation of the ENEN exchange courses, to the mutual recognition of courses and qualifications, to student and teacher mobility, to advanced continuous training schemes, and to the organisation of Master and PhD theses at the European level;
- Implementation of the European Master of Science in Nuclear Engineering Certificate (EMSNEC): The curriculum and criteria for obtaining the ENEN certificate of European Master of Science in Nuclear Engineering was already developed but the formal implementation, a set of procedures, modalities and forms had to be defined and developed as well as the layout and format of the certificate itself.

Harmonised European Scheme for Training

It was intended to implement a common standard for professional training. Compliance to the standard would be evaluated and verified on an independent basis, leading almost automatically to the mutual recognition of certificates or licences delivered on the basis of such training.

The concept involved three separate phases consisting of:

- Identification and selection of reference key positions in the nuclear industry. The selection was oriented to the nuclear power plants, and by the importance of the position with a focus on the impact on *nuclear safety*. For each position, a reference job description, a corresponding set of qualifications and competences and a recommended training programme has been developed;
- The elaboration of criteria for the evaluation of the training programmes and best practices for the mutual recognition and mobility of trained professionals. A self-assessment with respect to a number of criteria was proposed, followed by an independent assessment through a peer review. The whole process would be supervised by a new body, the European Academy for Nuclear Training. The criteria would refer to the SAT concept;
- The design, organisation and operation of an independent body in charge of evaluating the training programmes. From meetings with the industries, it became clear that the peer review would to some extent be a duplication of WANO and IAEA OSART evaluations and a third review

would give no more added value. It was recognised, however, that the European Academy for Nuclear Training would be very useful in assisting the industry with the implementation of the recommendations made by the WANO and IAEA OSART reviews in the field of training.

Four pilot training courses were organized addressing mainly young professionals but also students having a first degree in nuclear engineering. It´s only mentioned in one of the courses that an examination session was organized in order to award, in this case, 4 ECTS corresponding to the course.

Based on the experience with the advanced courses given and the relatively small number of participants, better advertising and trans-national joint organisation of well-developed high quality advanced courses for a mixed attendance of students and young professionals was recommended. With respect to further networking, it was recommended to maintain and strengthen interactions with other networks for E&T, e.g. the World Nuclear University, The Asian Network for Education in Nuclear Technology, the University Network of Excellence in Nuclear Engineering, etc. in order to avoid competition and duplication and benefit from the exchange of experience and synergism.

PhD researchers should be encouraged to partly perform their research at another European research centre and/or university laboratory for periods of 6 months to 1 year on an exchange basis. It was also recommended that international advanced courses, workshops and seminars addressing more specialised filed for Ph.D. researchers would be organised to stimulate and strengthen the European research area and that this courses would be rewarded ca. 10 ECTS.

Harmonisation is needed in particular at lower level job positions and should be based on the transferability of skills, for example by an *employment passport*. Sharing of training infrastructures of common interest would be beneficial and contribute to the harmonisation and mutual recognition of professional training packages.

3.2 ENEN III – European Nuclear Engineering Network Training Schemes

(19 partners from 12 EU countries)

The project covered the structuring, organisation, coordination and implementation of training schemes in cooperation with local, national and international training organisations, to provide training courses and sessions at the required level to **professionals in nuclear organisations or their contractors and subcontractors**. The training schemes provide a portfolio of courses, training sessions, seminars and workshops, offered to the professionals for continuous learning, for updating their knowledge and developing their skills to maintain their performance at the current state-of-the-practice and to anticipate the implementation of new scientific and technological developments. The training schemes allow the individual professional to acquire a profile of knowledge, skills and expertise, which is documented in his/her personal transcript. The recognition is subject to qualification and validation of the training courses according to a set of commonly agreed criteria, which can be ratified by law or established on a consensus basis within a network.

Seventeen of the twenty partners of the ENEN III consortium are members of the ENEN Association and most of them have been involved already in the FP5 ENEN coordination project and in the FP6 NEPTUNO and ENEN-II coordination projects. The lessons learned from these projects with respect to the design, organisation and implementation of E&T modules served as a basis for the design and development of training schemes in ENEN-III.

The aims of the ENEN III framework are to:

- Develop a cohesive approach to education, life-long learning, and mobility of personnel, with recognised accreditation of courses;
- Promote and develop the framework as a tool to support lifelong learning;
- Develop and maintain relationships with other frameworks in Europe and internationally;
- Develop the concept of a European Nuclear Competence Passport.

Training schemes for specific jobs in the following four generic categories have been developed.

- Basic training in selected nuclear topics for non-nuclear engineers and professionals in the nuclear industry.
- Technical training for the design challenges of Gen III Nuclear Power Plants
- Technical training for the construction challenges of Gen III Nuclear Power Plants.
- Technical training on the concepts and design of GEN IV nuclear reactors

The framework established for the EFTS is based on the 5 phases of the SAT methodology.

1. In cooperation with the future employers an *analysis* has been made of the required qualifications and skills to perform the tasks of a specific professional profile. The analysis was based on past experience, lessons learned and recommendations of the stakeholders and international organisations active in the field.
2. The training scheme was *designed* in detail to provide the trainees with the general background knowledge, the basic and specialist theoretical education, and the practical work and experience to develop the required qualifications and skills.
3. To *develop* a training scheme a survey was made to identify the E&T organisations providing the necessary components in terms of courses, seminars, workshops, internships, etc.
4. A first *evaluation* was carried out by a quality assurance group together with the future employers to verify the technical content and pedagogical value of the components of the training scheme and the logical sequence of the different modules. A second *evaluation* has been carried out after running the training schemes with a number of trainees and assessing the qualifications acquired and the skills developed during the training. For evaluation of training programmes in the nuclear sector the European Academy for Nuclear Training (EANT) establishes evaluation standards and assists members in achieving and maintaining the objectives and criteria. The independent European Nuclear Evaluation Board (ENEB) makes the final recommendation regarding whether the objectives are met and suggesting a calendar for implementing the appropriate changes to improve the areas with problems.
5. The training schemes were *implemented* in a test phase with trainees supported or already employed by the future employers.

The training schemes established will allow the individual professional to acquire a profile of skills and expertise, through basic nuclear courses, training sessions complemented with internships. The schemes will be documented in “training passports”. In this framework, evaluating the barriers that could oppose this process, in terms of qualifications to be delivered by specific bodies in each EU Country according to its law, is a crucial aspect. While the training passports will testify about the acquired competencies, the need that these competencies be recognised by different national laws and regulations, according to possibly different requirements, may create a challenge for the implementation of this concept. Removing mobility barriers (e.g course programmes are programmes of the national industry and held in national language, its contents will generally vary

from country to country and in addition is the required experience site specific of the respective licensee) will require bilateral, multilateral or international agreements of regulators and utilities.

Accreditation

There are already in existence various life-long learning accreditation services, both at European level (EQF) and national level. In the UK, National Skills Academy Nuclear (NSAN) has already embarked on evaluating employer training courses using an independent organisation New Engineering Foundation (NEF). A step-wise approach to accreditation would be a logical approach to accreditation i.e. initially accreditation at national level with subsequently harmonization across Member States. Consulting the *European Quality Assurance Reference Framework* (EQARF) would be a sensible first approach. The EQARF is designed to promote better vocational E&T by providing authorities with common tools for the management of quality. It supports lifelong learning strategies, European labour market integration and promotes a culture of quality improvement at all levels, while respecting the rich diversity of national education systems.

For the Nuclear Skills Passport Concept three options of format are recommended by ENEN III

- the development of a EU nuclear skills passport that is complementary with other existing nuclear passports;
- modification of Europass incorporating more employer involvement;
- internationalisation of the UK National Skills Academy Nuclear passport.

The ENEN-III project adopted to the full extent the concept of ECVET and the associated learning outcomes and included this concept from the initial phases into the analysis and description of the E&T needs for the job profiles addressed in the four target groups of the nuclear engineers. For each category, several hundred learning outcomes in the field of knowledge, skills and attitudes have been described and hundreds of courses and training sessions, covering them, have been listed.

For introductory courses two assessment exercises, in agreement with employer and course deliverer, were suggested I) Short dissertation addressing an agreed topic and II) Examination paper. It is recommended that either of these assessment exercises would have to be acceptable to an independent accreditation body like an academic institution.

For the design engineers of GEN IV nuclear reactors the issue of skills and attitudes were considered rather superficial as the research character of the various job profiles defines the basic competences needed. The qualification can formally be documented in the person´s learning portfolio and it would be reasonably easy to create an authoritative body for unofficial auditing. *The body could consist of GEN IV expert group persons and to academia, if formal acceptance is needed*.

One of the latter phases in the ENEN III *accreditation* process is the delivery of pilot courses developed under the umbrella of this project and those (fundamental nuclear courses) already available elsewhere to a selected audience (internees). For every phase of the project, definition of learning outcomes, course research, implementation, internships, and on-the-job training, an evaluation has been made and feedback has been collected from the providers and in consultation with their employer the internees would rate the effectiveness/value of these courses and feedback their views to the ENEN-III project.

In the general recommendations it was stated the ENEN III should review appropriate existing learning schemes such as EQARF, NARIC, EUROPASS etc. to ascertain their value to the nuclear sector.

3.3 CINCH – Cooperation in Education and Training in Nuclear Chemistry

CINCH consists of three projects:

CINCH-I: Cooperation in Education in Nuclear Chemistry

(9 partners from 7 EU countries)

CINCH-II: Cooperation and training in Education in Nuclear Chemistry

(11 partners from 6 EU countries)

MEET-CINCH: A Modular European Education and Training Concept in Nuclear and Radio Chemistry (11 partners from 8 EU countries)

CINCH-I and CINCH-II aimed at mitigating the special skill-based deficits within **nuclear chemistry** at masters and doctorate levels and the decline of number of staff qualified in this field. The projects were built around the SAT methodology. While CINCH-I dealt with the first three phases of the process, CINCH-II concentrated on the implementation. Additionally, evaluation mechanisms were proposed and tested on the pilot courses developed during the projects.

3.3.1 CINCH II

The main results may be categorized by the four work packages I) EuroMaster in Nuclear Chemistry, II) Completing a pan-European offer of training courses for the customers from the end-users, III) Modern E-learning Tools to Enhance Teaching in Nuclear Science, and IV) Vision, Sustainability and Awareness.

Another achievement in the field of the development of standards for mutual recognition regarded the quality of training. Two important outputs were produced I) *Training passport* requirements for NRC and II) *Assessment criteria* for hands-on courses.

EuroMaster in Nuclear RadioChemistry

One of the objectives of CINCH-II was to develop and implement the plan for the European master's degree in nuclear chemistry (NRC EuroMaster).

The objectives of the NRC EuroMaster label are to I) give European NRC students common knowledge and skills in nuclear and radiochemistry, II) promote the exchange of students, teachers and teaching tools and III) aid the employment of nuclear and radiochemists at a European level.

The European Chemistry Thematic Network ECTN EuroMaster® would be well recognised as the standard quality label but this option was seen too restrictive. Therefore, alternative, less restrictive way was selected and the Division on Nuclear and Radiochemistry (DNRC) of the European Association for Chemical and Molecular Sciences (EuCheMS) accepted the invitation to become the body guaranteeing the NRC EuroMaster. The DNRC will evaluate candidate universities by comparing their NRC curricula to the minimum requirements. If the NRC curriculum fulfils the requirements by 90% (with respect to topics covered) the university will be given the right to grant NRC EuroMaster label to their NRC students.

The intention with the NRC EuroMaster certificate/label is that employers and other institutions will recognise it as a quality label and thus can be certain that the holder has at least knowledge and training equal to the Minimum Requirements specification.

The evaluation criteria for the NRC EuroMaster and a sample application package, including detailed instructions for applicants was created.

The master’s program should contain at least 60 ECTS credit units (cu) studies in nuclear and radiochemistry in the following way:

- BSc in chemistry 180 cu
- Compulsory studies in nuclear and radiochemistry minimum 25 cu (of which at least 10 cu exercises)
- Optional studies in nuclear and radiochemistry minimum 5 cu
- Project work and master's thesis in nuclear and radiochemistry minimum 30 cu
- Remaining cu is elective

In total the BSc and MSc programs should add up to 300 cu. For master's programs having a different size than 120 cu the workload of nuclear and radiochemistry studies should be equivalent to at least 60 cu.

The European NRC Network

A European Network on Nuclear and Radiochemistry Education and Training (European NRC Network) was formed to collaborate and enhance teaching in Nuclear and Radiochemistry (NRC). Within this network a NRC EuroMaster Group will be formed by the universities that fulfil the "Minimum Requirements for the EuroMaster Degree in Nuclear and Radiochemistry" and that were granted the right to award NRC EuroMaster label to their students.

Additional members to the Network are accepted by application and by approval of the general assembly. To become a member of the Network the candidate organisation needs to be a relevant provider or end-user of NRC education and/or training. For the application process the steering group has prepared evaluation criteria and application form.

The EuroMaster label guarantees mutual recognition but does not necessarily facilitate the mobility of trainers and trainees across the EU.

Significant efforts were devoted to the development of the *Training Passport* in Nuclear Chemistry. Training passport requirements for NRC and assessment criteria for hands-on courses were issued, where the minimum requirements for providing an internationally recognised passport that enables borderless mobility for nuclear chemists working within Europe were designed and set. In addition, assessment criteria for hands-on courses were proposed and included. The results obtained were completed with and summarized in "Training passport requirements for NRC and assessment criteria for hands-on courses".

3.3.2 MEET - CINCH

The objective of MEET-CINCH, is to develop the training materials and training platforms needed for the implementation of the NRC EuroMaster. In order to maintain European nuclear operations, expertise in nuclear and radiochemistry (NRC) is of strategic relevance. The MEET-CINCH project will counteract the massive lack of NRC expertise by three actions.

- A teaching package for high schools and a MOOC on NRC for general public are built in order to attract young persons to the NRC field. Two additional actions focus on vocational training and (university) education.
- develop completely new E&T approaches based on remote teaching and the flipped classroom concept including and further developing material generated in the CINCH I and CINCH II projects, such as the NucWik platform and the remote controlled RoboLab experiments.
- provide ECVET course modules in an e-shop adapted to the needs of end-users which have been surveyed in the previous projects. After the end of the project the e-shop will be continuously operated by the NRC-network as part of a sustainable EFTS.

MEET-CINCH mainly aims at European Qualifications Framework (EQF) level 7, i.e. academics and students at BSc /MSc level and beyond.

In detail there will be:

- The CINCH-II VET Syllabus update to cover all the courses developed and demonstrated under CINCH projects.
- Courses will be updated several new courses will be completed and brought up to the pilot level. These courses will make use of combination of all the existing tools – e.g. RoboLab exercises, Computers in Science exercises, CINCH Moodle course management system
- A new platform – CINCH VET-e-shop – will be launched that will provide easy access to and details of all courses brought at least to a pilot level.
- The Massive Open Online Course (MOOC) on NRC's importance, to increase the awareness, and the number of students that select a career path which includes a NRC component.
- A teaching package aimed for use in high-schools for 16-18-year-old pupils, demonstrating the importance of NRC for society and future work opportunities. A pilot will be run in the UK for their "A-level" pupils at the targeted age group.
- Mobility Fund that will facilitate participation of students and young researchers from other “chemistry” Euratom joint projects, in lab courses and summer schools provided by MEET-CINCH or other activities.
- The modern Flipped Classroom (or so called Inverted Classroom) concept complementing the available tools for teaching and training in the nuclear and radiochemistry field.
  A set of the RoboLab remote operated laboratory experiments and the CINCH Moodle distant learning management platform MEET-CINCH will provide a comprehensive toolkit, available in the VET e-shop mentioned above. The end user will be able to compile courses tailored to individual needs from this flexible modular base of teaching material.

3.4 PETRUS II and III – Towards an European training marked and professional qualification in geological disposal

PETRUS consists of two projects:

PETRUS-II: Towards a European training market and professional qualification in geological disposal

(17 partners from 12 EU countries)

PETRUS-III: Implementing sustainable E&T programmes in the field of Radioactive wastes disposal

(20 partners from 11 EU countries)

The objective of PETRUS II+III was to ensure the continuation, renewal and improvement of the professional skills by filling the gap between growing demand for structured E&T in the field of **radioactive waste disposal** and the current offer. To achieve this close collaboration between key stakeholders (i.e. end users, training providers and academia) committed to develop suitable common frameworks for the implementation and delivery of sustainable E&T programmes accredited at the European level was foreseen.

The main results of the PETRUS II project were:

- The development of:
  - Adequate E&T schemes and the delivery of courses integrated to these schemes relative to the radioactive waste disposal;

- A framework for the mutual recognition and accreditation of the E&T programmes;
- A comprehensive database and its integration to the ENEN web database providing up-to-date information on E&T provisions and other relevant data;
- The settlement of the PETRUS end-user council for long-term collaboration between end-users and E&T providers beyond the present project.

The main results of the PETRUS III project were:

- Practical implementation of PETRUS training programme following ECVET principles;
- Elaboration of multidisciplinary training and research framework for PhD student;
- Development of strategies and frameworks for maintaining PETRUS initiative over the long-term.

The Petrus II project allowed the delivery of 120 hours per year of specialised common courses developed within the Bologna process which address Master students in geosciences. The programme was followed by about 30 students during the project life using synchronous e-learning methodology that allowed broadcasting live lectures into multiple distance sites.

In the PETRUS III project multidisciplinary lectures were elaborated for PhD students and were taught in an innovative format during the two PETRUS PhD Conferences held in Nancy in 2015 and in Delft in 2016. The project also produced framework for "Doctoral School on waste disposal innovation" in order to combine existing national regulation with a common complementary Innovation and Entrepreneurship (I&E) education which include organisational and geographic mobility.

In PETRUS II the project aimed at joining efforts towards building a common training framework. The project included the identification of training needs, the inventory of available resources; the development of adequate training schemes and delivery of courses integrated to these schemes (training scheme consist of professional development and of European masters), and the development of a framework for the mutual recognition and accreditation of the training programmes. A three weeks programme was scheduled in Josef underground laboratory for practical training, and lectures and training programme were tested during two pilot sessions as a part of the regular universities Master programme.

PETRUS III developed training modules defined in terms of learning outcomes in a "Competency-Based Curriculum" following ECVET principles. The objective was to set up qualification in geological disposal that could be achieved, accredited and recognised through Professional Development training programmes. The project identified the most needed job profiles and elaborated three training units based on learning outcomes for a safety Engineer. Units were as detailed as possible to better assess the thematic content of the programmes and the corresponding qualification level. These training programmes allowed participants to understand the multi-faceted nature of the geological disposal problem and to obtain the necessary skills to communicate with others to produce a collaborative solution through a common scientific perspective. To disseminate this programme multidisciplinary lectures were elaborated for PhD students and were taught in an innovative format during the two PETRUS PhD Conferences held in Nancy in 2015 and in Delft in 2016.

The compatibility with the ECVET system was studied in PETRUS II: 3 job profiles were identified and corresponding qualification programmes defined and partially tested through the organisation of a pilot session. An example of learning agreement was also developed.

Faced with the delay in the implementation of ECVET system across Europe, the PETRUS III elaborated a framework (for Safety Engineer) for the learning agreement model (that is essential for the accreditation evaluation), the learner profiles (including the criteria for accepting the students), a model for linking ECVET and ECTS systems, the description of the prototype of the planned program and the Memorandum of Understanding. Further the duties of competent institutions in the

procedures of implementation as well as relevant information for the evaluation of the administrative efficiency and transparency as a part of the quality control were drafted.

3.4.1 Accreditation in PETRUS II

There is a reference to ENEN's parallel work in geological disposal E&T nuclear engineering. Graduate students can receive a European master supplement, accreditation of studies according to mutually agreed quality assurance principles of ENEN.

Informative training is understood as short and easily adapted to situations courses which do not require formal accreditation.

A strategy allowing training programmes validation (i.e. accreditation and recognition) of the programmes based on comparative study of the existing national accreditation systems for non-formal training was developed in order to find and propose the best structure applicable to the specific case of the geological disposal. Comparable criteria used in most European countries were identified that could constitute the framework for the accreditation of PETRUS training programme. Criteria for programme accreditation were categorised according to the 4 steps model generally used for management purpose consisting in input, process, output, and review. However no E&T within PETRUS II were accredited as such.

3.4.2 Accreditation in PETRUS III

One of the project's objectives was to embed the PETRUS training programme in a higher education system for accreditation purpose (implement the PETRUS training programme in at least one of the partner universities as a pathway for the obtainment of a Master degree with recognition agreements from other partners is targeted). Unfortunately, due to the postponement of the implementation of the ECVET system across Europe, it was not possible to effectively implement the programme from the administrative point of view. However, the project produced a prototype programme with an instructional plan assessed against Quality Assurance procedure and criteria. Accreditation of PETRUS programme through academic institutions seems to be the best way to guarantee its recognition at European level.

3.5 ELINDER – European Learning Initiatives for Nuclear Decommissioning and Environmental Remediation

(13 partners from 8 EU countries)

Decommissioning and site remediation of a nuclear facility refers to all technical and management actions associated with ceasing operation of a nuclear installation and its subsequent dismantling. This will finally lead to the release of the facility from regulatory control, including restoration of the site to the conditions existing before the construction of the plant. The availability of qualified and experienced personnel to support nuclear decommissioning is probably one of the most critical issues to address, the industry and organisations will face a significant shortage of competent personnel in this field.

ELINDER is a training and knowledge-sharing initiative to prepare specialists for the dismantling of present and future obsolete nuclear plants in Europe as they reach their end-of-life. The project is conceived as an integrated set of learning opportunities. The training programme in nuclear decommissioning is split into a set of complementary modules starting from a generic introduction to nuclear decommissioning to specific courses focussing on the different decommissioning activities. Each module includes lectures, practical hands-on exercises and case studies at the premises of the organising partners and visits to relevant facilities in the vicinity. In addition complementary e-

learning induction training modules are proposed to allow becoming familiar with the subject before participating to training in decommissioning.

To ensure a coherent and harmonised approach, shared minimum quality criteria including learning outcomes will be defined for acceptance of the course modules within the ELINDER programme and receiving the ELINDER stamp. For courses to qualify for the ELINDER stamp they have to have defined learning outcomes and prerequisites for the trainees, a coherent training programme with the learning outcomes and a training system adapted to the learning outcomes. Finally at the end of the course an assessment of the achievement of the learning outcomes and a satisfaction survey have to be organised.

3.6 ENETRAP project series – European Network on Education and Training in Radiological Protection

ENETRAP consists of three projects:

ENETRAP (11 Partners from 9 EU countries)

ENETRAP II (12 Partners from 12 EU countries)

ENETRAP III (13 Partners from 9 EU countries)

The Education & Training framework in radiation protection in EU is mainly inspired by its regulatory requirements. Although in principle the framework is the same in Europe, the implementation in each EU member state is different. In 2002 a large survey initiated by the European Commission showed that the national E&T programmes for experts showed often large differences in content, duration, level, the introduction of practical work, etc.

The ENETRAP project series focused on the policy and implementation of education and training in radiation protection, at the European and national level. The overall objective of these projects was to develop European high-quality "reference standards" and good practices for E&T in Radiation Protection (RP), specifically with respect to the radiation protection expert (RPE) and the radiation protection officer (RPO). These "standards" reflect the needs of the RPE and the RPO in all sectors where ionising radiation is applied.

The first ENETRAP project aimed at developing a harmonised approach in E&T in radiation protection, using the information of the ENETRAP survey, but also IAEA and local requirements. In the area of education, an international network of universities was founded to launch a European Master in Radiation Protection. In the domain of training, the delivery of a pilot session for the training in radiation protection and the recommendations to the EUTERP platform regarding the recognition of this training, especially for the qualified experts are the main achievements.

3.6.1 ENETRAP II

ENETRAP-II developed the European reference training scheme for RPEs, complying with specific requirements stipulated in the European basic safety standards, and taking into account European approaches in E&T such as the *European Credit System for Vocational Education and Training (ECVET) and European Qualifications Framework (EQF) principles*. This development takes into account the existing provisions and the needs expressed by the stakeholders in the different Member States. It also investigated the local implementation of E&T for RPOs, where it was difficult to find a harmonised approach due to the large variety in national implementation. Next to this, ENETRAP-II developed accompanying training material to support the training of RPEs and RPOs, and conducted

some pilot sessions. In addition, the mutual recognition of RPEs in Europe was studied. A suggestion was made for the introduction of a *European Training Passport*, and mechanisms to compare training materials and providers to facilitate mutual recognition were established.

In a pilot session during the ENETRAP II project, it was stated by participants and employers that international training events for RPE can only be attractive when endorsed and/or mutually recognised certificates, stamps or credit points are available.

3.6.2 ENETRAP III

ENETRAP III further developed the European reference training scheme with additional specialized modules for RPE working in the medical area, geological disposal and nuclear power plants or research reactors. It implemented the ECVET principles and investigated possibilities for targeted assistance from regulators which plays a crucial role in the endorsement of the proposed courses and learning objectives. All developed training modules were implemented in practice by organizing pilot sessions in different European countries. All training modules can be taken up in the European training passport of the trainee.

In addition, ENETRAP III also introduced a train-the-trainer strategy; a unique first-of-a-kind training topic in Euratom's E&T projects. All organized pilot sessions were open to young and more experienced students and professionals. In this way, ENETRAP III aims to contribute to increasing the quality of different actions involving transfer of knowledge and skills, facilitating competence building.

Defining the requirements for RPE and RPO and methodology for the recognition of RPEs:
Criteria for RPE recognition were developed following consultation with relevant stakeholder groups, such as the Heads of the Radiological Protection Competent Authorities (HERCA), Article 31 Group of Experts, European Commission, IAEA, IRPA, EUTERP and EFOMP. ENETRAP III demonstrated the practical feasibility of earlier developed concepts for mutual recognition (between four countries) and thus provided leading examples in Europe demonstrating effective borderless mobility. It based itself also on the ENETRAP III guidance document for implementation of E&T for RPE and RPO in accordance with the revised Euratom BSS.

Develop and apply mechanisms for the evaluation of training material, events and providers:
ENETRAP II aimed to facilitate the evaluation of training material and events, which resulted in a methodology where each provider can compare his material or event to the European reference RP training scheme (ERPTS). Quality criteria were developed that could be used as a European quality standard for training providers. If a training provider fulfils all these quality criteria the provider equals the European quality standard. The evaluation of training material and events is based on the evaluation of learning outcomes in three different categories: knowledge, skills and competences. The learning outcomes of ERPTS are described in the terminology of the levels of EQF.

Creation of a database of training events and training providers:
A database of training events and providers conform to the agreed standards was started in the ENETRAP II project, and further fine-tuned in the ENETRAP III project. The database was made public, adding credibility to the recognition process and helping to provide reassurance to RPE candidates and to employers that the training obtained satisfies an agreed European standard. This database also incorporates an overview of institutes hosting on-the-job-training possibilities. Special attention was given to internships in the stakeholders' organisations, with emphasis on coaching and/or mentoring schemes, whenever appropriate.

ENETRAP III took it one step further, and developed a web based platform including all relevant information regarding E&T in radiation protection, results of European projects, legal requirements and implementations at national level. With this website, for reasons of sustainability was built

further on the existing EUTERP website, ENETRAP III aimed at contributing to efficient knowledge transfer and capacity building in Europe and beyond. Links with other dissemination tools of i.e. IAEA were foreseen. The frame of the database is available to other groups and organisations dealing with E&T, offering a chance for efficient and harmonized dissemination of E&T information on courses, events and opportunities in Europe and beyond.

A major outcome from ENETRAP III was the 'Guidance for implementing E&T for Radiation Protection Experts and Officers', providing extremely important assistance to all Member States who are expected to transpose the Euratom Basic Safety Standards requirements into their national legislations. With the support of HERCA and other European authorities participating to the ENETRAP III Regulatory and end-user Consultancy Group, the effectiveness and helpfulness of this tool for the Member States is guaranteed.

For all activities mentioned above, the ENETRAP consortium strongly connected with all stakeholders, i.e. end-users, E&T providers, legal authorities, and to other relevant international organisations, groups and networks dealing with E&T in radiation protection.

3.7 MEDRAPET – Medical Radiation Protection Education and Training

(6 professional organisations as partners)

The objective is to provide an improved implementation of the Medical Exposure Directive provisions related to radiation protection E&T of medical professionals in the EU Member States. This is done through cooperation of the most relevant European umbrella organisations that represent national professional organisations and relevant regulatory authorities (e.g.: European Society of Radiology (ESR), European Federation of Organisations for Medical Physics (EFOMP), the European Federation of Radiographer Societies).

The outcomes of the projects are:

- EU-wide study on radiation protection training of medical professionals in the EU Member States;
- Organisation of a European workshop on radiation protection training of medical professionals in EU Member States;
- Development of a European guidance document on radiation protection training of medical professionals.

No E&T was organized within MEDRAPET however a study on E&T was conducted during the project. A questionnaire (web-based survey) was developed to obtain information on radiation protection E&T of health professionals in the EU Member States from a) national radiation protection authorities, b) professional and scientific societies and organisations whose members are working with ionising radiation on a daily basis and c) educational institutions related to graduate and post graduate education of health professionals. The main conclusion of the survey is that radiation protection E&T is far from being harmonized. Despite the Medical Exposure Directive's requirements it is in some instances in EU countries not even implemented.

The project concluded that a European body for accreditation in medical radiation protection is needed to promote radiation protection by evaluating and accrediting graduate, residency and CPD courses focused on medical radiation protection.

MEDRAPET developed a European Guidance document published by the European Commission (Radiation Protection Series, No 175) in February 2014 (Guidelines on Radiation Protection Education

and Training of Medical Professionals in the European Union), discussing accreditation, certification and recognition of medical E&T in radiation protection. The guidelines acknowledge the strong demand for new E&T courses in medical radiation protection due to the rapid development of medical techniques based on ionising radiation, growth of hospitals and the continuous need to produce competent health professionals. They also emphasise external assessment of the quality of E&T provision is needed through accreditation, certification and recognition processes, and that accreditation should be based upon established standards and guidelines from CEDEFOP.

3.8 EUTEMPE-RX – European Training and Education for Medical Physics in Radiology

(14 partners from 9 EU countries)

The main responsibility of the **medical physics expert** (MPE) is to ensure the optimal use of ionizing radiation for medical applications and to bring new knowledge and expertise from physics into healthcare. To fulfil this responsibility it is essential that these healthcare professionals are trained to the highest level, defined as EQF level 8 by the European Commission's 'Guidelines for the MPE'. These Guidelines have developed a harmonized qualification framework and specialised specific learning outcomes. While the basic training of medical physicists to EQF level 7 is established in most of the EC Member States, educational tracks for EQF level 8 i.e., the medical physics expert level, the future leaders in the profession, were missing.

The main objective of the EUTEMPE-RX project was to provide a model training scheme that allowed the medical physicist in diagnostic and interventional radiology (D&IR) to reach this high level. This would then give them all knowledge skills and competences to work at the best healthcare for the patients.

The learners that were targeted by the project are medical physicists with typically 2 years of practical experience in radiology in hospitals, medical device companies or nuclear authorities, PhD students in radiology physics and biomedical engineers working in radiology. The European training scheme had to address physicists from all over Europe and even beyond.

The project has developed 12 Modules at EQF level 8 for medical physicists in diagnostic and interventional radiology, with the greater part of each module delivered online, followed by a face-to-face instruction in the institution of the module leaders. The course modules used a blended learning scheme: each course aimed at 80 hours of active learning by the participants, divided between a preparation phases at home via online learning and onsite training in the institution of the module leader.

A purposely developed quality manual guided the project from the approval of the course abstract to the quality survey sent to the participants after the course. The manual consists of the following parts: scope and methods, definitions, the EUTEMPE-RX consortium, the definition of quality, the quality management system, and the quality operating procedures with their forms. Typical quality operating procedure forms are part of the quality manual.

Actions to achieve quality:

- Module leaders complete the module form (title of the module, teaching team, abstract, elements of the online phase, content of the face-to-face, teaching methods, assessment method, etc.), using a template;
- Accreditation request is sent to EFOMP, using a standard operating procedure;
- Material is prepared for online and face-to-face part (with scientist in coordination team);

- Web conferences (with E&T team of the KU Leuven);
- Online teaching is started, followed by the face-to-face phases;
- Assessment is done;
- Survey the participants for feedback;
- Web conference with module leaders, E&T team & educational board;
- Sending of assessment results to the participants.

Educational workshops were organized to familiarize the teachers with techniques of online teaching, e-learning, interacting with small groups and assessment methods.

The consortium ratified a sustainability plan to repeat the courses, and developed the EUTEMPE-net (European Network for Training and Education of Medical Physics Experts).

3.8.1 Accreditation

Accreditation bodies can use the guidelines presented in the EC guidelines on the Medical Physics Expert to evaluate the content of E&T programmes in medical physics offered by organisations such as professional and scientific societies, etc.

It is important to establish criteria for "mutual recognition" between EU Member States. If effective mutual recognition is to be achieved then there must be a good degree of commonality with respect to the key elements of, and criteria applied to, the various national schemes. The challenges were I) ensure sufficient flexibility for European Union Member States to establish systems for MPE recognition that can be readily accommodated within their national infrastructures, but also to II) ensure a degree of commonality sufficient to facilitate mutual recognition of the MPE between European Union Member States.

At the EUTEMPE-RX Consortium Meeting of March 2014, it was decided to ask the European Federation of Organisations for Medical Physics to explore the feasibility of establishing two new boards:

- *The European Board for Accreditation in Medical Physics* (EBAMP) which would be external to EFOMP for medical physics programmes and learning modules at the MPE level (EQF level 8). The EFOMP/EUTEMPE-RX working group established the EBMPA quality manual, setting out its operational procedures and protocols. The documents were approved by the EFOMP Council at its meeting in September 2015. EBAMP is operational since September 1st, 2016;
- *Examination board (EBB*) for the attestation and certification of MPEs that should then facilitate the recognition of participants as MPEs by the relevant national competent authorities. The EFOMP/EUTEMPE-RX working group prepared documentation for the set-up of the EFOMP Examination Board, the final documentation was approved by the EFOMP Council on the 10th of April 2016.

The realizations of EBAMP and EEB represent a success story of the EUTEMPE-RX project.

The projects sustainability

The courses are organised through EUTEMPE-net. Each course is accredited by the independent body EBAMP. It does this by allocating CPD credits depending on the number of hours of education and hands-on training required of participants.

Examination Board (EEB) introduces the European Diploma of Medical Physics (EDMP) and the European Attestation Certificate to those Medical Physicists that have reached the Medical Physics Expert level (EACMPE). EEB examinations are tests of excellence in Medical Physics. They are

designed to assess the knowledge, skills and competences requisite for the delivery of high standard Medical Physics services.

The EEB examinations are voluntary. EEB diplomas will not replace any national certificates. However, they will be a common European qualification for medical physicists and will help to standardise training and expertise in Medical Physics across Europe.

Medical physicists in European countries face difficulties in providing the necessary qualification evidence when they seek employment in other EU Member States or other countries. The EDMP will facilitate mobility of medical physicists in Europe and beyond. Furthermore, EEB provides an attestation certificate to those medical physicists that have reached the Medical Physics Expert level to be recognised by the relevant competent authorities of the EU.[2]

3.9 TRASNUSAFE – Training Schemes on Nuclear Safety Culture

(18 Partners from 9 EU countries)

To maintain high safety standards, specific training opportunities of high quality need to be offered to managers of both industrial and radiological installations, like nuclear power plants, radioactive waste repositories, radiotherapy department of hospitals, or components of the medical radioisotopes supply chain. It is the purpose of the TRASNUSAFE training modules to raise the knowledge and understanding of managers about safety culture in order to avoid incidents occurring as a result of human errors or organisational deficiencies and to develop adequate concern about the importance of radiological protection issues in the operation of facilities. Nuclear safety culture is based on knowledge and understanding, behaviour, research, experience feedback, training and communication, management commitment, assessments, as well as regulation and regulatory processes. Through this highly interactive training, the managers will better understand that their leadership is crucial in building, promoting and encouraging safety culture in the context of complex technical and organisational systems. They will also understand that nuclear safety culture is closely linked to economical operation and societal responsibility.

TRASNUSAFE designed, developed and validated two training schemes on nuclear safety culture with a common basis, for professionals operating at a high level of managerial responsibilities in nuclear installations. One training scheme was related to the nuclear industry, while the other was related to the installations making use of ionising radiation based technology. The topics of the modules, the training outcomes and the principles of the training methodology were selected at the beginning of the project by means of a survey widely spread over the European Union and a set of local seminars.

The survey on the needs for a high managerial level training in nuclear safety culture showed that organisations where safety training for managers were available, organise this as an internal training or with an external national organisation. On an international level, IAEA is one of the main providers of training. The durations of the training sessions are very variable, and the registration fees are none or mostly low, showing a not well developed market for training companies addressing individuals.

A majority of the survey participants prefers classroom style multiday sessions combined with homework and/or internet based training. A big consensus was noted on the need for an exam or test, and the need for a diploma or accreditation (over 80%), but many suggestions were expressed on non-traditional exams and on-the-job follow-up. Also a European recognition was demanded (70%).

The survey was completed by a set of five workshops, held in different parts of the European Union. The workshops enabled to discuss the training methodology in details, to define the learning

[2] Detailed information can be found at http://www.ebamp.eu

outcomes of the common generic module, and to select the four most promising topics for the specialised modules. The common basis was the generic module: “Managerial Competences and Leadership for Safety Culture”. The two modules oriented towards managers in the industry were: 'Compliance of contractors with safety systems' and 'Observation techniques', and the two towards the training needs of managers of the medical sector were: 'Economics of safety culture' and 'Setting up a management system'.

All modules, the generic and the four specialised, were taught in a highly interactive way, using problem solving session and case studies, involve facilitators and mentors. They were tested in pilot sessions, in the form of five European courses. After the pilot sessions, the design and methods have been revised with the help of the feedbacks. This closes the validation loop of the five training modules, which could then be considered as ready for professional operation at the end of the project

In addition, the idea of a European Passport acquired through training using the ECVET system is gaining interest.

3.9.1 Accreditation

It was agreed in one of the workshop that the training courses must be short (2 to 3 days) and highly interactive between the trainees and with the facilitators. Awarding a diploma or an accreditation is advisable, especially if many trainees come from the medical sector.

Instead of establishing a final test it would be better to give trainees an end of course assignment so that they prepare a final work about some issue related to the subjects explained and they send within one month to the coordinator to grade their course progress.

The operation and valorisation of the TRASNUSAFE training courses will take place under the umbrella of the ENEN Association taking into account the agreements set in its Consortium Agreement, the TRASNUSAFE Consortium will transfer the exclusive right to use the products to the ENEN Association and the moral obligation to valorise and maintain the products during 5 years.

ENEN, was in charge of the quality assessment of the project and proposed a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats).

Based on the experience of this project, the Coordinator suggested that to attract trainees from the medical sector the links with the Safety Authorities, and in particular obtaining their recognition for these course would be a major factor of attractiveness.

It was also pointed out that a clear definition of learning outcomes is of upmost importance to attract trainees and with short courses for managers extending over two or three days, an exam can best take place as a follow-up of the courses.

3.10 NUSHARE – Sharing Nuclear Safety Culture Competence

(9 partners from 5 EU countries)

The main objective was to develop and implement education, training and information programmes to strengthening competences required for achieving excellence in nuclear safety culture. Particular attention was being paid to lessons learned from stress tests conducted on all EU nuclear Power Plants in response to the Fukushima accident and to sharing best practices at the European level.

NUSHARE addresses the specific needs of different stakeholders in nuclear safety by the development and EU-wide dissemination of those programmes for three target groups:

- TG1- Journalists and civil society representatives;

- TG2 - Staff members of Nuclear Regulatory Authorities (NRAs) and Technical Safety Organisations (TSOs);
- TG3 - Electric utilities, systems suppliers, and providers of nuclear services at the level of responsible personnel, in particular managers.

The program was focused on the development of education, training and information concepts supporting the NUSHARE objectives and on the design of relevant basic European Education, Training and Information (ETI) programmes, the main product being a 'NUSHARE ETI catalogue'. The catalogue is supplemented by a plan of actions for the implementation, validation and optimization of pilot programmes and for their later EU-wide dissemination. The EIT programmes may range from short courses related to (nuclear) safety culture up to major programmes consisting of several modules designed for building the competences required.

3.10.1 - Journalists and civil society representatives

A workshop with European journalists to inform about, collect, provide and develop material on Nuclear Safety Culture made by journalists and for journalists and policy makers was set up. A Media Education Package [3] was created in order to provide material on Nuclear Safety culture written by journalists for journalists, always assessed by nuclear experts.

The World Federation of Science Journalists, WFSJ would identify the opportunities and needs for a Nuclear Media Educational program on Nuclear Safety Culture.

3.10.2 - Staff members of Nuclear Regulatory Authorities (NRAs) and Technical Safety Organisations (TSOs)

The rapid expansion of nuclear and radiation related activities in many countries highlighted the limited number of skilled and experienced experts available at NRAs and identified the need for using external technical expert support to ensure the availability of adequate technical competence necessary to fulfil regulatory responsibilities.

Basic Training Programme for new entrants and professional staff working at NRAs and TSOs was developed and was followed by the development of an Advanced Training Programme. The task was coordinated and implemented by the European Nuclear Safety Training and Tutoring Institute (ENSTTI). The objective of the Basic Training Programme was to strengthen nuclear safety, radiation protection and nuclear security, to foster a common nuclear safety culture by transferring specific knowledge and skills required to carry out efficiently and effectively regulatory functions, and to support the harmonization of regulatory excellence in the EU. The focus of the Basic Training Programme was on the legal framework and regulations, nuclear safety culture, technical concepts governing nuclear safety, nuclear security and radiation protection necessary for regulatory control of nuclear and radioactive materials in all their applications, regulatory practices and soft skills as well as international cooperation with a focus on best practices and sharing of nuclear safety culture.

The prerequisite for the Basic Training Programme is that the learner should have had a formal education to a level equivalent to a university degree in physics, chemistry, life sciences or engineering and should have been selected to work in the field of nuclear safety, radiation protection or nuclear safety at NRA or a technical support organisation.

[3] http://www.wfsj.org/nuclear/

The Standard Syllabus consists of five independent modules: an introductory module, with a focus on the historical background, and four thematic modules. Each module is divided into sessions. For each module the prerequisite is indicated as well as the learning outcomes:

- Module I: Legal and Regulatory Framework & Regulatory Functions;
- Module II: Technical Concepts governing Nuclear, Radiation and Waste Safety;
- Module III: Regulatory Oversight of Safety Culture;
- Module IV: Tutoring.

For each module, a list of practical training sessions will be suggested. These sessions were planned to be face-to-face or e-learning, work in groups or in pairs, simulation exercises, case studies or technical visits.

All Modules were evaluated by the trainees. The evaluation forms were treated through a standard ENSTTI process described in its quality management system

For Module I a standard multiple-choice exam was held on the final day.

To implement Module II, ENSTTI used its existing Introduction to Nuclear Safety course. The course was a twenty days training module covering all the major issues in nuclear safety, nuclear security and radiation protection. The module was evaluated by the Trainees. They were given a weekly evaluation of the individual technical chapters and working groups within that week. The participants were asked to grade both their interest in the topic and the quality of the knowledge and know-how transfer.

In module III two courses were given face-to-face. The first course objective was to provide the participants with understanding of the background of the concept of safety culture, related regulatory requirements and methods for assessment of safety culture. The participants learned about the importance of human and organisational factors and safety culture for nuclear safety. Module III aimed at professionals at NRAs and TSOs. The course is suitable for both newcomers and experienced practitioners with a technical background. The course was evaluated by the trainees in the same way as for module II.

Module IV took the form of a three month tutoring course. At the conclusion of the tutorial, the tutee's knowledge is verified by means of a comprehensive assessment to validate skills acquisition, as defined in the original program. Once this has been validated by a jury of experts, ENSTTI issues a 'Certificate of Competence'.

3.10.2.1 Accreditation

In all its training and tutoring activities, ENSTTI delivers Knowledge/Competence Certificate in line with ECVET Manual for the Conversion of Qualifications. ENSTTI uses the European Qualifications Framework. The Basic Training Programme which was used for the Pilot Test Case covers EQF levels from level 3 to level 5.

If the ECVET system were to be in place for nuclear and radiation safety assessors, a successful completion of the Basic Training Programme could credit them of 16 ECVET: 1 for Module I, 3 for Module II and 12 for Module III.

General comments:

European training has to be associated with a European reward (credit point, training passport) system to make it more attractive and useful for the trainee. The system could account not only for training but also for mobility periods or participation to international projects or expertise.

It appears that even if EU Directives address staff training at NRA and TSO, there are no guidelines, or not known guidelines, supplementing them on developing the staff competences in EU safety organisations. The absence of a standardised and organised system of competence building in Europe for staff from NRA and TSO is most detrimental for safety organisations from countries with no or small nuclear programme. The need of at least a common platform of information on capacity building/competence development for staff from EU NRAs and TSOs was pointed out.

3.10.3 - Electric utilities, systems suppliers, and providers of nuclear services at the level of responsible personnel, in particular managers

Top Managers of the European Nuclear Industry were targeted in TG3. This target group has very specific characteristics that require a tailor made design of the program. It is widely recognised that this target group is very much influential on the culture of the organisation, and particularly on the safety culture, and that they are suffering significant time limitations. The program had consequently to be adjusted to those limitations.

For the most effective learning approaches to the target group a combination of different approaches were selected: webinar, micro-e-learnings (E-Doceo), workshop with all the participants present, virtual meetings, mentors, facilitators, journal, personal action plans, etc.

With the final goal aiming to produce an important improvement in safety culture, a Personal Action Plan would be developed along the training with actions to be taken and some follow up measures.

Along the micro-e-learnings a “journal” was included by the use of reflection questions that were relevant for the elaboration of the Personal Action Plan. Recognising the importance of providing to the participants the opportunity to get together and share experiences a workshop was included in the program.

During the workshop the participants were supported of two mentors with practical experience in achieving important improvements in organisation/safety culture. The mentors with the help also of the facilitators supported the participants in their development of the Personal Action Plan. In the workshop it was determined how to follow up of the Personal Action Plan, in order to reinforce the achievement of the actions planned.

In the webinar launching the program the importance of emotional influence to support attitudinal changes was addressed in a motivational speech by a TEPCO manager.

For the Pilot Course top level managers was selected from organisations that were considered at a good level on safety culture with the role to provide feedback to improve the ETI Catalogue and its practical implementation.

For the First Program, as a new approach, the material, 'Top Nuclear Industry Leaders' Program on Culture for Safety was provided. Reaping the benefits of a deeper understanding of culture and leadership for safe and efficient performance was sent to all participants previously to the webinar. As a consequence of the comments of the participants in the pilot program a micro-mobile e-learning module "Creating an Environment of Trust" was added.

An additional test has been conducted with a Second Program, but this time inside own company. This is a significant difference with the Pilot and First Program that were open to many different organisations. Also this program got a positive assessment of the participants.

The ETI Catalogue was completed in terms of topics and learning outcomes, and contained 11 modules. Feedback was obtained from different recognised experts.

3.11 CORONA – Establishment of a Regional Centre of Competence for VVER Technology and Nuclear Applications

The safe and sustainable use of the nuclear energy requires operating staff that has adequate scientific and engineering capabilities. Correspondingly, the necessary regulating, engineering and technical support in all related fields should be available throughout the lifetime of a nuclear power plant. Training is essential, particularly when state-of-the-art science and technology must be implemented. Thus, access to high level E&T on the key matters has to be promoted and the availability of important knowledge and tools for its transfer should be guaranteed, in order to ensure the safe operation of nuclear power plants. Most of the EU Member States that operate VVER reactors (Water-Water Energetic Reactors) are relatively small and don't have the capability to individually manage such problems. For this reason it is necessary to improve and expand the methods for providing training in VVER technology to regional and also to EU extent. To meet these challenges the CORONA II project was launched.

CORONA consists of two projects:

CORONA I: Establishment of a Regional Centre of Competence for VVER Technology and Nuclear Applications (11 partners)

CORONA II: Enhancement of training capabilities in VVER technology through establishment of VVER training academy (8 partners from 6 EU countries)

3.11.1 CORONA I

The overall objective of the project was the establishment of a Regional Centre for Competence for VVER Technology and Nuclear Applications. The essence of the project was to provide a structure for the training and qualification needs of staff working with the VVER technology. Such an approach should allow unifying existing VVER related training schemes according to IAEA standards and commonly accepted criteria recognised in the EU.

During the three years of the project the following results were achieved:

- Establishment of a consortium, covering the whole spectrum of the nuclear area (nuclear industry, engineering companies, research institutes, universities and international organisations);
- Identification of the training needs for all target groups were identified;
- Implementation of pilot training schemes for the different target groups;
- Development of a training scheme for nuclear professionals and researchers, non-nuclear professionals and subcontractors, and students of nuclear study courses. The scheme also includes safety culture training;
- Evaluation of the scheme by means of pilot trainings for all target groups.

3.11.2 CORONA II

The project was focused on building a Europe-wide source for E&T and knowledge preservation in the VVER technology area. Providing tools for cross-border E&T and unite countries across Europa on a common platform.

The more specific objective of the project was to continue the development of a state-of-the-art regional training network for VVER competence (called CORONA Academia), already started under CORONA I, which focused on master's degree programmes.

A pilot implementation of the ECVET system was also planned as part of the project.

During the first 18 month of the project the following results were achieved:

- Development of the updated training schemes description and the updated training programs for non-nuclear professionals and subcontractors;
- Elaboration of an action plan for the completion of the training materials;
- For the implementation of ECVET: Selection of one particular job for a pilot implementation;
- Definition of the competence requirements for the qualification;
- Creation of an information platform for CORONA training;[4]
- Identification of an existing e-learning training platform which will be used to further disseminate the distance training courses: "Cyber Learning Platform for Network Education and Training" (CLP4NET), by IAEA;[5]
- Creation of a project website.[6]

The proposed CORONA Academia will maintain the nuclear expertise by gathering the existing and generated new knowledge in the VVER area. It shall bring together the most experienced trainers in the different aspects of the area within EU and abroad, thus overcoming the mobility challenge that stands ahead the nuclear E&T community. The selected form of the CORONA Academia, together with the online availability of the training opportunities shall allow trainees from different locations to access the needed knowledge on demand. The available set of courses shall cover the whole range of training of VVER specialists from the university until reaching high professional skills and competences in the area.

3.11.2.1 Accreditation

There is no mention of the sort of accreditation of the training in the various descriptions of the CORONA II project but it is emphasised several times that the implementation of ECVET in the sectors of nuclear fission and radiation protection is particularly important in all E&T actions under EURATOM.

3.12 ECNET – EU-CHINA – Nuclear Education and Training Cooperation

(18 partners from 7 EU countries)

The general objective of the ECNET project was to coordinate the cooperation between the EU and China in the field of Nuclear Education, Training and Knowledge Management in three areas: Nuclear Engineering, Radiation Protection and Nuclear Waste Management and Geological Disposal. For each of the areas the framework, the objectives and the strategy for long term cooperation are described.

For Nuclear Engineering a description of the current nuclear energy status in the EU, the assessments of the current manpower and the future needs, the response and funding provided by Governments, industries, nuclear education networks and the actions by national regulatory bodies is given. The organisation of nuclear E&T is described, not only at the higher education levels, but also at the craftsman and technical level, as well as initiatives to "nuclearize" non-nuclear professionals. Lack of input from the Chinese side on nuclear engineering E&T in this project prevented any detailed reporting.

[4] http://vverportal.com/information/
[5] http://clp4net-nkm.iaea.org/index.html
[6] http://corona2.eu

In Radiation Protection E&T an elaborate review of the international safety standards covering radiation protection and the professionals in charge of its implementation is provided. Detailed information is provided on the EU and national legislation and directives, the regulator coordination and cooperation bodies, as well for the nuclear industry and the research facilities, as for the protection of the patients and staff in the medical nuclear sector. The expected development and coordination at European level is described, with the detailed qualifications and E&T needs for the two qualified staff categories, the Radiation Protection Expert and the Radiation Protection Officer.

With respect to Nuclear Waste Management and Geological Disposal, a review of national policies, research and demonstration facilities and the associated opportunities for E&T is provided. The PETRUS concept is presented, drawing students from different disciplines (mining, geology, construction, hydrology, engineering, etc.) into a common set of courses and a thesis work addressing specific nuclear waste management and disposal issues. The Chinese education system and higher education system is analysed with a view on the needs for professionals in the current Chinese nuclear waste management and disposal policy. A proposal for cooperation between the EU and China in this field is developed and described in detail.

3.12.1 Accreditation

In order to enhance mobility of students in nuclear sciences between China and Europe, it is of paramount importance to establish a common recognition of the crediting system to evaluate student's work. In Europe, universities have set up the Bologna Process crediting system – ECTS. One part of the project goal was to setting up a mutual recognition of credit systems for academic education (ECTS) and vocational training (ECVET) between European and Chinese universities.

Attention must be given to validation of credits acquired from the courses followed in the host University. For this purpose, several agreements must be signed by the two parties including financial terms. In the learning agreement more detailed information concerning the courses and notably the number of ECTS must be reported. Actual attendance and the amount of the Credit earned (both local and converted to the home system) must be recorded in an 'Evaluation Certificate'. The validity of this document must be first agreed by both sides through an official agreement.

Most European universities have been signing formal agreements with counterparts in China in the past years. Several agreements are proving to be quite effective for student exchanges. The possibility to reach and to establish a formal agreement leading to a double degree is proved, for instance, by the agreement that has been signed between Politecnico di Torino and Shanghai JaoTong University for granting a double degree in Electric/Energy and Nuclear Engineering. These existing agreements could serve as the basis for future similar agreements between European universities or consortia, such as ENEN, and Chinese institutions.

3.13 ENEN-RU II - Strengthening of Cooperation and Exchange for Nuclear Education and Training between the European Union and the Russian Federation

17 partners from 9 EU countries

The project consisted of two parallel projects on the EU side and the Russian side.

Linking with high-level Russian stakeholders in the nuclear sector, the initiative built on the earlier ENEN-RU project to further enhance bilateral nuclear energy activities and benefit both regions. With this goal in mind, the project partners analysed the nuclear energy landscape in the EU and Russia to identify barriers and opportunities for sustainable collaboration.

The objective was to harmonise E&T programmes between both regions at the Master's degree and PhD level, as well as for young professionals. Opportunities for cooperation were identified and taken up through joint collaboration at the Masters level through credit system agreements, joint courses and university exchanges. This included the study of a joint EU-Russian Federation MSc certificate in the field of nuclear engineering. In addition, PhD level students conducted joint lines of research based on established doctorate stages, whilst young professionals took part in joint training programmes.

Agreement on credit systems, online databases and the coordinated sharing of information through the forum and the website was achieved through the knowledge management framework. This provided the basis for the mutual recognition of E&T programmes between the EU and the Russian Federation and extended the scope of the student, researcher and young professional exchanges. This offered nuclear research centres and industry a wider basis for human resources and promoted cooperation in nuclear energy development

Sustainable mechanisms for short-term and long-term cooperation were established through a permanent E&T Forum. This was reinforced by several bilateral collaboration agreements among the participants and an online database (of infrastructures and E&T facilities). Coordination was successful through the sharing of information on the website, with the main objective to map E&T facilities, laboratories and equipment for exchange purposes in EU and Russia, as well as clarify access rules and procedures. The database offers the possibility of storing and accessing all this information in a structured way. The database (www.enenru-db.net) is available to all the ENEN-RU II project partners. Upon request, access can be granted to students of nuclear engineering from EU countries and Russia. Representatives of any E&T facilities, laboratories and equipment from EU and Russia can also acquire access of the database, enabling them to check and add relevant information to ensure the high quality of the collected data.

3.13.1 Accreditation

An analysis of the existing, in the framework of ENEN Association, European Master in Nuclear Engineering (EMSNE), showed that the mutual recognition of the nuclear education at master level for Russian graduates could be based on a common certificate fulfilling the requirements of EMSNE, based on the graduate’s achievements regarding duration of studies, number of total and nuclear credits specialization and mobility.

Mutual recognition of nuclear E&T should be based on common certificate, generically named REMSNE (Russian-European Master of Nuclear Engineering certificate). Establishment of REMSNE will allow and strengthen the mobility of students and exchanges between EU and Russian universities.

The REMSNE Board is composed by ENEN, National Research Nuclear University MEPhI in Russia and possibly ROSATOM members. This Board will also become a continuation of the ENEN-RU Forum.

It was concluded that both credit systems are compatible: the European Bologna process and ECTS together with the Russian credit system at university level.

ENEN-RU II will improve the mobility of personnel researching nuclear energy, as well as enhance access to facilities, laboratories and equipment for European and Russian students.

3.14 EURECA! - Cooperation between EU and Canada in Education, Training and Knowledge Management on Super-Critical Water Reactors

The EU and Canada work on the Super-Critical Water-cooled Reactor (SCWR), a reactor concept selected by the Generation-IV International Forum because of the advantages regarding safety and sustainability.

The EURECA! project, being a collaboration between the EU and Canada, will define an international sector, (ii) attracts young graduates and professionals in other sectors to work in the nuclear field and (iii) enhances the mobility of professionals in the EU and Canada.

The project focuses on the innovative SCWR concept and paves the way for future collaboration between the EU and Canada on this reactor type. Although the SCWR is still a conceptual reactor, the level of knowledge and skills regarding current, water-cooled reactors will be improved and ensured as well, since the concepts and technology of the SCWR are close to the ones of conventional water-cooled nuclear plants.

The EURECA! project consists of a European organisational branch (consisting of EU participants), and a mirrored, Canadian organisational branch (consisting of Canadian participants). Although financially separated, both branches will have a strongly symbiotic, collaborative relationship.

3.15 GENTLE - Graduate and Executive Nuclear Training and Lifelong Education

(11 partners from 10 EU countries)

The GENTLE Coordination and Support Action is a joint effort by leading academic and research institutions in Europe to coordinate an E&T programme in the field of nuclear fission technology. The consortium has as goal to create a sustainable lifelong E&T programme in the field of Nuclear Fission Technology that meets the needs of the European stakeholders from industry, research and technical safety organisations. Specifically, the GENTLE project aimed at the successful implementation of the following joint E&T tools:

- Student research experiences grants (SREs) to facilitate students from the universities to get hands-on experience in Europe's unique and specialised academic, research and industrial laboratories;
- Intersemester courses for graduate and post graduate students on special industry related topics. A set of eight courses was defined in detail. Four inter-semester courses, on (a) Nuclear Waste (b) Nuclear decommissioning c) Reactor techniques and d) Thermal hydraulics phenomena were held at the different places. They were attended by respectively 18, 4, 6 and 19 students/young professionals of different countries and institutions (universities, research centres, etc.);
- An executive master course on Nuclear Energy Systems (e-MNS) for young professionals working in, among others, industry, consultancy companies or regulatory bodies, to enhance their knowledge of nuclear reactors and fuel cycles was provided. Due to lack of applicants from Europe the approach was changed. To enhance the interest in nuclear education an approachable form of education is chosen, a Massive Open Online Course (MOOC) "Understanding Nuclear Energy". The MOOC will inform and enhance the understanding about nuclear science and nuclear energy to the general public and provide a general introduction to nuclear energy, both from a societal, economical and technical point of view. The MOOC was made with second year technical-bachelor students in mind, but is online open and free to everyone. Next to guarantee

new comers, the MOOC can be used as a marketing tool and will be durable by easily reruns. The MOOC is available through the edX platform.[7]

3.15.1 Accreditation

The GENTLE intersemester courses were accredited three ECTS. In general an attendance and a successful test certificate were released, which the university of the student then converted into ECTS according to their internal criteria.

For the MOOC course a certificate can be given after fulfilled course.

3.16 ANNETTE - Advanced Networking for Nuclear Education and Training and Transfer of Expertise

(25 partners from 12 EU countries)

The ANNETTE Project is a European Horizon 2020 project that is co-funded by the European Commission under the Euratom Research and Training Programme on Nuclear Energy within the H2020 Programme, Grant Agreement Number 661910. The ANNETTE Project started at the beginning of 2016, and will be run until the end of 2019.

The project description of ANNETTE states that "the present situation of nuclear energy in Europe asks for a continuing effort in the field of E&T aimed to assure a qualified workforce in the next decades. In this scenario, ANNETTE is aimed at enhancing and networking the Europe-wide efforts initiated in the past decades by different organisations belonging to academia, research centers and industry to maintain and develop E&T in the nuclear fields. This will allow consolidating, developing and better exploiting the achievements already reached in the past and to tackle the present challenges in preparing the European workforce in the nuclear fields."[8]

Its main objective is to set up a major coordination of nuclear E&T in Europe in different nuclear fields (like nuclear safety and engineering, radiation protection, waste management and geological disposal, and also fusion), with a long-lasting impact through a sustainable structure of courses delivered by different course providers. ANNETTE, as a project that is coordinated by the European Nuclear Education Network (ENEN), is sharing with this Association the mission to contribute effectively to maintaining and developing high level competences in the nuclear fields in Europe.

To achieve its mission, ANNETTE addresses various topics in which following main results are already achieved:

- Survey and Coordination of Networking in E&T and Vocational Education and Training (VET) in the Nuclear Area. The broad inquiry which was launched among institutions involved in nuclear E&T in Europe, allowed gathering interesting comments and suggestions about the needs for the delivery of specific courses and for setting up an advanced networking;
- Design and implementation of coordinated E&T and VET efforts, i.e. Master and Summer Courses for continuous professional development. The ultimate objective of ANNETTE is to create a permanent structure in which the first core of courses collected during the project will be progressively enriched and adapted to the evolving needs of nuclear industry and research;

  The perspective about the needs for courses to be deployed in continuous professional development (CPD) changed progressively via the analysis of the outcomes of the multiple contacts with Stakeholders. The initial idea of a conventional 'second level master' in which

[7] https://www.edx.org/course/understanding-nuclearenergy-delftx-nuclear01x-0
[8] http://www.enen.eu/en/projects/annette.html

professionals should engage for a full year to become experts in the nuclear field was reconsidered in view of the present context of the job market in Europe and of the industrial needs. Short and focused courses, which support professionals in developing the knowledge and skills required to work in the nuclear field in full compatibility with their professional activities, are considered instead. The European Courses for CPD are being advertised on the website and distributed to ENEN members in Monthly Bulletins;

A certification (final or intermediate) released under ENEN is preferred by the stakeholders. This ENEN label will have no legal value in any of the European member states. The supranational certification will be based on consensus and mutual trust instead of being recognised by any of the EU Member States. This certification system is under development;

The ANNETTE Summer School on Nuclear Technology, Nuclear Waste Management and Radiation Protection took successfully place on 24-30 June 2018 in Turku, Finland;

The successful establishment of master and summer courses to be launched and maintained also beyond the end of the project under the aegis of the ENEN and in cooperation with Stakeholders, will be one of the long-lasting impacts of the project;

- Generational transfer of expertise, i.e. sustainable production of educational material. The specific needs for E&T material in various domains are identified. An internal quality assessment of the provided E&T material will be made by ENEN members;
- Cross border transfer of expertise, i.e. implementation of ECVET based exchanges among industrial organisations. The experiment of cross-border mobility of nuclear professionals, following ECVET principles and rules, represents a valuable contribution to accomplish a better and more systematic exchange of professionals between different countries and companies. The difficult task of organising real cross-border mobility was successfully tackled in two exchanges between two industrial partners;
- Reinforcing Education, Training and Information actions for sharing and enhancing nuclear safety culture competence. The feedback from the recently completed NUSHARE project was used to orient the future offer of courses related to nuclear safety culture, a relevant issue in the management of the nuclear activities;
- Facilitating the nuclear transition in fusion, by coordinating the necessary E&T action. A specific group of Stakeholders involved in on-going fusion projects specified the needs for nuclear competences in these fusion projects. The results were used to identify E&T required for development of these competences, and subsequently to investigate which E&T is already available, which gaps still exist and which courses could be adapted;
- Interaction with technology platforms and other bodies. Documenting Platforms and Stakeholders in a systematic way was done during various initiatives and during organized specific meetings.

4 SUMMARY

This document provides an overview of ongoing and past projects on vocational European Fission Training schemes and their accreditation. The important number of initiatives for the nuclear sector described above highlights the importance of harmonising the E&T systems while proposing mutual actions between European institutions and beyond. While it is rather easy to set up training scheme, certification remains difficult to achieve across Europe. In particular, we still a lot to do for certification in the framework of the ECVET system.

The overview will support the further actions in Work Package 5 of the ENEN Plus project targeting at a consolidation of vocational EFTS through voluntary accreditation.

4.1 NEPTUNO – The Nuclear European Platform of Training and University Organisations

In NEPTUNO project the European Master of Science in Nuclear Engineering certification and its essential base elements of mutual recognition, international exchange courses and student mobility was fully implemented.

It was also stressed that criteria for the evaluation of the training programmes should refer to the Systematic Approach to Training (SAT) concept.

In meeting with the nuclear industries it was recognised, that it would be very useful to have a training programme assessment body.

Harmonisation is needed in particular at lower level job positions and should be based on the transferability of skills, for example by an employment passport.

4.2 ENEN III – European Nuclear Engineering Network Training Schemes

In the ENEN III project E&T schemes have been developed, according to the SAT model, for the four generic categories.

The ENEN-III project adopted to the full extent the concept of ECVET, several hundred learning outcomes have been described and hundreds of courses and training sessions, covering them, have been listed. One of the latter phases in the ENEN III accreditation process is the delivery of pilot courses.

A step-wise approach to accreditation would be a logical approach to accreditation i.e. initially accreditation at national level with subsequently harmonization across Member States. Consulting the European Quality Assurance Reference Framework (EQARF) would be a sensible first approach. For the Nuclear Skills Passport Concept three options of format were recommended.

4.3 CINCH II + MEET CINCH- Cooperation and training in Education in Nuclear Chemistry

The CINCH II project aimed at mitigating the special skill-based deficits within nuclear chemistry at masters and doctorate levels. The project was built around the SAT methodology. While CINCH-I dealt with the first three phases of the process, CINCH-II concentrated on the implementation. Additionally, evaluation mechanisms were proposed and tested on the pilot courses developed during the projects.

The main results of CHINCH II were the implementation of the NRC EuroMaster quality label system and the establishment of a European Network on Nuclear and Radiochemistry Education and Training (European NRC Network). The Division on Nuclear and Radiochemistry (DNRC) of European

Association for Chemical and Molecular Sciences (EuCheMS) became a guarantor of the NRC EuroMaster label. Significant efforts were devoted to the development of the internationally recognised Training Passport in Nuclear Chemistry.

The objective of MEET-CINCH, is to develop the training materials and training platforms needed for the implementation of the NRC EuroMaster. In order to maintain European nuclear operations, expertise in nuclear and radiochemistry (NRC) is of strategic relevance. MEET-CINCH mainly aims at European Qualifications Framework (EQF) level 7, i.e. academics and students at BSc /MSc level and beyond.

4.4 PETRUS II+ III - Towards an European training market and professional qualification in geological disposal

The ECVET principles were used to develop a competence-based curriculum for the elaboration of the radioactive waste disposal Professional Development training programme.

Using a methodological approach in connection with European Qualifications Framework (EQF) and European Quality Assurance in Vocational Education and Training (EQAVET) the profile of a safety engineer specialized in assessment and safety analysis was established and the corresponding Learning Outcomes were developed. A voluntary partnership agreement (Memorandum of Understanding[9]) was established where E&T mobility is concluded between competent bodies. For each mobility period a Learning Agreement (LA) was established.

Criteria for programme accreditation in PETRUS II were categorised according to the 4 steps model generally used for management purpose consisting in input, process, output, and review. However no E&T within PETRUS II were accredited as such.

One of the objectives of PETRUS III was to embed the PETRUS training programme in a higher education system for accreditation purpose. Unfortunately, due to the postponement of the implementation of the ECVET system across Europe, it was not possible to effectively implement the programme from the administrative point of view. However, the project produced a prototype programme with an instructional plan assessed against Quality Assurance procedure and criteria. Accreditation of PETRUS training programmes through academic institutions seems to be the best way to guarantee its recognition at European level.

4.5 ELINDER - European Learning Initiatives for Nuclear Decommissioning and Environmental Remediation

The training programme in nuclear decommissioning is split into a set of complementary modules starting from a generic introduction to nuclear decommissioning to specific courses focussing on the different decommissioning activities.

To ensure a coherent and harmonised approach, shared minimum quality criteria including learning outcomes will be defined for acceptance of the course modules within the ELINDER programme and receiving the 'ELINDER stamp'.

4.6 ENETRAP project series - European Network on Education and Training in Radiological Protection

The E&T framework in radiation protection in EU is mainly inspired by its regulatory requirements. Although in principle the framework is the same in Europe, the implementation in each EU member state is different. The ENETRAP project series focused on the policy and implementation of E&T in radiation protection, at the European and national level. The overall objective of these projects was

[9] PETRUS-III PROJECT, Deliverable: D.1.6, Memorandum of Understanding: http://www.enen.eu/en/projects/petrus-iii/petrus-iii-deliverables.html

to develop European high-quality reference standards and good practices for E&T in Radiation Protection (RP), specifically with respect to the radiation protection expert (RPE) and the radiation protection officer (RPO). These standards reflect the needs of the RPE and the RPO in all sectors where ionising radiation is applied.

The first ENETRAP project aimed at developing a harmonised approach in E&T in radiation protection, using the information of the ENETRAP survey, but also IAEA and local requirements. In the domain of training, the delivery of a pilot session for the training in radiation protection and the recommendations to the EUTERP platform regarding the recognition of this training, especially for the qualified experts are the main achievements.

ENETRAP-II developed the European reference training scheme for RPEs, complying with specific requirements stipulated in the European basic safety standards, and taking into account European approaches in E&T such as the ECVET and EQF principles. Next to this, ENETRAP-II developed accompanying training material to support the training of RPEs and RPOs, and conducted some pilot sessions. In addition, the mutual recognition of RPEs in Europe was studied. A suggestion was made for the introduction of a European Training Passport. A database of training events and providers conform to the agreed standards was started in the ENETRAP II project, and further fine-tuned in the ENETRAP III project. The database was made public, adding credibility to the recognition process.

ENETRAP III further developed the European reference training scheme with additional specialized modules for RPE working in the medical area, geological disposal and nuclear power plants or research reactors. All developed training modules were implemented in practice by organizing pilot sessions in different European countries. In addition, ENETRAP III also introduced a train-the-trainer strategy; a unique first-of-a-kind training topic in Euratom's E&T projects. A major outcome from ENETRAP III was the document "Guidance for implementing E&T for Radiation Protection Experts and Officers"[10], providing extremely important assistance to all Member States who are expected to transpose the Euratom Basic Safety Standards requirements into their national legislations.

4.7 MEDRAPET - Medical Radiation Protection Education and Training

MEDRAPET developed the European Guidance document "Guidelines on Radiation Protection Education and Training of Medical Professionals in the European Union".[11] The guidelines acknowledge external assessment of the quality of E&T provision is needed through accreditation, certification and recognition processes, and that accreditation should be based upon established standards and guidelines from CEDEFOP.

4.8 EUTEMPE-RX - European Training and Education for Medical Physics Experts (MPE) in Radiology

The main objective of the EUTEMPE-RX project was to provide a model training scheme that allowed the medical physicist in diagnostic and interventional radiology to reach EQF level 8.

The consortium ratified a sustainability plan to repeat the courses, and developed the EUTEMPE-net (European Network for Training and Education of Medical Physics Experts)[12].

EUTEMPE-RX Consortium together with European Federation of Organisations for Medical Physics (EFOMP) established two new boards:

- The European Board for Accreditation in Medical Physics (EBAMP) being external to EFOMP for medical physics programmes and learning modules at the MPE level. The EBMPA quality manual

[10] http://euterp.eu/uploaditems/ENETRAPIII/ENETRAP-III-European-Guidance-Document-01-03-2016.pdf
[11] Guidelines on Radiation Protection Education and Training of Medical Professionals in the European Union; Luxembourg: Publications Office of the European Union, 2014; ISBN 978-92-79-36420-4; doi 10.2833/19786
[12] http://eutempe-net.eu/

was established by the EFOMP/EUTEMPE-RX working group, operational procedures and protocols was set up;

- Examination board (EBB) for the attestation and certification of MPEs that facilitate the recognition of participants as MPEs by the relevant national competent authorities.

The realizations of EBAMP and EEB represent a success story of the EUTEMPE-RX project.

The courses are organised through EUTEMPE-net. Each course is accredited by the independent body EBAMP, by allocating Continuous Professional Development credits. The Examination Board introduces the European Diploma of Medical Physics (EDMP) and the European Attestation Certificate to those Medical Physicists that have reached the Medical Physics Expert level (EACMPE). EEB diplomas will not replace any national certificates. However, they will be a common European qualification for medical physicists and will help to standardise training and expertise in Medical Physics across Europe.

4.9 TRASNUSAFE - Training Schemes on Nuclear Safety Culture

In TRASNUSAFE, two training schemes on nuclear safety culture have been designed, developed and validated for managers for both the nuclear industry and the radiological sector (including medical).

ENEN, was in charge of the quality assessment of the project.

4.10 NUSHARE - Sharing Nuclear Safety Culture Competence

In the NUSHAR project five modules were developed: an introductory module, with a focus on the historical background, and four thematic modules.

In all its training and tutoring activities, ENSTTI delivers Knowledge/Competence Certificate in line with ECVET Manual for the Conversion of Qualifications. ENSTTI uses the European Qualifications Framework. The Basic Training Programme which was used for the Pilot Test Case covers EQF levels from level 3 to level 5.

If the ECVET system were to be in place, a successful completion of the Basic Training Programme could credit 16 ECVET.

4.11 CORONA - Establishment of a Regional Centre of Competence for VVER Technology and Nuclear Applications

The objective of the project was to continue the development of a state-of-the-art regional training network for VVER competence.

There is no mention of the sort of accreditation of the training in the various descriptions of the CORONA II project but it is emphasised that the implementation of ECVET in the sectors of nuclear fission and radiation protection is particularly important in all E&T actions under EURATOM.

4.12 ECNET EU-CHINA – Nuclear Education and Training Cooperation

In order to enhance mobility of students in nuclear sciences between China and Europe, it is of paramount importance to establish a common recognition of the crediting system to evaluate student's work.

Most European universities have been signing formal agreements with counterparts in China. These existing agreements could serve as the basis for future similar agreements between European universities or consortia, such as ENEN, and Chinese institutions.

Another initiative set up several years ago is the French-Chinese Institute of Nuclear Energy IFCEN (Sun Yat-Sen University) where French teachers are delivering their lectures in China while many Chinese students are joining France for internships and PhD studies.

4.13 ENEN-RU II - Strengthening of Cooperation and Exchange for Nuclear Education and Training between the European Union and the Russian Federation

The knowledge management framework provided the basis for the mutual recognition of E&T programmes between the EU and the Russian Federation.

Sustainable mechanisms for short-term and long-term cooperation were established through a permanent E&T Forum.

Mutual recognition of nuclear E&T should be based on common certificate, generically named REMSNE (Russian-European Master of Nuclear Engineering certificate). The REMSNE Board is composed by ENEN, National Research Nuclear University MEPhI in Russia and possibly ROSATOM members. This Board will also become a continuation of the ENEN-RU Forum.

4.14 GENTLE - Graduate and Executive Nuclear Training and Lifelong Education

The GENTLE project aimed at the successful implementation of the E&T tools:

- Student research experiences to get hands-on experience;
- Intersemester courses for graduate and post graduate students on special industry related topics;
- Executive master course on Nuclear Energy Systems for young professionals;

The GENTLE intersemester courses were accredited three ECTS. In general an attendance and successful test certificate were released, which the University of the Student then converted into ECTS according to their internal criteria.

4.15 ANNETTE - Advanced Networking for Nuclear Education and Training and Transfer of Expertise

The ultimate objective of ANNETTE is to create a permanent structure in which the courses collected during the project in different nuclear fields (like nuclear safety and engineering, radiation protection, waste management and geological disposal, and also fusion) will be progressively enriched and adapted to the evolving needs of nuclear industry and research.

A certification (final or intermediate) released under ENEN is preferred by the stakeholders. This ENEN label will have no legal value in any of the European member states. The supranational certification will be based on consensus and mutual trust instead of being recognised by any of the EU Member States.

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List of abbreviations and definitions

ANNETTE	Advances Networking for Nuclear Education and Training and Transfer of Expertise
BSS	Basic Safety Standards Directive (Euratom)
CEDEFOP	European Centre for the Development of Vocational Training
CINCH	Cooperation in Education in Nuclear Chemistry
CLP4NET	Cyber Learning Platform for Nuclear Education and Training
CORONA	Establishment of a Regional Centre of Competence for VVER Technology and Nuclear Applications
CPD	Continuous Professional Development
CV	Curriculum Vitae
D&IR	Diagnostic and Interventional Radiology
DNRC	Division on Nuclear and Radiochemistry
E&T	Education and training
EACMPE	European Attestation Certificate on Medical Physics Expert Level
EANT	European Academy for Nuclear Training
EBAMP	European Board for Accreditation in Medical Physics
EBB	Examination Board
ECNET-EU-CHINA	Nuclear Education and Training Cooperation: Mirror Project to be Financed by the Chinese Atomic Energy Authority
ECTN	European Chemistry Thematic Network
ECTS	European Credit Transfer System
ECVET	European Credit System for Vocational Education and Training
EDMP	European Diploma of Medical Physics
EFOMP	European Federation of Organisations for Medical Physics
EFTS	Euratom Fission Training Schemes
ELINDER	European Learning Initiatives for Nuclear Decommissioning and Environmental Remediation
e-MNS	Executive Master Course on Nuclear Energy Systems

EMSNE	European Master in Nuclear Engineering
EMSNEC	European Master of Science in Nuclear Engineering Certificate
ENEB	European Nuclear Evaluation Board
ENEN	European Nuclear Education Network
ENEN-RU	Strengthening of Cooperation and Exchange for Nuclear Education and Training Between the European Union and the Russian Federation
ENETRAP	European Network on Education and Training in Radiological Protection
ENSTTI	European Nuclear Safety Training and Tutoring Institute
EQARF	European Quality Assurance Reference Framework
EQAVET	European Quality Assurance in Vocational Education and Training
EQCM	European Quality Charter for Mobility
EQF	European Qualifications Framework
ERPTS	European Reference Radiation Protection Training Scheme
ESCO	European terminology on Skills, Competences, Qualifications and Occupations
ESR	European Society of Radiology
ETI	Education, Training and Information
EuCheMS	European Association for Chemical and Molecular Sciences
EURECA	Cooperation between EU and Canada in Education, Training and Knowledge Management on Super-Critical Water Reactors
EUTEMPE-RX	European Training and Education for Medical Physics Experts in Radiology
EUTERP	European Training and Education in Radiation Protection Foundation
FP5	European Union's Research and Innovation funding programme for 1998 - 2002
FP6	European Union's Research and Innovation funding programme for 2002 - 2006
GENTLE	Graduate and Executive Nuclear Training and Lifelong Education
HERCA	Heads of the Radiological Protection Competent Authorities
IAEA	International Atomic Energy Agency
IAEA OSART	International Atomic Energy Agency – Operational Safety Review Team

IRPA	International Radiation Protection Association
KSC	Knowledge. Skills, Competences
LA	Learning Agreement
LO	Learning Outcomes
MEDRAPET	Medical Radiation Protection Education and Training
MEET-CINCH	Modular European Education and Training Concept in Nuclear and Radiochemistry
MOOC	Massive Open Online Course
MPE	Medical Physics Experts
NARIC	National Academic Recognition Information Centre (UK)
NEF	New Engineering Foundation
NEPTUNO	Nuclear European Platform of Training and University Organisations
NRA	Nuclear Regulatory Authority
NRC	Nuclear and Radiochemistry
NRC EuroMaster	European Master's Degree in Nuclear Chemistry
NSAN	National skills Academy Nuclear
NUSHARE	Sharing Nuclear Safety Culture Competence
PETRUS	Towards an European Training Market and Professional Qualification in Geological Disposal
REMSNE	Russian-European Master of Nuclear Engineering Certificate
ROSATOM	State Atomic Energy Corporation (Russian Federation)
RP	Radiation Protection
RPE	Radiation Protection Expert
RPO	Radiation Protection Officer
SAT	Systematic Approach to Training
SCWR	Super-Critical Water-Cooled Reactor
SRE	Student Research Experience Grant
SWOT	Strength, Weakness, Opportunities and Threats

TEPCO	Tokyo Electric Power Company
TRASNUSAFE	Training Schemes on Nuclear Safety Culture
TSO	Technical Safety Organisation
VET	Vocational Education and Training
VVER	Water-Water Energetic Reactor
WANO	World Association of Nuclear Operators
WFSJ	World Federation of Science Journalists

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