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

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ABSTRACT

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

1. Introduction

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

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

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

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

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

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

Table 1: Nuclear pilot projects testing ECVET features

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

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

2. Pilot implementation of ECVET approach in CORONA II project

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

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

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

2.1. RPW qualification selection

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

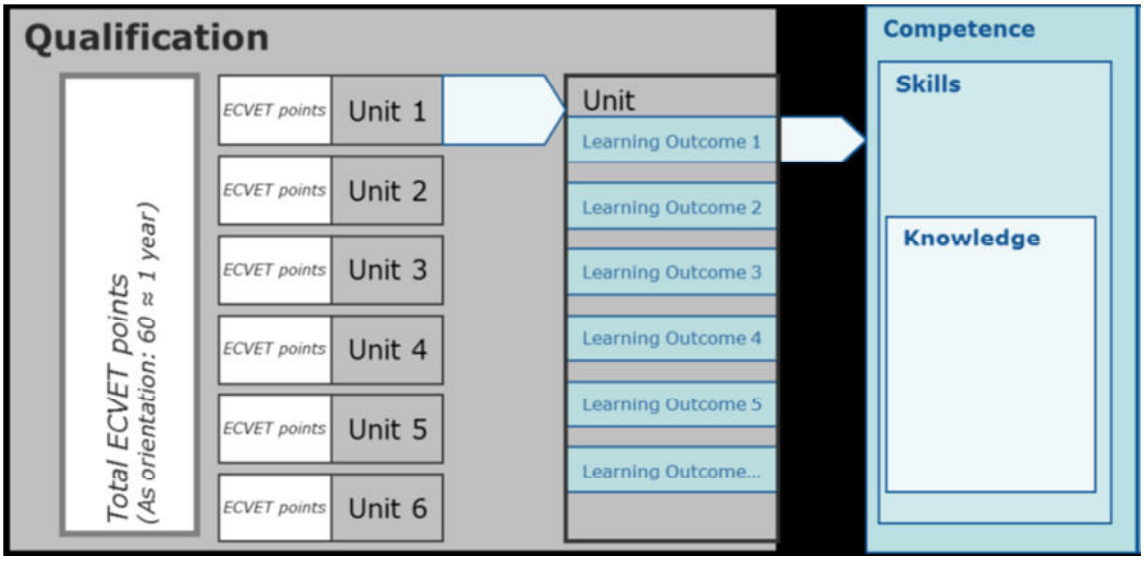

Figure 1: The ECVET qualification

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

Before implementing a mobility action, the partner institutions were faced with the challenge of agreeing on a common language and common terminology regarding the contents and objectives of a mobility project. The basis for this agreement were both the EQF system and the use of ECVET instruments for describing learning outcomes as well as for assessing, documenting and validating units of learning outcomes [5].
The first task in the application of the methodology is the development of general criteria for selection of a qualification. The general selection criteria were initially developed in CORONA II project proposal and are listed below. The selected for the pilot project qualification had to meet the following requirements:

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

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

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

The qualification of RPW was selected amongst five shortlisted candidates as the one matching most of the specific criteria. It meets the established criteria to the more complete extent than the other qualifications. The complete set of training courses was available and more than half of them were available in English language. Different types of training are ready to be held – theoretical, practical and e-learning training.
The next step was development of a Classification of occupations, qualifications and jobs in NPP Operation (Table 2. From jobs to occupations), which is done in order to distinguish between jobs and qualifications. The Classification of occupations, qualifications and jobs in nuclear Decommissioning, developed during Lisbon Workshop was used as a model [3].

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

Table 2. From jobs to occupations

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

2.2. RPW competence based qualification structure design

The qualification design was initiated and leaded by Risk Engineering Ltd. and was developed with active participation of MEPhI (Russia), BME (Hungary) and Kozloduy NPP (Bulgaria).
A unit of learning outcomes (ULO) is a component of a qualification consisting of a coherent set of knowledge, skills and competence that can be assessed and validated. The units of learning outcomes for RPW qualification were designed in such a way as to provide a consistent and structured learning process, with agreed coherent learning outcomes and clear criteria for assessment [6].
ECVET requirements for Units of Learning Outcomes/ULOs design are emphasized in the Table 3.

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

Table 3 ECVET requirements for ULOs

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

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

Each Unit was expressed via Learning Outcomes, each of which were defined in the terms of knowledge, skills and competence items.
The Table 4 presents an example of construction of ULO 2 Radiation protection.

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

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

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

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

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

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

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

Training course No. 2: RADIATION PROTECTION ACTIVITIES

Autonomy/Responsibility	
MODULE 2.1 Ionizing radiation	
Skills	**Knowledge**
S.2.1. Explain the nuclei composition (p, n and e)	K.2.1. General characteristics of atoms (electrical charge, nuclei, mass and

S.2.2. Use the chart of nuclides and nuclear data and find important constants. S.2.3. Perform different dosimetry calculations.	dimension) K.2.2. Interaction of ionising radiation with matter K.2.3. Biological effects of ionising radiation K.2.4. Physical principles of detection and the interactions of radiation with matter K.2.5. Natural and artificial sources of ionizing radiation
MODULE 2.2 Radiation protection activities	
S.2.4. Choose the appropriate protective equipment according to the working environment. S.2.5. Propose a suitable active or passive dosimeter for different radiation protection situations. S.2.6. Calibrate device for external dose measurement. S.2.7.Measure the level of contamination of the package. S.2.8. Apply the shielding procedures. S.2.9. Decontaminate and/or commission the decontamination of a surface. S.2.10. Apply international legislation S.2.11. Apply ALARA principle of individual and collective doses	K.2.6. Dosimetry and dose types (absorbed dose, equivalent dose and effective dose) K.2.7. Methods and tools for radiation protection for internal and external radiation exposure K.2.8. Detection and measurement of ionising radiation K.2.9. ALARA principles and their implementation K.2.10. General EU occupational health and safety regulations K.2.11. Dose limits for occupational and public exposure K.2.12. Personal protective equipment for occupational radiation protection K.2.13. Basic principles of surface and air contamination and decontamination
Assessment criteria (used by the trainer to assess the trainees): Capability in application of the ALARA implementation strategy Proper behaviour in emergency situations Ability in implementation of radiation protection program Nuclear safety and radiation protection culture behaviour Compliance with national legislation in radiation protection area	Precision of dose measurements evaluation Precision of calibration of the equipment Pertinence and precision of procedures implementation Accuracy of interpretation and reporting of radiological parameters
Recommended assessment methods (used by the Competent institution to recognize the training): Written test - case study, problem solving Practical test - simulation exercises Oral test (interview) Multiple choice questionnaires (MCQ)	Face to face examination, etc.

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

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

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

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

Two universities: BME – Hungary and MEPhI – Russia were chosen to play role of host provider. The rest of the Consortium's partners played role of a sending provider.
The target audience was established for non-nuclear professionals or students, which are graduated at least to the level of bachelors or are currently bachelors' students, with negligible prior knowledge or without knowledge and experience in nuclear field could be trained. The pilot training was aimed to students or professionals working in support of nuclear facilities as civil engineers, physical protection employees, government employees, secondary school teachers, journalists, etc. The course was expected to provide competences necessary for trainees to participate in further nuclear course(s) or to perform works related to VVER NPP, radiation monitoring and radiation protection of places of ionizing radiation for medicine and industry applications, radioactive waste management, custom offices, etc.
The training course aimed to give competencies at EQF Level 3 and 4. It was intended to cover different aspects needed to start working in the nuclear related area with sufficient general nuclear knowledge and culture.

3. Pilot training and the evaluation of the pilot training

The pilot training was organised from 30.01. till 03.02.2017 at Budapest University of Technology and Economics premises in Budapest, Hungary. The announcement of the pilot training was issued in a timely manner and established aim of the pilot training, topics to be covered, duration of the training, target audience, working language, preliminary program and registration form. No registration fee was requested from trainees.
Eight (8) trainees: three (3) from Bulgaria, three (3) from Czech Republic and two (2) from Russia participated in the training.
Main field of activities during the last three years of the trainees were:

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

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

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

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

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

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

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

4. References

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

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