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1 Introduction

This report presents the evolution of the establishment of a training program for the Radiation Protection Expert (RPE).

For this ENETRAP II project and in this Work Package 4, it was decided to implement the ECVET system (European Credit system for Vocational Education and Training) for the RPE training, taken into account the results of the ECVET meeting (Cordoba meeting in January 2011).

Methodological reflection that followed was to describe the required competences for future RPE.

Based on the EQF reference, we have elaborated Competences and Learning Outcomes for the RPE job profile. It is important to know what the participant is able to do at the end of the training he has followed rather than, what was the content of the course the participant has followed.

In the ECVET process, the emphasis is made on defining Learning Outcomes. However, we encountered difficulties with chosen descriptors to translate into Learning Outcomes RPE competences identified.

A significant number of studies and recent projects have opened the way for new thinking on the establishment of training programs. CEDEFOP (European Centre for the Development of Vocational Training) has some relevant projects that can serve as an example for the development of the RPE training scheme. The most significant areas investigated by this ECVET approach are for example aerospace and automotive industries.

Although the examples are taken in the industrial sector, namely aerospace and automotive industries, the nuclear industry and specifically the radiation protection area with the RPE, is not directly comparable.

The RPE is considered to be a function and not a job; which opposes such a car electrician likely to work alternately in the manufacturer A and then in the manufacturer B

If we take the short definition of the RPE, it is difficult to identify main competences using only this definition.

> *"Persons having the knowledge, training and experience needed to give radiation protection advice in order to ensure effective protection of individuals, whose capacity to act as radiation protection expert is recognized by the competent authorities."*

That is why we started a drafting of competences that must have a RPE by using descriptors such as Learning Outcomes describing Knowledge, Skills and Attitude (KSA).

2 The ECVET system

2.1 History and context

ECVET is a stand-alone system connected to others European initiatives called EQF (*European Qualifications Framework*), EQAVET (*European quality assurance in vocational education and training*) and Europass.
ECVET system uses components such as Learning outcomes, units and points, Memorandum of Understanding, learning agreements…

Objectives which are quoted in different policy statements of the European Commission started in 2002 with the **Copenhagen declaration.**

> **2002 Copenhagen declaration**: "… increase voluntary cooperation in vocational E&T in order to promote mutual trust, transparency, and recognition of competences and qualifications, and thereby establishing a basis for increasing mobility and facilitating access to lifelong learning."

Every two years meeting with communiqué were established and summarized here after.

> **2004 Maastricht communiqué:** "… integrate mobility into initial and continuing training."
>
> **2006 Helsinki communiqué:** "… increase transparency and common understanding on quality issues, and hence mutual trust between VET systems and practices."
>
> **2008 Bordeaux communiqué: subtitle:** "Make the concept of Life Long Learning and mobility a reality."

> *"Workers, learners' and teachers' mobility, from one system to another, from one country to another, should be promoted in VET systems. Citizens should be able to accumulate and transfer learning outcomes in formal, non-formal or informal contexts so that those learning outcomes can be recognized thanks to the implementation of European tools for transparency and recognition of qualifications."*

At that time, it was the first introduction of ECVET and EQARF (later EQAVET) as "tools/instruments"

> ***2010 Bruges communiqué:*** *"participating countries should systematically use and promote European transparency tools such as EQF, ECVET, and Europass to promote transnational mobility."*

Following all these conferences, it has been decided to define a strategy to the horizon 2020 whose important points are:

"*In a changing world, we want the EU to become a smart, sustainable and inclusive economy. These three mutually reinforcing priorities should help the EU and the Member States deliver high levels of employment, productivity and social cohesion.*"

To implement this ECVET concept, there are some initiatives and tools that support the Life Long Learning pathway.
This pathway is built by the formal education and training (school, university…), the work experience, the informal learning and non-formal learning (by companies, CPD) and in some case the formal training achieved abroad.

In order to support the "validation" of LLL pathway, the Commission has developed four supporting systems.

2.2 Other EU related tools

2.2.1 EQF

EQF: the European Qualification Framework deals with qualification and not with academic diploma.
The EQF aims to relate different countries' national qualifications systems to a common European reference framework using eight levels.
The Member States are invited firstly to relate their national qualifications systems to the EQF and to indicate the EQF level for new qualification (by 2012).
Secondly, MSs are invited to use an approach based on Learning Outcomes when defining and describing qualifications, and promote the validation of non-formal and informal learning.
MSs had been asked to designate a national coordination point in order to promote and apply the principles of quality assurance in education and training.
What are the descriptors used in EQF. In the table below, the eight levels are described by the three main descriptors:

- Knowledge
- Skills
- Competence

It has to be noticed that this terminology isn't the same used for instance at the IAEA:

- Knowledge
- Skills
- Attitude

When asking to member of ECVET-Team, the use of the other set of 3 descriptors is relevant and perfectly acceptable.

Level	Knowledge	Skills	Competence
Level 1	Basic general knowledge	basic skills required to carry out simple tasks	work or study under direct supervision in a structured context
Level 2	Basic factual knowledge of a field of work or study	basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	work or study under supervision with some autonomy

Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
Level 7	- Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research - Critical awareness of knowledge issues in a field and at the interface between different fields	specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	the most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

FIGURE 1: LEVELS FROM EQF: 1 (BASIC) TO 8 (MOST SPECIALISED)

Based on other work package results, the appropriate level for RPE is between 5 to 7, depending of country approach and RPE' roles and duties.

2.2.2 EQAVET

EQAVET is a quality system combined with quality indicators. They should be used in order thet different Member States can trust each other's on indications of what is the EQF level for a specific training.
For that purpose, EQAVET proposes, indicators to measure quality in vocational education and training, tools for supporting quality assurance, and increasing the quality of VET so that making VET more attractive. The table below presents the list of EQAVET quality indicators.

1. Relevance of quality assurance systems for VET providers
2. Investment in training of teachers and trainers
3. Participation rate in VET programmes
4. Completion rate in VET programmes
5. Placement rate in VET programmes
6. Utilisation of acquired skills at the workplace
7. Unemployment rate
8. Prevalence of vulnerable group
9. Mechanisms to identify training needs in the labour market
10. Schemes used to promote better access to VET

FIGURE 2: LIST OF EQAVET QUALITY INDICATORS

FIGURE 3: EQAVET; THE QUALITY CYCLE

2.2.3 Europass

This is a tool recently developed by European Commission, since European countries are increasingly emphasizing the need to recognize the full range of an individual's knowledge, skills and competences (or Attitudes), those acquired not only at school, university or other education and training institutions, but also outside the formal system.

The Europass should be seen as an extension of traditional CV, so like "a document to make your skills and qualifications clearly and easily understood in Europe".
Europass is based on five documents: CV, language passport; Europass mobility, certificate supplement, diploma supplement and validation of formal and non-formal learning.

2.3 ECVET approach

If somebody has some proper qualification, how do we introduce the transfer and the recognition of these qualifications? Therefore, The European credit system for vocational education and training is a tool designed to make qualifications systems more easily understood and flexible throughout the European Union and so to support more mobility for workers and learners. ECVET is an instrument for mobility and recognition and it is supposed to facilitate the Life Long Learning experience.

The definition of the European Credit System for Vocational Education and Training (ECVET) is

> "a technical framework for the transfer, recognition and, where appropriate, accumulation of individuals' Learning Outcomes with a view to achieving a qualification. "

What it has to be done before ECEVT can be implemented is in recommendation addressed to Member States is defined by six key points:

1. ***promote the European Credit system for Vocational Education and Training*** *('ECVET') as set out in Annexes I and II at all levels of the EQF with reference to VET qualifications, in order to facilitate trans-national mobility and the recognition of learning outcomes in VET and borderless lifelong learning ;*
2. ***create the necessary conditions and adopt measures, as appropriate, so that as from 2012 – in accordance with national legislation and practice, and on the basis of trials and testing – it is possible for ECVET to be gradually applied to VET qualifications at all levels of the EQF****, and used for the purpose of the transfer, recognition and accumulation of individuals' learning outcomes achieved in formal and, where appropriate, non-formal and informal contexts ;*
3. ***support the development of national and European partnerships and networks*** *involving institutions and authorities responsible for qualifications and diplomas, VET providers, social partners and other relevant stakeholders dedicated to trialling, implementing and promoting ECVET ;*
4. ***ensure that stakeholders and individuals in the area of VET have access to information and guidance for using ECVET****, whilst facilitating the exchange of information between the Member States. Furthermore, ensure that the application of ECVET to qualifications is properly publicised by the competent authorities and that associated 'Europass' documents issued by the competent authorities contain explicit relevant information ;*
5. ***apply, in accordance with national legislation and practice, the common principles for quality assurance in VET*** *set out in the Council conclusions of 28 May 2004 on Quality Assurance in Vocational Education and Training when using ECVET, particularly in relation to the assessment, validation and recognition of learning outcomes ;*
6. ***ensure that there are functioning coordination and monitoring*** *mechanisms at the appropriate levels, in accordance with the legislation, structures and requirements of each Member State, in order to guarantee the quality, transparency and consistency of the initiatives taken to implement ECVET.*

All these issues are already running even now in the nuclear domain and precisely, the ENETRAP II project, tries to fit with the ECVET timetable below.

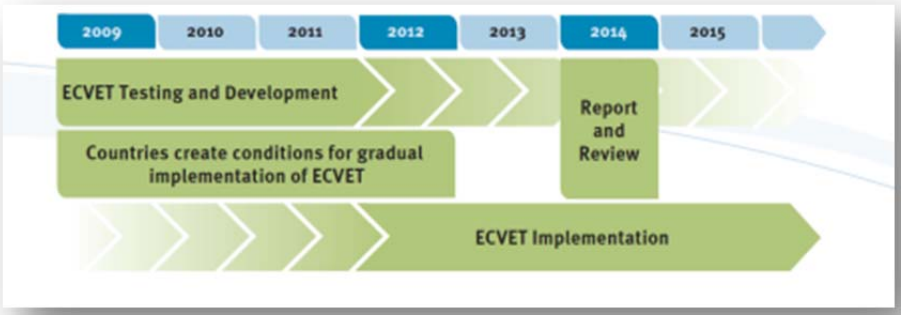

FIGURE 4: ECVET SCHEDULE AND PROGRESSIVE IMPLEMENTATION

2.3.1 Technical components

The time running now corresponds to a preparatory period until end 2012. From next years on, the objective is to have a period of gradual introduction of ECVET in the different Member States for the different learning experiences. This should run until 2014 with a possibility to make revision based on the possible revision of the European recommendations in 2014.

The ECVET system can be seen as a complex system regarding its different components visible through the figure.

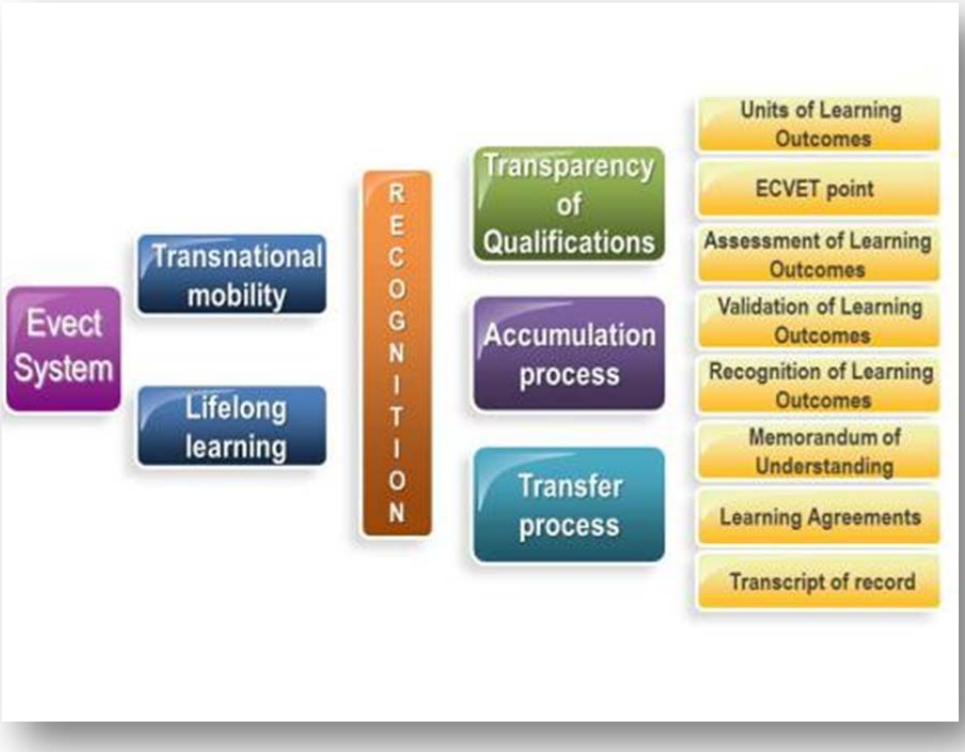

FIGURE 5: ECVET AND TECHNICAL COMPONENTS

When create units of Learning Outcomes for a given part of training course and characterised by ECVET points, these LOs are assessed or validated and then recognized. The Commission has also established a tool for partnership which is the Memorandum of Understanding (MoU) between the different partners that, if they join the system with such a MoU, means that it trusts each other on the quality of delivered courses.
There is also the Learning agreement introduced which is an agreement between a provider and a learner and using a transcript of records (Europass).

2.3.2 Learning Outcomes

Learning outcomes are statements about what a learner knows, understands and is able to do on completion of a learning process and which are defined in terms of knowledge, skills and competence.

The descriptors used by the Commission are:

- **'Knowledge'** means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study.

- **'Skills'** means the ability to apply knowledge and know-how to complete tasks and solve problems.

- **'Competence'** means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development.

In the framework of ENETRAP II, we created all different LOs we think needed to be achieved after a RPE participant has followed a certain part of the course.

It is important to note that ECVET system does not provide a template or a taxonomy concerning the frame of Learning Outcomes descriptions.
ECVET has not prescribed how to formulate LOs, but ECVET put emphasis on the different EQF levels. For instance for the RPE Learning Outcomes and EQF level, if they are describe with "basic general knowledge" (EQF level 1 to 3) that means that these LOs are certainly not for a RPE. If description of LOs involves a "knowledge at the most advance frontier of a field of work or study and at the interface between fields", so this matches with the Level 8 of EQF.
As a result of other work packages, the proposal of RPE EQF level should be placed between level 5 to 7 (depending of countries).
Then, after creation of LOs for a course, the process is to start adding units.

2.3.3 Units

A unit is a component of a qualification, consisting of a coherent set of knowledge, skills and competence (or attitudes – KSA) that can be assessed and validated. Units identify what learners can learn and describe the learning outcomes that the learner is expected to achieve. Thanks to ECVET, the credit to this unit can be recognized.
Credits and units in ECVET system are not the same thing. LOs can be grouped to create units. Grouping of LOs, could be based on the same set of occupational activities or tasks.

But LOs can be grouped because they are related to the same product or production technique or even, LOs can also be grouped according to the stages in the production process or process of performing a service.
LOs can be aggregated in a unit because they relate to the same field of knowledge, skills or attitudes.

In this project, we combine the different modules of the entire RPE course and we take one module as one unit. For each unit, we have to allocate ECVET points.

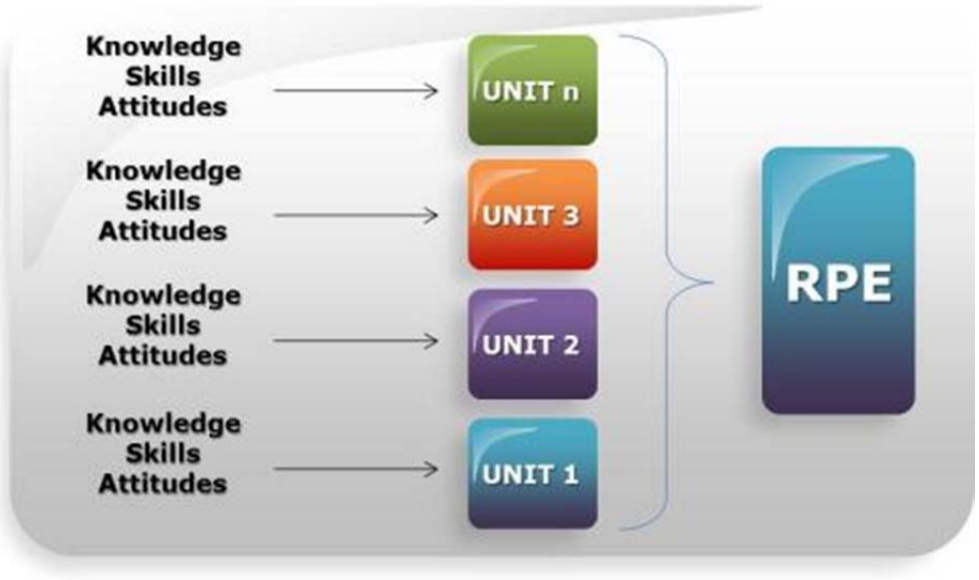

FIGURE 6: ECVET - A TOOL FOR PROMOTING THE TRANSFER, ACCUMULATION AND RECOGNITION OF CREDIT FOR VET

2.3.4 ECVET points

Allocation of ECVET points to a qualification is based on using a convention according to which 60 points are allocated to the learning outcomes expected to be achieved in a year of formal full time of vocational and training.
Each unit is allocated a number of points based on its relative weight within the qualification. The relative importance of the unit for labour market, for progression to other qualification levels or for social integration, is also taken into account.
Other parameters could be used as the complexity, scope and volume of the Unit and the necessary effort for a learner to acquire the knowledge, skills and attitudes required for the unit.
ECVET could be correlated with the other European system at academic level: ECTS (European Credit Transfer System). At the end, it becomes easier to exchange points that a learner receives from vocational education and training and the points that a learner receives from the formal education. ECVET points are to be confused with credit. Credit designates the Learning Outcomes the learner has achieved, where ECVET points provide information about the qualification and the units.
Finally ECVET points provide information about the credit the learner has transferred and accumulated.

2.3.5 Mobility through transfer and accumulation of ECVET points

The loop that ECVET serves in order to achieve the mobility is represented in figure 7.

The process starts from a provider, which make a Learning Agreement with the host provider. An individual acquires knowledge, skills and competences (or attitudes – KSA). Credits are awarded to this learner. These LOs are assessed by the provider. The Credits can be recorded in the Europass and transcript. Then they are validated and in a final phase, LOs are recognized and accumulated as part of the intended qualification corresponding to a certain amount of ECVET points.

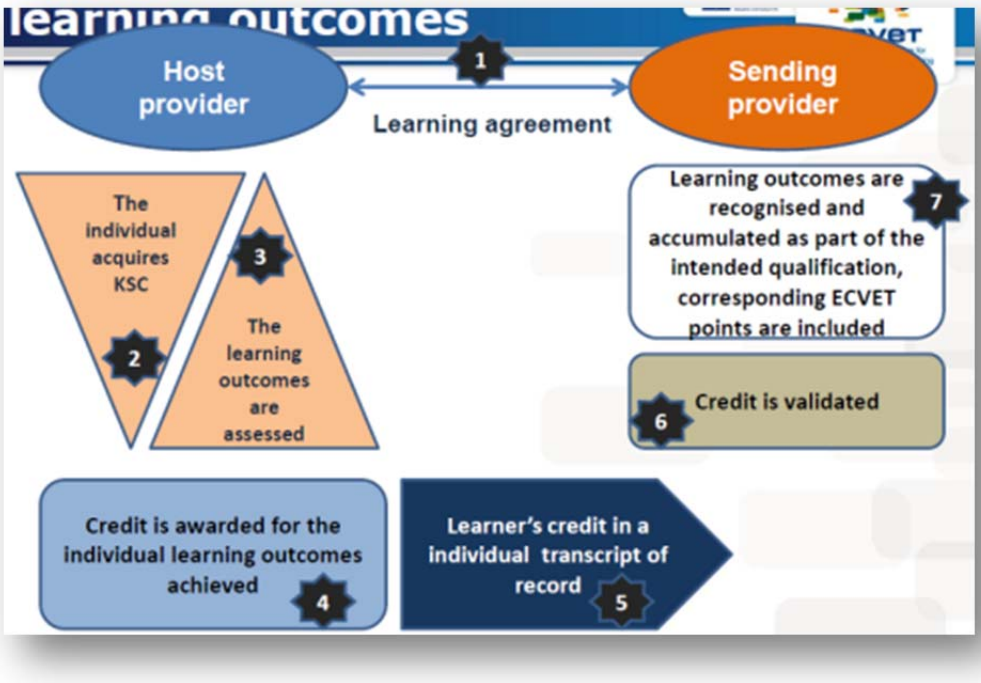

FIGURE 7: TRANSFER AND ACCUMULATION SERVING EUROPEAN MOBILITY

2.3.6 Memorandum of Understanding and mutual trust

If a learner follows a course from provider A or provider B, if they both have a MoU, they will accept the ECVET points that are given by either one of them.
The mutual trust for both the horizontal and vertical way is represented in figure 8.
The horizontal trust corresponds to the trust between authorities with equivalent competencies from different countries. The other axis implies the vertical trust between the national or sectorial authorities and VET providers.
A MoU is an umbrella agreement between competent institutions which sets the framework for credit transfer. It formalises the ECVET partnership by stating the mutual acceptance of the status and procedures of competent institutions involved. This describes an institution which is responsible for designing and awarding qualifications or recognizing units or other components linked to ECVET. These components can be the allocation of ECVET points to qualifications and units, the assessment, the validation and the recognition of learning outcomes under the rules and practices of participating countries.

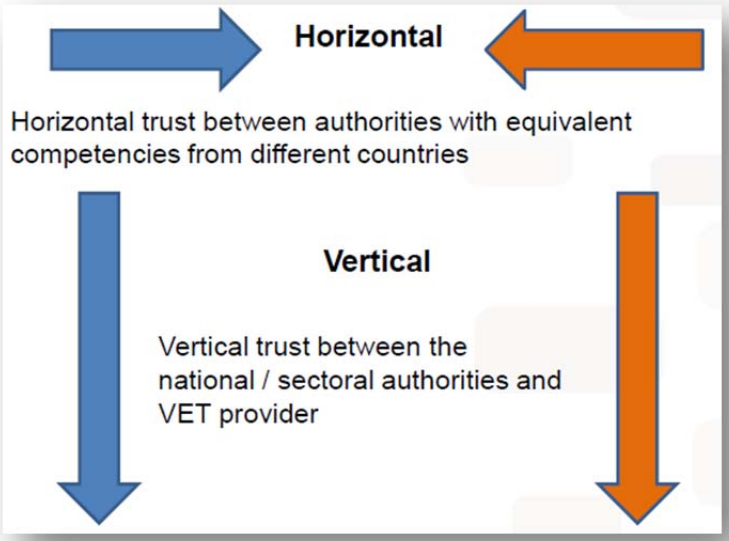

FIGURE 8: MOU HORIZONTAL AND VERTICAL TRUST

2.3.7 Learning Agreement

Learning agreement is an agreement at operational level in the framework for mobility exchanges. This document incorporates detailed information about qualifications concerned, the mobility exchange and conditions for assessment, and at least validation and recognition of credits. Finally, the decision on who needs to sign such an agreement would also depend on the responsibilities of different actors within the qualifications system (EQAVET).

2.4 ECVET and competence

The competence could be defined as following:

> *" Competence includes: i) cognitive competence involving the use of theory and concepts, as well as informal tacit knowledge gained experientially; ii) functional competence (skills or knowhow), those things that a person should be able to do when they are functioning in a given area of work, learning or social activity; iii) personal competence involving knowing how to conduct oneself in a specific situation; and iv) ethical competence involving the possession of certain personal and professional values.*[1]

This explanation is not sufficient to describe quantitatively and therefore easy to verify later in terms of knowledge, know-doing and know-being.

1 [TWG ECVET] European Credit System for VET (ECVET). Technical Specifications (Report 2005 of the Credit Transfer Technical Working Group)

That is why we have introduced more than the three standard descriptors for competence - knowledge, skill and attitude (KSA system) - the concept of sub competence.

Although the use of an action verb to describe a competence, it is important to contextualize this competence by specifying the field, the area in which it operates.

2.5 Sub competences linked to RPE activities

We previously introduced the activity concept which allows to specify the field, the area in which competences are applied. For example, when RPE should have the competence "apply physical dosimetry systems", this competence is too general and should be broken down into sub competence (SC1: List the passive dosimetry devices, SC2: List the active dosimetry devices, SC3: Explain the principles of internal dosimetry).

For each sub competence, we define the Learning Outcomes that will be broken down into Learning Outcomes related to Knowledge (KLo), Learning Outcomes related to Skills (SLo) and finally Learning Outcomes associated to Attitudes (ALo) that will be owned by the RPE. It is important to note that for a given sub competence, the three outcomes are not necessarily present in the table. A sub competence, predominantly "manual" will be described using its descriptor "Learning Outcomes for Skill" and do not necessarily include descriptor associated to an attitude or knowledge.

This differentiation allows for each LO, identifying quantifiable indicators to measure achievement of objectives. It is more important for an enterprise to identify what his learner is able to do after a training period rather than what he has learnt.

2.6 Competences and Learning Outcomes tables

The completion of a table to clearly visualize the different components of expertise will facilitate the subsequent addition of skills depending on the evolution and demand of employers and / or authorities and / or stakeholders.

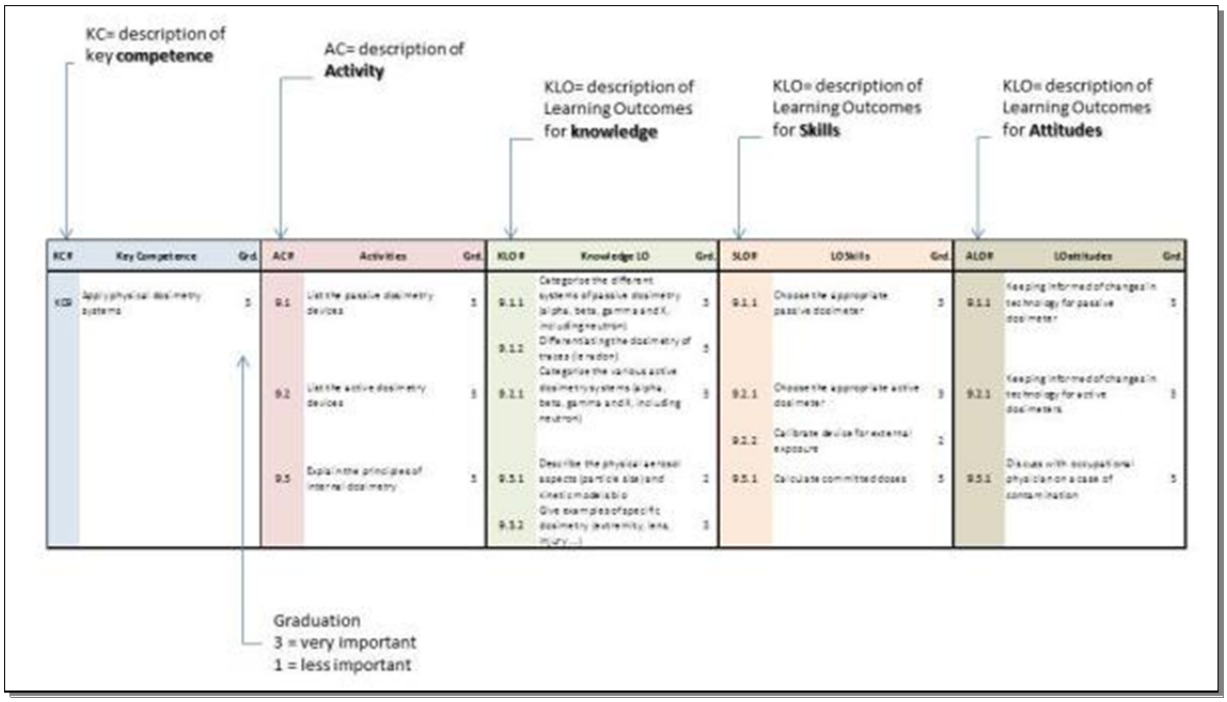

FIGURE 9: COMPETENCES TABLE FOR RPE

The approach that has prevailed in the creation of the ENETRAP training program was based on a training scheme focusing more on content than on learning outcomes.

The RPE training is tailed for professionals (VET) and not for students as part of an academic program. However, some academic programs cover the entire spectrum of the RPE training for radiation protection expert. This is the case of the European Master's degree in Radiation Protection (EMRP). It is interesting to note that the approach of ECTS (Bologna system) at the academic level was declined by the ECVET approach for lifelong learners. This system represents a unique opportunity in Europe to accumulate, capitalize and transfer ECVET credits.

This ECVET system enables the attesting and recording of the learning achievement / Learning Outcomes of an individual engaged in a learning pathway leading to a qualification, a vocational diploma or certificate. For future RPEs, the use of ECVET approach will enable them to capitalize units and thus eventually to expand portfolio of skills, attitudes and competences during their progression in the training

A special numbering was developed to easily connect a Learning Outcome to a sun competence or a competence. This numbering system will support the identification by an employer of a competence that he would like his staff get.

2.7 The difficulty of assessing the degree of relevance

The work of WP5 has introduced a scale associated with skills and by extension to Learning Outcomes. Therefore, we also introduced a measure to assess the relative importance of a competence, a sub competence and associated LOs to the RPE portfolio. This quantification ranges between one and three respectively less relevant (1) and the most important (3) was abandoned in favour of the EQF graduation.
Thus we find to the right of each column, the column "grade" for the consideration of this relevance.

3 Identification of competences

3.1 Development of list of competences

The development of the list of relevant competences in order to implement the ECVET approach was undertaken based on knowledge of the field of radiation protection by RP specialists, training specialists in radiation protection domain and also based on feedback of inspectors in radiation protection. This first list, by no means exhaustive, is an important step of the drafting competences process that should possess a RPE.
This list has been validated by the other project partners.

In the process of identifying and writing key competences for RPE, the difficulty of using action verbs to describe competences appeared. Indeed, as the competences are closely linked to knowledge, the action verb "know" is often used. Nevertheless, it is difficult to quantify such knowledge. Therefore it is preferable to use a different action verb to describe. In that way, Bloom and Anderson taxonomies help. The results from EUTERP platform highlighted the competences of the RPE as follows:

> *"Competence:*
> *The RPE will need to have a high level of knowledge, experience and ability (i.e. competence) to be able to satisfactorily perform the duties. The RPE must have the ability to:*
> *a) Anticipate and recognise the interactions of radiation with matter and to understand the effects of radiation on people, animals and the environment;*
> *b) Carry out a risk assessment: identify and assess risks of actual and potential exposure to ionizing radiation, including the calculation of potential exposure;*
> *c) Interpret regulatory requirements and provide practical situations for compliance;*
> *d) Identify and propose appropriate control procedures to restrict radiation exposure, in accordance with the principles of optimisation;*
> *e) Interpret and apply radiation protection data (e.g. radionuclide decay and emission data, source outputs, dose histories, workplace monitoring results, manufacturer's data, shielding data).*
> *In addition to scientific and technical competence, it is very important that the RPE has the ability to communicate effectively with a wide range of persons and has a good understanding of the social and environmental considerations associated with different radiation practices.*

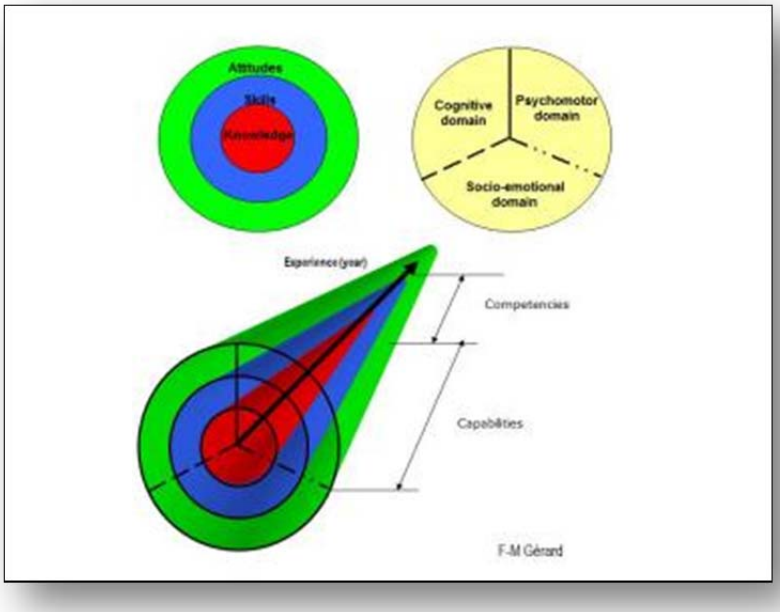

FIGURE 10: REPRESENTATION OF COMPETENCE, KNOWLEDGE, SKILLS AND ATTITUDES (F-M GÉRARD)

A competence involves the ability to meet complex demands, by mobilising different resources (including knowledge, skills and attitudes) in particular contexts.

As discussed in chapter 2.4, writing competences is not self-sufficient and requires the use of sub competence. Thus, for a competence, we can have one or more sub competences.

3.2 Necessity to develop a tool

The establishment of a standard of competences can be a difficult task to achieve. If the profile of the job is very detailed, it will be necessary to describe precisely all associated competence / sub competence / knowledge / skills / attitudes with the job profile. Within the RPE, and taking into account the work of the first program ENETRAP, we knew that the competences list would be long. Therefore, we undertook a study to describe in detail these competences

.

We saw in chapter 2.3.3, that a unit within the meaning of the ECVET approach, may correspond to one module of the RPE training scheme. These units will build the training scheme.

Having initiated the development of the competences framework of RPE (figure 9), we were quickly confronted with the multitude of entries in the matrix. The analytical approach is transcribed using a spread sheet, and has quickly showed its limits.

The first table contained more than eighty competences described using approximately 400 learning outcomes.

Continue on this path, inevitably led us to a table whose extension was compromised. In the process of developing this competences framework, we have been led to add, modify competences or learning outcomes. It was followed by a long process of renumbering competences or learning outcomes and these operations were highly time-consuming.

3.2.1 Why developing a tool?

We decided to conduct the development of a tool in order to describe a standard of competences respecting the ECVET approach.
Numerous researches have been performed to find out if such tools were developed as part of the ECVET approach. In CEDEFOP (European organisation for the implementation of ECVET and professional learning), to our knowledge, no such IT development was undertaken. Sheets describing competences exist but do not have the level of detail to which we wanted to lead.

What should reflect such a tool? What information should be there? How will data be organised?
In this ENETRAP II WP4, the development of software was not planned. However, given the accuracy of competences description, we tried with the help of CEN-SCK team, to develop a prototype to test if for the RPE profile, the use of such tool would be useful.

Although a specification is a prerequisite for any IT project, we conducted a brief study of the existing tools, a needs analysis and specify functional characteristics.

Study of existing

- Web search
- HR Professional exhibition
- SaaS oriented HR management but not competences
- SAT approach has not developed such application

Needs analysis

- Desire to speak and share the same language
- Adaptable, thanks to the EQF level associated with a LOs or competence
- Rapid addition of competence at any level of the hieratical tree
- Automatic renumbering (not fully operating because of Access application limitation)
- Move (cut and paste)
- Copy / paste
- Modify
- Tracking versions of LOs (not implemented in the prototype)
- Specifications of functional characteristics
- Sorting competences
- Adding fields (bibliography, keywords etc.)
- Report printing (export format, not only .pdf but also .docx in order to integrate in a report)

3.2.2 Description of prototype

The development of this prototype is based on an analytical approach.
In fact, we start from the competence and we tried to characterize it. But we have to keep in

mind that a competence (as IAEA glossary) can be characterized by three descriptors "Knowledge, Skills and Attitude" (KSA).
Competence is usually the combination of several sub-competences. This is why we used the hierarchical relationship as follows:

Competence → sub competence → Knowledge and/or Skill and/or Attitude
The competences set described can be collected in a teaching unit called Unit or ECVET Unit. For each ECVET Unit, a number of ECVET points is associated.

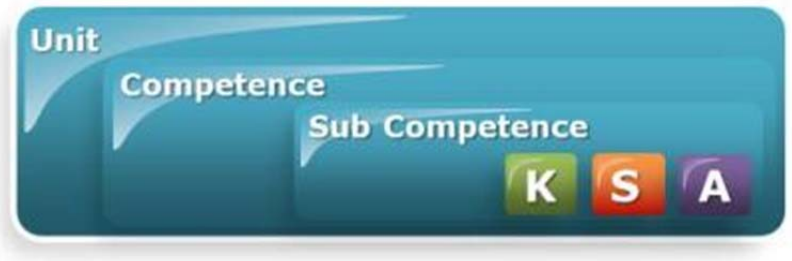

FIGURE 11: HIERARCHICAL RELATIONSHIP OF ECVET STRUCTURE

As part of the training program of the RPE, each ECVET Unit corresponds to a module.

ID	Label	ID	Label
Module name	Unit name	DescriptionLO	Description Learning Outcomes
Coursedescription	Course description	Type	Descriptor type « knowledge - attitude – skills »
Course id	Course identification	Grd	EQF
Est_duration	Estimated duration	ScoID	?? identification
tutPWOJTinchours	Tutorat, pratical work, on the job training in hours	SequenceIDLO	Sequence identification Learning Outcomes
Est_ECVETpoints	Estimated Ecvet point	sequenceID	Sequence identification
Prerequisite	Prerequisite	SubsequenceID	Susbsequence identification
Lecturer	Lecturer	Main	Main competence
Objectives	Objectives	Coursecontent	Course content
Keywords	Keywords	Bibliography	Bibliography
Assessment	Assessment	Module number	Module number
References	References	CoursedescriptionUnit	Course description Unit

FIGURE 12: IDENTIFICATION AND LABEL OF PROTOTYPE TABLE

3.2.2.1 Course table

This table is used to enter the highest level of the structure chosen: Unit.
The information can be entered either using a list, as shown in figure 13, or as a form. The value of the entry using a list is that it has a broader view of the entire formation.

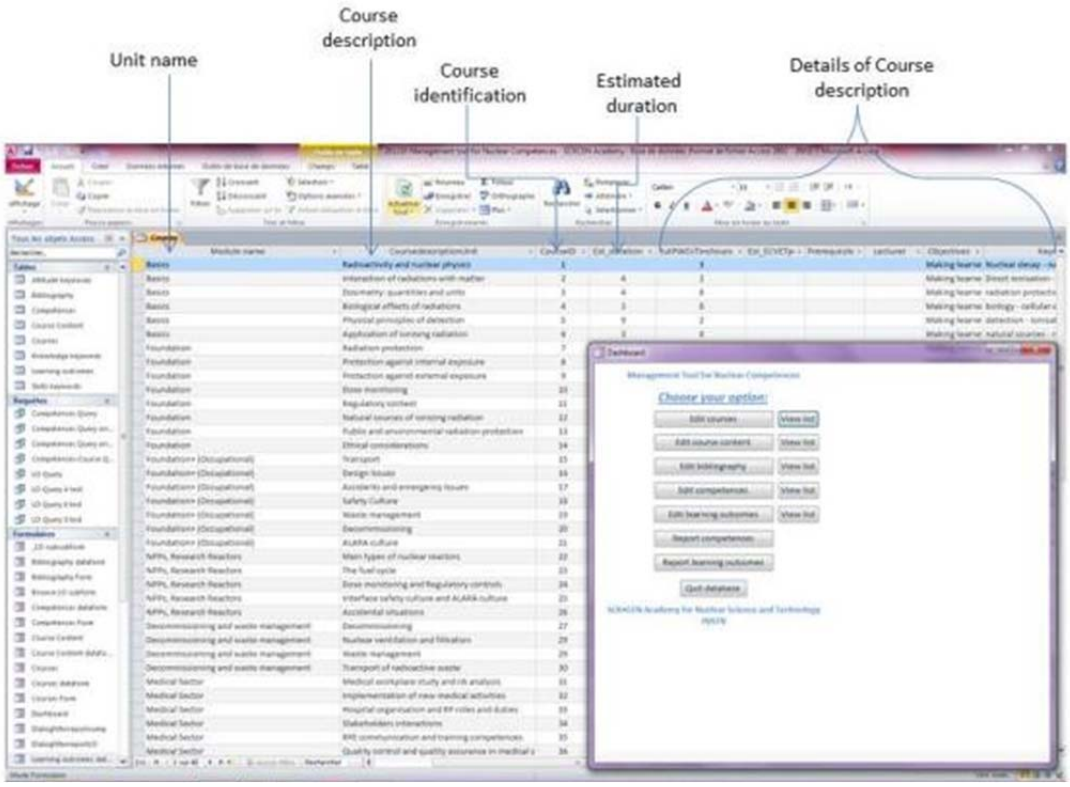

FIGURE 13: COURSE TABLE DESCRIPTION

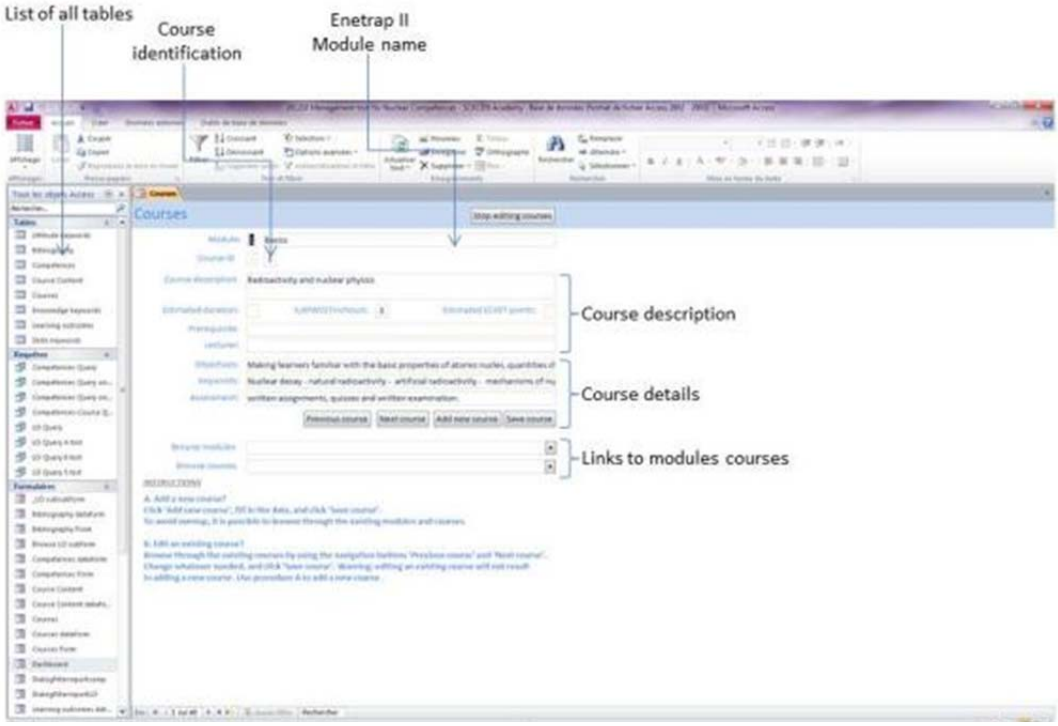

FIGURE 14: COURSE FORM DESCRIPTION

3.2.2.2 Form for competence

The form for competence includes several input fields. The numbering is pseudo-automatic because you must enter the number knowing the last number used (displayed).
This is a software limitation that Access does not allow automatic direct numbering nor renumbering after a new competence has been introduced.

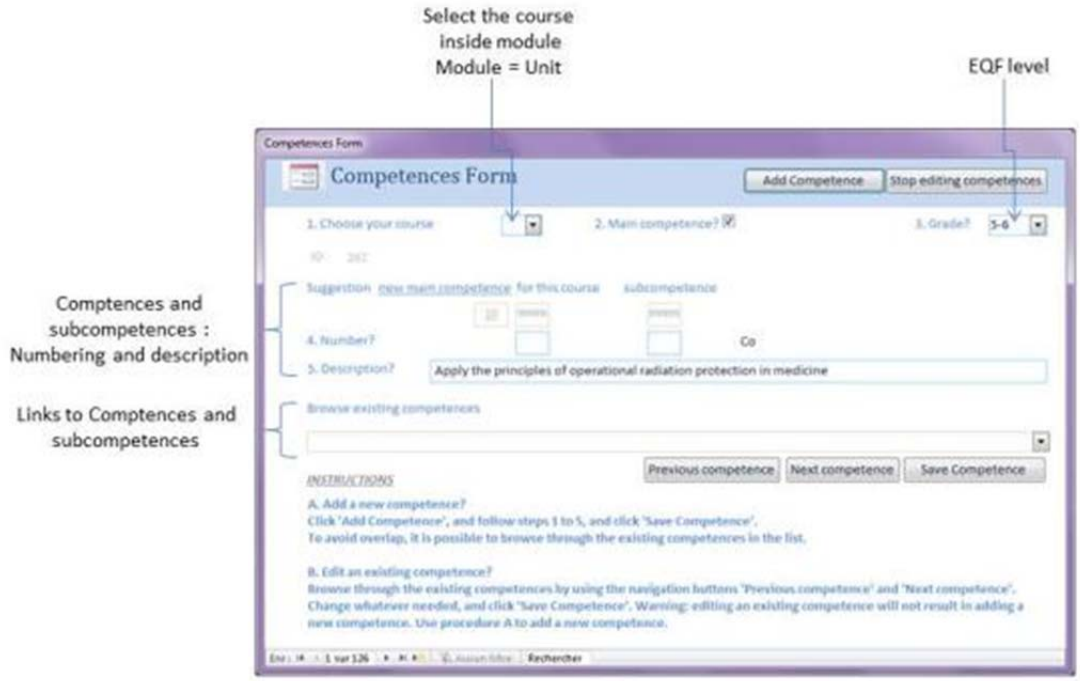

FIGURE 15: COMPETENCE FORM DESCRIPTION

3.2.2.3 Form for Learning Outcomes

This form allows you to enter the Learning Outcomes having a direct view of the elements to which they relate. Assistance in the drafting of Learning Outcomes proposed using a drop-down menu. Thus, the editor may have access to specific action verbs for Knowledge, Skills and Attitudes. The selection of action verbs is coming from the Bloom and Anderson taxonomies.

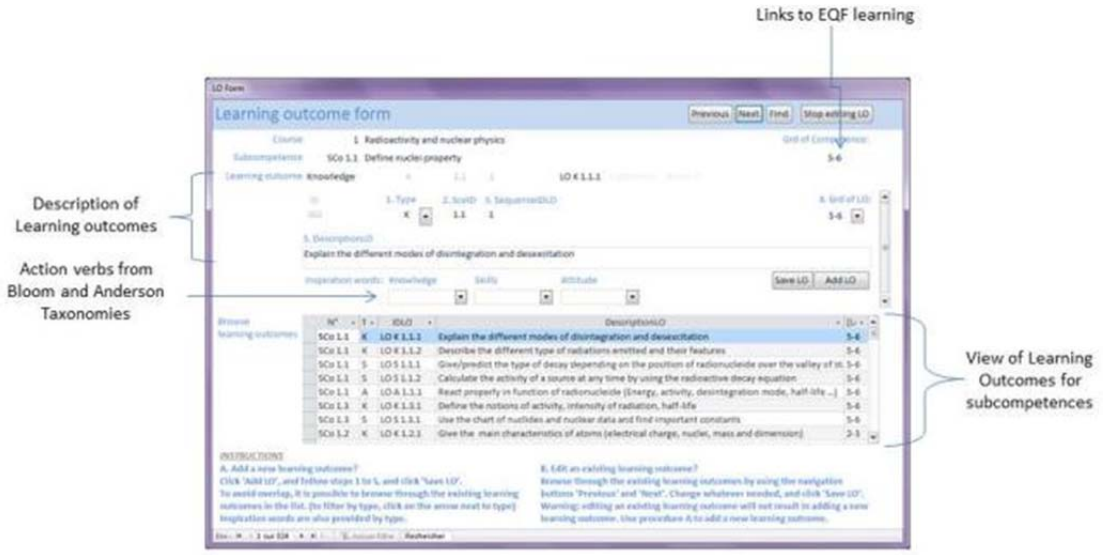

FIGURE 16: LEARNING OUTCOMES FORM DESCRIPTION

3.2.3 A specific software could be developed

A specific software development could be performed, perhaps at the CEDEFOP level or ECVET-Team, to offer a common tool in order to describe properly competences. For example, in a given area of activity, competences frameworks were described in the same way. It would be easy to compare, reuse descriptions of competences, create common set of competences *e.g.* the nuclear safety culture, radiation protection culture, conventional security culture and so on.

These blocks of generic competences can be found in the description of several profiles in a given area. In addition, thanks to the European EQF system, we can adjust the detail level of competence in using the EQF levels ranging from 1 to 8 depending on the depth of the desired level.

Beyond the IT approach, such a tool would evolve, enrich and share standard of competences and thus to promote the recognition and mobility inside EU.

3.3 From sub-competence to Learning Outcomes

A sub-competence is described by one or more Learning Outcomes associated with either knowledge or skills or attitudes.
In fact, Learning Outcomes describe what a learner is expected to know, understand and be able to do after successful completion of a process of learning Learning outcomes can be achieved in a variety of contexts and are assessed by the learning, skills and competences demonstrated by the learner[2].
Based on three descriptors (KSA) used in our methodology, we have for each sub competence describes the learning outcomes.

3.3.1 Learning Outcomes-related to Knowledge

The level of a RPE in respect to the European Qualifications Framework (EQF) was assessed at 6 or 7 (even 5 to 7 depending of countries). This classification uses a matrix in which knowledge can be described as follows:

Level 6: advanced knowledge of a field of work or study, involving a critical understanding of theories and principles

Level 7: Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research - critical awareness of knowledge issues in a field and at the interface between different fields

3.3.2 Learning Outcomes related to Skills

The RPE position (duties) is based on a wider field of knowledge than know-how. Indeed, the function of RPE is hardly comparable to for example, a car electrician who should have a wide range of skills and habilities.

[2] ECVET Cedefop Glossary http://www.ecvet.org.uk/Glossary.aspx

Nevertheless, it is clear that the RPE should also possess skills that must be identified through the Learning Outcomes Skills (column LOS in appendix 8.1.1).

3.3.3 Learning Outcomes related to Attitude

The know-being or the postures to be taken by a RPE in the workplace are numerous. From an advisor posture to an inspector one, the RPE must demonstrate "soft skills" of utmost importance. In addition, he/she will transmit his/her knowledge and expertise to employees or to the public.
The RPE's ability to act as a professional is shown by communicating and arguing effectively with a wide range of persons.

3.4 From Learning Outcomes to validation

The writing of Learning Outcomes is associated to the validation process that can be done taking the form of an examination, an oral with a jury or through a multiple choice questionnaire.
Other ENETRAP II work packages working on these issues.

3.5 From Learning Outcomes to training scheme

The interest of the ECVET approach is that once the Learning Outcomes have been identified, they can be translated in terms of learning unit. In appendix8.2, we have established the training program corresponding to the main competences declined in sub competence and Learning Outcomes.
The RPE training scheme use a modular approach. Thus a learner may choose to capitalize the ECVET credits.
The learner has the choice to follow continuously the modules one after the other or to separate each period of training.

	ENETRAP II - description table							
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
Description by Learning Outcomes	✓	✓	✓	✓	✓		✓	
Number of LOs for Comp+subc	17	29	16	10	12		23	
Number of LOs for indicators (KSA)	54	73	42	42	60		28	
Description by Learning Objectives	✓	✓	✓	✓	✓	✓	✓	✓
Course content	✓	✓	✓	✓	✓	✓	✓	✓
Bibliography	✓	✓	✓					

FIGURE 17: ENETRAP II TABLE OF OUTCOMES FOR EACH MODULE

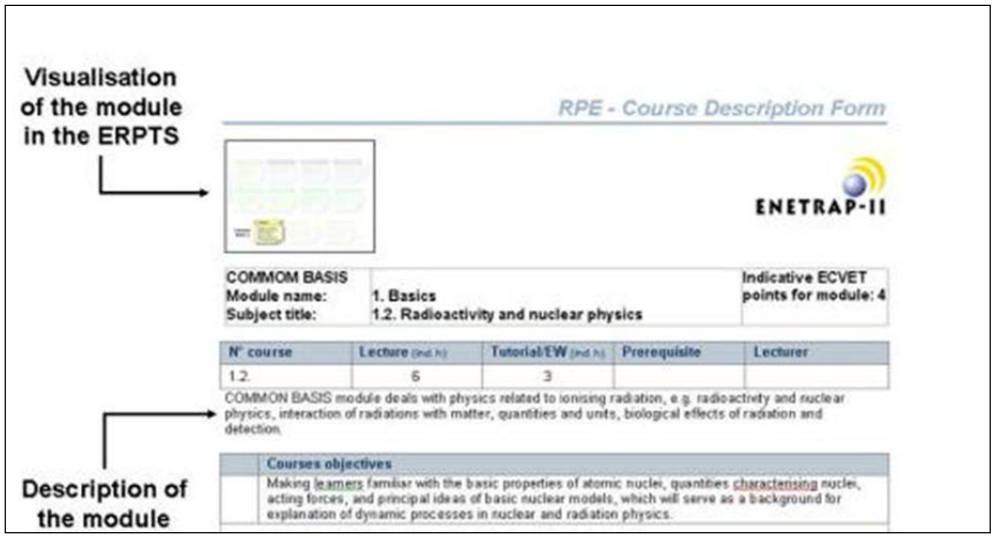

FIGURE 18: ENETRAP II COURSE DESCRIPTION FORM (APPENDIX 8.2)

3.6 Are there competences that are not addressed in the previous program?

In the definition of a Radiation Protection Expert, as proposed in the future EU-BSS, it is stated that the expert must provide advices. But, the competence "advice" is not explicitly covered in the first ENETRAP training program. No clearly identified part of the training course does fit with the attitude of one who gives advice.

3.6.1 Communication

- Communication in post accidental or incidental situation

The Fukushima accident teaches us that an adequate communication to the public, in addition affected by an accident or incident, is essential. This task seems to be addressed to those involved in radiation protection. The RPE would inevitably be involved in a communication plan at a local, national or supra-national scale.
Ultimately, the RPE may contribute to a "European intervention force" in radiation protection, facilitated by the European harmonization of training content they have received and considered and for which they were assessed.

- Communication in normal situation

Competence related to the normal communication must fit with what the RPE should be able to do in order to meet the definition of "give advices". This ability has to be practiced with different populations such as public, workers and learners.

- Communication with the public

Communication with the public on issues related to radiation protection is an important point. Nevertheless, the radiation protection is often closely linked to nuclear safety where communication specialists of the operator may be involved.

- Communication for learning

In addition to his/her duties as communicating, the RPE is required to provide more and more training. Learners are as diverse as new recruits, trainees, employees wishing to update their knowledge. Therefore the competence related to the ability to give lecturer or to train is important for RPE and thus transcribed in the table of competences.

3.6.2 Training

As explained in the previous paragraph, the training can become an important component of the RPE job for instance in a large company and represent a significant number of hours.

- Train the trainers

The ability of RPE to conduct training sessions, not part of the core activities of the RPE. However, collected experience suggests that training actions increases significantly.

3.6.3 Set of common competences (nuclear field)

Due to the trans-disciplinarity of the radiation protection field, a wide knowledge in a set of topics is required.
In the same way, working in a nuclear domain required a set of common competences to be developed in order to support the implementation of:

- A nuclear safety culture
- A nuclear security culture
- A radiation protection culture
- An ALARA culture which is embedded in the RP culture
- A health safety culture

For each RPE unit (ECVET component), a set of competences could be created and re-used for the development of other nuclear profiles.
This set of common competences could be describe by same descriptors. The EQF levels regarding the job profiles may change.

4 The ENETRAP training scheme

The figure below represents the global European Radiation Protection Training Scheme. The trainee must keep in mind that common basis is a mandatory part. In addition, at least one specific module must be selected.

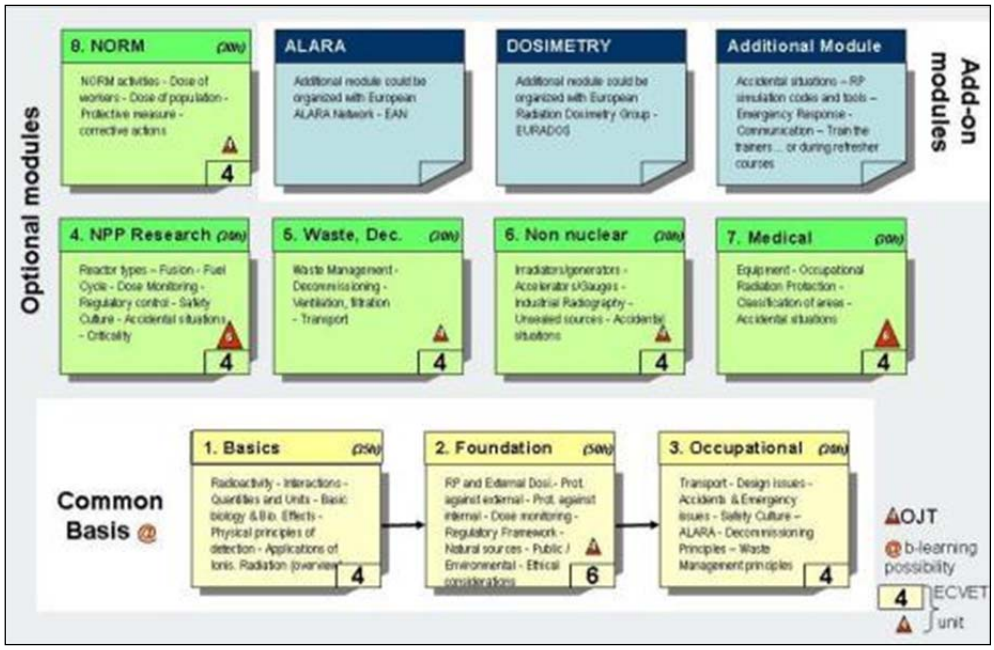

FIGURE 19: ENETRAP II, THE RPE TRAINING SCHEME

The structure of this training programme is based on 3 types of modules:

- Common basis modules
- Specialised modules
- Optional modules

In order to bring this new approach to the future European RPE training, learning objectives for each module/lecture have to be properly formulated. These objectives are knowledge and skills that trainees are expected to have gained on completion of their training or identified parts of the course. These Learning Outcomes can be seen as performance goals for trainees with measurable outcomes. That is why, practical work/exercises should be described in more detail in the syllabus.

Course contents are uploaded in the Moodle platform specially developed for WP4 and WP7 purposes. www.rpe-training.eu

4.1 The common basis

The common basis is built around three modules, also called units.

It is worth noting that participants, not nuclear workers but wishing to invest this field, will receive a training enabling them to understand the various aspects of radiation protection domain.

This shall be without prejudging the domain in which they will practice (research, industry, NORM...).

As a result, all the general principles of radiation protection are covered in these three modules. Then, in the specialised modules, further information will be given.

As an example for emergencies issues: in Unit 3 (module 3) of the Common Basis, these situations are discussed in a general way. It is from the specialised module that the specificities of emergencies will appear. For example, for a future RPE that will work in the NPPs' field, a course on emergencies that may be encountered in nuclear power plants, will be offered.

It will be different from the one related to NORM for example, but the basics will have been taught in the Common Basis.

As part of the implementation of ECVET process, a summative evaluation is foreseen at the end of each of the three modules.

Thus it will be possible to assess whether learning outcomes are satisfactory. The definition of criteria and indicators for assessing the achievement of learning outcomes is developed in other work packages.

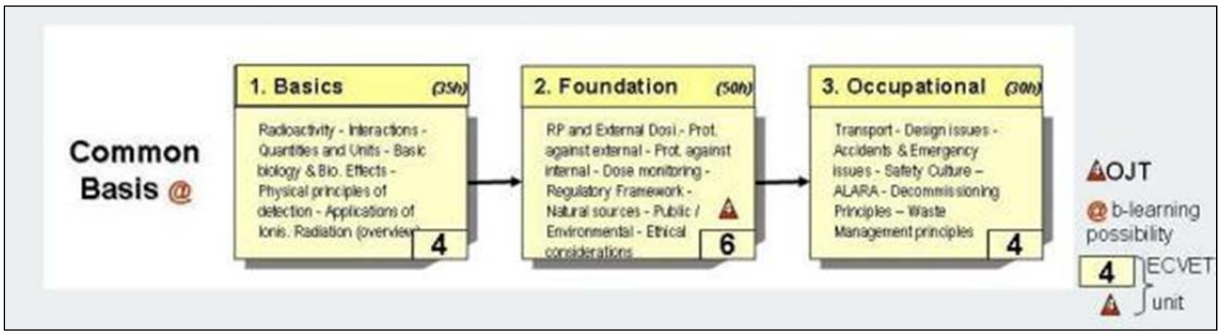

FIGURE 20: ENETRAP II; THE COMMON BASIS WITH 3 MODULES

4.1.1 Unit 1 (module 1): Basics

This module represents the first part of the "common basis" and deals with physics related to ionizing radiations: radioactivity and nuclear physics, interaction of radiations with matter, dosimetry, biological effects of radiations, detection, physical principles and ends with an overview of ionising radiations applications.

List of RPE competences
Understand the phenomenon of radioactivity
Understand the interaction of ionising radiation with matter
Apply the dosimetric concepts
Apply the different operational quantities used for dosimetry
Know the biological effects of ionising radiations
Analyse/understand an epidemiological study
Use different detection devices
Describe the main uses of radiation in various fields

List of RPE sub competences
Define nuclei property
Explain principal concept of basics nuclear model
Define quantities characterising nuclei
Explain the main type of interactions with matter in function of nature and energy of radiations
Compare with the neutron interactions
Differentiate the efficiency of different shielding for different radiations
Assess and interpret external dosimetry
Evaluate internal and/or superficial dosimetry
Describe dosimetric quantities
Classify the different biological effects (deterministic, stochastic and hereditary effects)
Assess of the risks linked to doses

Make measurement
Use the appropriate device
Be able to advice on adapted devices for a situation
Know limit of detection
Categorise different types of radiation sources
Explain application of radiation sources (natural and human made radionuclides; consumer products)

4.1.2 Unit 2 (module 2): Foundation

This part highlights fundamental aspects of the operational radiation protection; external and internal exposures, dose monitoring, regulatory context, natural sources, RP of public and environmental issues and at least, ethical considerations.

List of RPE competences
Apply physical dosimetry systems
Apply the three means of protection against ionising radiation (time, display, distance)
Apply the rules of the workplace dosimetry
Characterize a workplace
Using the supra national regulations and national regulatory frame of reference
Use the main regulatory texts
List the natural sources of ionizing radiations
Incorporate ethical considerations

List of RPE sub competences
List the passive dosimetry devices
List the active dosimetry devices
Explain the principles of internal dosimetry
Apply radiation protection by setting up shielding
Apply radiation protection by reducing the exposed time
Apply radiation protection by increase the distance
Estimate collective dose
Know the regulatory arrangements put in place (zone dosimetry)
Know the rules of the Art of nuclear ventilation
Explain the risk of criticality
Supervise a workplace study
Know the regulation connection between supra national and national
Identify the actor of regulation (ICRP, IAEA, EU..)
Follow the news of regulations
Make a critical interpretation of regulations (on a topic)
Achieve the training of exposed persons
Identifying the natural sources of ionizing radiations
Manage the public and environmental radiation protection
Integrate ethical considerations in the medical field
Integrate ethical considerations in the industrial field
Communicate information between RPE

4.1.3 Unit 3 (module 3): Occupational

The last module deals with all other aspects common to different domains of radiation protection example e.g. transportation, accidental and emergency situations, implementation of ALARA principle, safety culture, labs and nuclear installations design issues, decommissioning and waste management principles.

List of competences
Implement the regulatory measures for transport of radioactive material (Class 7)
Design a facility based on the source term
Study the accidental / incidental situations
Being involved in the interface safety - Radiation
Take account of radiation protection issues for waste generated by the installation

List of RPE sub competences
Apply the repository
Design an installation with sealed sources
Design an installation with unsealed sources
Use the feedback of accidental / incidental situations
Consider applications from authority
Analyze safety report in terms of radiation protection
Manage waste for an operation

4.2 The optional modules

The basis knowledge called "common basis" has been established. In complement of this common grounding, different modules are offered.

Although these modules are self-standing and as seen before, there is a grouping of the first three modules that represents the minimum common knowledge on radiation protection. Other independent modules and named “specialised modules” are related to specific topics such as: nuclear plants and research reactors, waste management and decommissioning, research and non-nuclear areas, medical and naturally occurring radioactive materials (NORM).

Chosen module(s) depend(s) on the domain in which the RPE is going to be engaged.

RPEs should at least follow the part "Common Basis" plus a minimum of a optional module.

Each module is self-standing and a final summative evaluation is introduced at the module’s end, taking the form of multiple choice questions, exercises or problems to solve.

The following diagram represents the scheme and shows all optional modules offered for the RPE training.

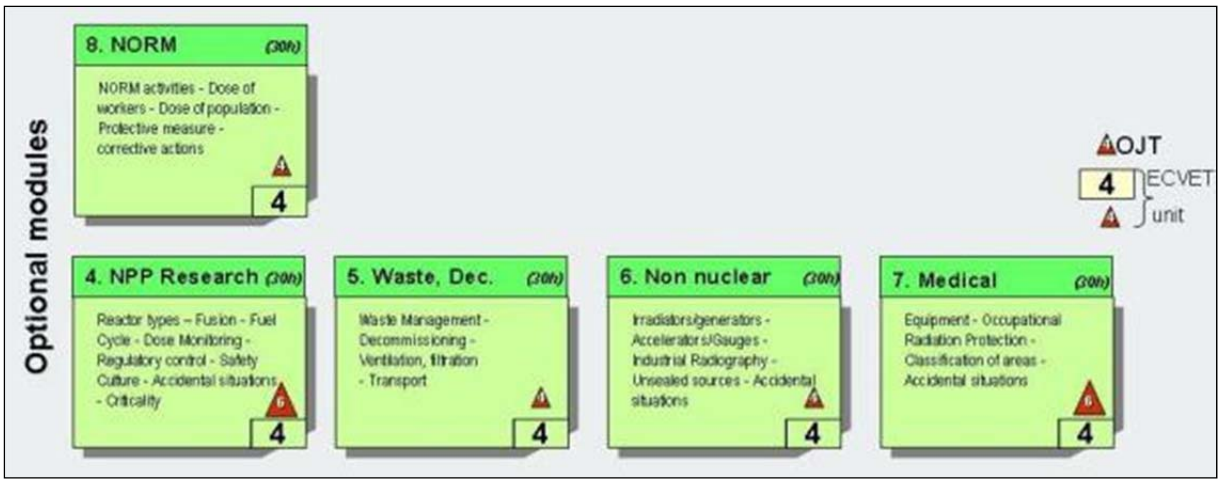

FIGURE 21: ENETRAP II; THE OPTIONAL MODULES

There is a clear need to build a structure of "flexible" training programmes so that supply can meet the training requirements in compliance with the concept of Radiation Protection Experts under the EU Directive.

For example, does an expert in radiation protection only working for nuclear power plants, has to undergo special training in radiation protection for the medical field? The answer is no because the only area where such an expert operates, remains the industrial sector.

However if an individual who wants to become a RPE, would like to cover several areas, the modular approach allows him to select the modules to be studied.

The approach in this project is to achieve a balance between theoretical knowledge and skills best suited to meet the RPE definition.

4.2.1 Unit 4 (module 4): NPPs and Research reactors

List of RPE competences
Describe the general principle of operation for NPPs
Apply the RP reference of an installation or for an operator
Advice on radiation protection actions to be implemented in normal operation

List of RPE sub competences
List the issues of radiation protection for nuclear power plant
Know the issues of radiation protection in the various steps of the fuel cycle
Apply radiation protection in the installation
Monitor the workplace
Follow the evolution of the nuclear installation (Safety + RP aspects)
Follow the evolution of the nuclear installation (Safety + RP aspects)
Be prepared for interventions
Ensure the application of optimization principle (ALARA)

4.2.2 Unit 5 (module 5): Waste management and decommissioning

List of RPE competences	List of RPE sub competences
Ensure the technical support function to the dismantler	Be involved in the drafting of specifications
	Know the regulatory reference for dismantling
	Be involved in the validation of decommissioning procedures
	Manage (or have managed) the operational dosimetry
	Monitor the workplace in terms of radiation protection
	Manage waste in terms of radiation protection
	Ensure the transport of radioactive materials (radiation protection aspects)
	Perform radiation monitoring of storage areas

4.2.3 Unit 7 (module 7): Medical

This unit describes the competences that a RPE working in the medical uses to apply a radiation protection program. RPE competences are limited to the radiation protection of workers and the public. They do not interfere with the exposure of patient that is the responsibility of medical physicists.
The RPE has also to establish the classification of areas (controlled and supervised).

List of RPE competences	List of RPE sub competences
Apply the principles of operational radiation protection in medicine	Carry out work place study
	Conduct a risk analysis (all types)
	Perform staff training
	Participate in the design of new activities
	Analyse new situation of occupational exposure (exposed workers or not) in the case of new techniques (i.e. Samarium combined with dialysis of an injected patient)
	Manage solid/liquid and gaseous waste
	Organize the hospital security (security guard) in case of fire in relation to the presence of radioactive sources
	Organize the intervention of Technical Services (i.e. clogged toilets and presence of I131)
	Know all actors involved directly and indirectly by radioactive sources
	Manage relations with the occupational medicine service
Know the organization of the hospital (local) and relationship with the head of the establishment	
Manage the interaction with stakeholders	
Manage the Quality Control/Quality Assurance and dosimetric assessment of radiation equipment and devices (for radiology and radiotherapy)	

Manage personal dosimetry service and dose recording procedure
Manage the radiation accidents and incident
Manage relationships with the regulatory body
Manage the authorisation to possess radioactive sources
Manage the declaration statements to possess radioactive sources
Manage the changes of installation file
Manage records for the implementation of new technics / installation (e.g. for intraoperative breast cancer)
Adapt existing installation (or old) to changes in regulation
Perform the dosimetric assessment of radiation equipment: 1) radiology: measurements of KAP/DAP, ESD/ESAK, ID, CTDI, etc. 2) radiotherapy: measurements of PDD, dose profiles, etc.

4.3 The refresher course mostly based on complementary modules

Regulatory developments around the radiation protection mean that RPE will be retrained with a frequency of 3 to 5 years. On this occasion, new knowledge can be proposed to him. These new units can be considered as complementary modules that RPE choose on a voluntary basis or, these units could be part of the refresher training including regulatory updates and one or more add-ons.

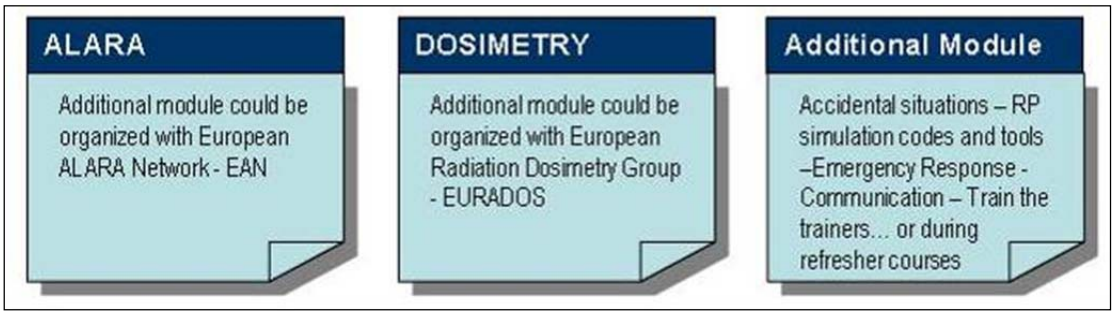

FIGURE 22: ENETRAP II; THE COMPLEMENTARY MODULES

5 Conclusion

Writing a training reference using descriptors such as Learning Outcomes is a long process. However, the ability to characterize the main competences contributes to the perfect match between the demand expressed by nuclear operators and training programs. Thus, it is possible to reformulate a main competence and also to make it evolve.

In this project we tried to apply the European ECVET system, and some difficulties have arisen.

On the one hand because the ECVET system may at first seems somewhat complex, it was necessary to deploy a methodology based on a hierarchical structure:

Unit → Competence → sub competence → Knowledge and / or Skill and / or Attitude.

On the other hand, given the level of detail used to describe RPE competences in both “Common Basis” units and optional modules, it was necessary to develop a prototype of software based on Access database management.
This prototype helped to input and organise the 80 competences and 350 learning outcomes.

The features of this prototype could advantageously be used in a specific software development that would describe uniformly competences.
These competences whose description would be harmonized, could allow describing in a coherent and consistent way most job profiles for nuclear and other industries.
This would also have the advantage of promoting the use of a common language and a shared methodology. In addition, this software will allow writing several common set of competencies that RPE, but also other nuclear workers, would share (e.g. common elements of safety culture).

In addition, the fact of using different levels of EQF to give information on the level of control of knowledge, skills and attitudes; allows adjusting the description of competences.
Finally, the description of the RPE can be used to establish the description of the RPO.

The experience gained from this work package provides information on the relative complexity of describing a job profile trying to use descriptors such as "Knowledge, Skills and Attitudes” embedded in the ECVET system.

6 Abbreviations table

CEDEFOP	European Centre for the Development of Vocational Training
E&T	Education and training
ECTS	European Credit Transfer System
ECVET	European Credit system for Vocational Education and Training
EMRP	European Master's degree in Radiation Protection
ENETRAP	European Network on Education and Training in RAdiological Protection
EQF	European Qualification Framework
EQAVET	European quality assurance in vocational education and training
EU BSS	European Basic Safety Standard
EUTERP	European Training and Education in Radiation Protection Foundation
IAEA	International Atomic Energy Agency
KSA	Knowledge, skills and Attitudes
KSC	Knowledge, skills and competences
LLL	Life Long Learner
LOA	Learning Outcomes for Attitudes
LOK	Learning Outcomes for Knowledge
LOS	Learning Outcomes for Skills
MoU	Memorandum of Understanding
MPE	Medical physics expert
NPP	Nuclear Power Plant
OJT	On-the-job training
QE	Qualified Expert
RP	Radiation Protection
RPE	Radiation Protection Expert
RPO	Radiation Protection Officer

7 Reference

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3. Council Directive 97/43/Euratom of 30 June 1997 on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure. http://ec.europa.eu/energy/nuclear/radioprotection/doc/legislation/9743

4. ICRP, 1991. 1990 Recommendations of the International Commission on Radiological protection. ICRP Publication 60. Ann. ICRP 21 (1-3). http://www.icrp.org

5. FP6 ENETRAP WD. 7 Report on European Radiation Protection Training Scheme (WP7) http://www.sckcen.belenetrap

6. IAEA Training Course Series No. 18 "Postgraduate Educational Course in Radiation Protection and the Safe Use of Radiation Sources - Standard Syllabus", 2002 http://www-pub.iaea.org/MTCD/publications/PDF/TCS-18

7. Council Directive 89/618/Euratom of 27 November 1989 on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency http://eur-lex.europa.eu/lexuriserv/lexuriserv.do?uri=celex:31989l0618:en:html

8. Council Directive 90/641/Euratom of 4 December 1990 on the operational protection of outside workers exposed to the risk of ionizing radiation during their activities in controlled areas http://eur-lex.europa.eu/LexUriServ/LexUrtServ.do?uri=0J:L:1990:34Y:o021:0025:EN:PDF

8 Appendix

8.1 List of Competences, sub competences and Learning Outcomes

8.1.1 Unit 1 - Module 1

Full report

ID	Description	Grd
1	**Radioactivity and nuclear physics**	
SCo 1.2	**Explain principal concept of basics nuclear model**	5-6
Knowledge		
LO K 1.2.1	2-3	
Give the main characteristics of atoms (electrical charge, nuclei, mass and dimension)		
Skills		
LO S 1.2.1	5-6	
Give the composition of any nuclei (p, n and e)		
SCo 1.3	**Define quantities characterising nuclei**	5-6
Knowledge		
LO K 1.3.1	5-6	
Define the notions of activity, intensity of radiation, half-life		
Skills		
LO S 1.3.1	5-6	
Use the chart of nuclides and nuclear data and find important constants		

ID	Description	Grd
2	**Interaction of radiations with matter**	
Co 2	**Describe the interaction of ionising radiation with matter**	5-6
SCo 2.1	**Explain the main type of interactions with matter in function of nature and energy of radiations**	5-6
Knowledge		
LO K 2.1.1 Define different type of interaction (charged and uncharged particles)		5-6
LO K 2.1.2 Describe ionisation and excitation phenomenon		5-6
LO K 2.1.3 Interpret attenuation of gamma radiation as a function of thickness and Z		5-6
Know the range of different radiation (alpha, beta, neutron, X and gamma)		5-6
LO K 2.1.5 List the different photons interaction effects		5-6
LO K 2.1.6 Estimate the energy range of different effects (photoelectric effect, Compton scattering and pair production)		5-6
Skills		
LO S 2.1.1 Calculate the range of a beta radiation and the attenuation of a radiation using curves		5-6
LO S 2.1.2 Calculate thickness of shielding in function of component (Z) and energy		5-6
LO S 2.1.3		5-6
Attitude		
LO A 2.1.1 security and caution to use adequate shielding		

ID	Description	Grd
2	**Interaction of radiations with matter**	
SCo 2.2	**Compare with the neutron interactions**	4-5
Knowledge		
LO K 2.2.1		5-6
List the different neutrons interaction effects		
LO K 2.2.2		4-5
Outline the specificities of absorption and moderation of neutrons source		
Skills		
LO S 2.2.1		5-6
Calculate shielding manually and by using calculation code		
SCo 2.3	**Differentiate the efficiency of different shielding for different radiations**	5-6
Knowledge		
LO K 2.3.1		5-6
Apply shielding properties (backscattering, build-up..)		

ID	Description		Grd
3	**Dosimetry: quantities and units**		
Co 3	**Differentiate between exposure, Kerma and apply the dosimetric concepts**		5-6
SCo 3.1	**Assess and interpret external dosimetry**		5-6
Knowledge			
LO K 3.1.1		5-6	
Assess individual dose for both external and internal exposure,			
LO K 3.1.2		5-6	
Determine the features of a dose monitoring program (area and individual),			
SCo 3.2	**Evaluate internal and/or superficial dosimetry**		4-5
Knowledge			
LO K 3.2.1		4-5	
Descibe biokinetic models used (ICRP)			
Skills			
LO S 3.2.1		5-6	
Calculate a commited effective dose			
Co 4	**Apply the different operational quantities used for dosimetry**		5-6

ID	Description	Grd
3	**Dosimetry: quantities and units**	
SCo 4.1	**Describe dosimetric quantities**	5-6
Knowledge		
LO K 4.1.1		4-5
Define the deposition and energy transfer		
LO K 4.1.2		4-5
Define the Relative Biological Effectiveness (RBE)		
LO K 4.1.3		4-5
Define the LET concept		
LO K 4.1.4		5-6
Skills		
LO S 4.1.1		5-6
Establish relationship between absorbed dose and the source activity		

ID	Description	Grd
4	**Biological effects of radiations**	
Co 5	**Identify the biological effects of ionising radiations**	5-6
SCo 5.1	**Classify the different biological effects (deterministic, stochastic and hereditary effects)**	5-6
Knowledge		
LO K 5.1.1 List various biological effects (tissue, cellular ...)	5-6	
LO K 5.1.2 Give and comment the ICRP risk factors	5-6	
LO K 5.1.3 Estimate the dose rate to different distances from a radioactive point source (beta or photon),	5-6	
LO K 5.1.4		
Skills		
LO S 5.1.1 Present the different mechanisms to a non-specialist public (cell reparation, cell death ...)	5-6	
LO S 5.1.2 Present the various biological effects to a non-specialist public	5-6	
Co 6	**Analyse/understand an epidemiological study**	5-6

ID	Description	Grd
4	**Biological effects of radiations**	
SCo 6.1	**Assess of the risks linked to doses**	4-5
Knowledge		
LO K 6.1.1		4-5
Interpret epidemiological result		
LO K 6.1.2		4-5
Describe the concept of radiation detriment by using Wtissue and Wradiation		
Skills		
LO S 6.1.1		4-5
Make calculation using epidemiological data taken into a specific study		

ID	Description	Grd
5	**Physical principles of detection**	
Co 7	**Use different detection devices**	5-6
SCo 7.1	**Make measurement**	5-6
Knowledge		
LO K 7.1.1		5-6
Describe processes of detection		
Skills		
LO S 7.1.1		5-6
Have attitude adapted to the probe used (probe displacement speed)		
LO S 7.1.2		5-6
Know the distances of detection for different type of nuclei		
Attitude		
LO A 7.1.1		5-6
React appropriately when a device indicates a measure (e.g. panic linked to the sound)		
SCo 7.2	**Use the appropriate device**	5-6
Knowledge		
LO K 7.2.1		5-6
Know the different kind of probe adapted to one (or more) type of radiation		
Skills		
LO S 7.2.1		5-6
Identify an unknown source		

ID	Description	Grd
5	**Physical principles of detection**	
SCo 7.3	**Be able to advice on adapted devices for a situation**	5-6
Knowledge		
LO K 7.3.1		5-6
Know the different providers of detection equipment		
Attitude		
LO A 7.3.1		5-6
Ensure a technology watch on detection devices		
SCo 7.4	**Know limit of detection**	5-6
Skills		
LO S 7.4.1		5-6
Calculate a detection limit		

ID	Description	Grd
6	**Application of ionising radiation**	
Co 8	**Describe the main uses of radiation in various fields**	5-6
SCo 8.1	**Categorise different types of radiation sources**	5-6
Knowledge		
LO K 8.1.1		5-6
	Raise a panorama of usages of ionizing radiations in different domains	
LO K 8.1.2		5-6
	Know the order of magnitude of the activities related to these radioactive sources	
Skills		
LO S 8.1.1		5-6
	Recognise a situation of exposure by seeing a source (picture, video or directly)	
SCo 8.2	**Explain application of radiation sources (natural and human made radionuclides; consumer products)**	5-6
Knowledge		
LO K 8.2.1		
7	**Radiation protection**	
Co 9	**Apply physical dosimetry systems for external and internal exposures**	5-6

ID	Description	Grd
8	**Radiation protection internal dosimetry**	
SCo 9.1	**List the passive dosimetry devices**	5-6
Knowledge		
LO K 9.1.1		5-6
Categorize the different systems of passive dosimetry (alpha, beta, gamma and X, including neutron)		
LO K 9.1.2		5-6
Differentiating the dosimetry of traces (ie radon)		
Skills		
LO S 9.1.1		5-6
Choose the appropriate passive dosimeter		
Attitude		
LO A 9.1.1		5-6
Keeping informed of changes in technology for passive dosimeter		
SCo 9.2	**List the active dosimetry devices**	5-6
Knowledge		
LO K 9.2.1		5-6
Categorize the various active dosimetry systems (alpha, beta, gamma and X, including neutron)		
Skills		
LO S 9.2.1		5-6
Choose the appropriate active dosimeter		
Attitude		
LO A 9.2.1		5-6
Keeping informed of changes in technology for active dosimeters		

ID	Description	Grd
8	**Radiation protection internal dosimetry**	
SCo 9.3	**Explain the principles of internal dosimetry**	5-6
Knowledge		
LO K 9.3.1		4-5
Describe the physical aerosol aspects (particle size) and kinetic models bio		
LO K 9.3.2		5-6
Give examples of specific dosimetry (extremity, lens, injury ...)		
LO K 9.3.3		5-6
Distinguish external and internal exposure		
Skills		
LO S 9.3.1		5-6
Calculate the committed dose by using the dose unit of intake h(g)		
Attitude		
LO A 9.3.1		5-6
Discuss with occupational physician on a case of contamination		

8.1.2 Unit 2 - Module 2

ID	Description	Grd
9	**Protection against external exposure**	
Co 10	**Apply the three means of protection against ionising radiation (time, display, distance)**	5-6
SCo 10.1	**Apply radiation protection by setting up shielding**	5-6
Knowledge		
LO K 10.1.1		5-6
Knowing the properties and different shielding materials		
Skills		
LO S 10.1.1		5-6
Calculate shielding and combination of shields		
LO S 10.1.1		5-6
Calculate shielding and combination of shields		5-6
Understand the technical constraints linked to the wearing of personal protective equipment (lead apron, gloves sealed)		
LO S 10.1.2		4-5
Calculate dose/shielding using Monte Carlo and other codes		
LO S 10.1.3		0
Estimate the doserate due to a point source (characteristics and activity given - beta or photon)		0
LO S 10.1.4		
Attitude		
LO A 10.1.1		5-6
Know the rules of implementation of protection in relation to the source (to protect themselves during installation)		

ID	Description	Grd
9	**Protection against external exposure**	
SCo 10.2	**Apply radiation protection by reducing the exposed time**	5-6
Knowledge		
LO K 10.2.1		5-6
Knowing the magnitude of the impact of training on exposed time		
LO K 10.2.2		5-6
Estimate the contribution of the factor "time" to the dose (workplace study)		
LO K 10.2.3		4-5
Skills		
LO S 10.2.1		5-6
Know how to calculate exposure time (different from time billing)		
LO S 10.2.2		5-6
Perform a work place study		
SCo 10.3	**Apply radiation protection by incrise the distance**	5-6
Knowledge		
LO K 10.3.1		5-6
List the existing tool to increase distance operator/source (distances clips, robotic ...)		
Skills		
LO S 10.3.1		5-6
Calculate a gain of dose (dose contact vs 50 cm) to the extremities		
LO S 10.3.2		5-6
Calculate a gain of dose (dose contact vs 50 cm) effective dose		

ID	Description	Grd
9	**Protection against external exposure**	
SCo 10.4	**Estimate collective dose**	5-6
Knowledge		
LO K 10.4.1		5-6
Give the average collective dose in main situation e.g reactor shutdown…		
Skills		
LO S 10.4.2		5-6
Calculate a previsional collective dose for an exposed situation		
LO S 10.4.3		5-6
List methods to decontaminate		

ID	Description	Grd
10	**Dose monitoring**	
Co 11	**Apply the rules of the workplace dosimetry**	5-6
SCo 11.1	**Know the regulatory arrangements put in place (zone dosimetry)**	5-6
Knowledge		
LO K 11.1.1		
Describe the workplace dosimetry devices		
Skills		
LO S 11.1.1		5-6
Locate and identify workplace dosimetry devices during visit (audit)		
LO S 11.1.2		5-6
Put in right place the workplace dosimeter		
LO S 11.1.3		5-6
Attitude		
LO A 11.1.1		5-6
Observe the device installed and their relevance to the source term		
LO A 11.1.2		5-6
Understand the technical constraints linked to the wearing of personal protective equipment (lead apron, gloves sealed...)		

ID	Description	Grd
10	**Dose monitoring**	
SCo 11.2	**Know the rules of the Art of nuclear ventilation**	5-6
Knowledge		
LO K 11.2.1		4-5
List the characteristics of nuclear ventilation		
Skills		
LO S 11.2.1		
Know where to locate the sampling point airflow		
LO S 11.2.2		5-6
Check local depressions between (cascade of depression)		
LO S 11.2.3		5-6
Attitude		
LO A 11.2.1		5-6
Observe the appropriateness of materials used (sampling tube, pressure drop, elbow) and device (mobile vs. Fixed)		
LO A 11.2.2		5-6
Consider when opening a door too easy (local depression)		

ID	Description	Grd
10	**Dose monitoring**	
SCo 11.3	**Explain the risk of criticality**	5-6
Knowledge		
LO K 11.3.1		3-4
Rebuilding effective doses following a criticality accident		
Skills		
LO S 11.3.1		5-6
be able to read snac		
LO S 11.3.2		5-6
Implement and enforce evacuation procedures related to the criticality risk		
Co 12	**Characterize a workplace**	5-6
SCo 12.1	**Supervise a workplace study**	5-6
Knowledge		
LO K 12.1.1		
Know and apply the methodological guide		
Skills		
LO S 12.1.1		4-5
Conduct a workplace study		
LO S 12.1.2		3-4
Determine the collective and individual protective means		
Attitude		
LO A 12.1.1		5-6
Integrate the multirisk approach (radiological and other occupational hazards) EvRP		

ID	Description	Grd
11	**Regulatory context**	
SCo 13.1	**Know the regulation connection betwwen supra national and national**	5-6
Knowledge		
LO K 13.1.1		5-6
List the founding texts ICRP, IAEA, Euratom BSS		
LO K 13.1.1		5-6
Know and apply the methodological guide		
Skills		
LO S 13.1.1		5-6
Search to find the texts for an exposure situation		
SCo 13.2	**Identifie the actor of regulation (ICRP, IAEA, EU ...)**	5-6
Knowledge		
LO K 13.2.1		5-6
Explain the process from ICRP, IAEA, EU recommendations to the National Regulatory		
Co 14	**Use the main regulatory texts**	5-6
SCo 14.1	**Follow the news of regulations**	5-6
Knowledge		
LO K 14.1.1		5-6
List the agencies and networks responsible for regulatory watch		
Attitude		
LO A 14.1.1		5-6
Adopt an attitude of vigilance with respect to regulations on a given topic		
SCo 14.2	**Make a critical interpretation of regulations (on a topic)**	5-6

ID	Description	Grd
11	**Regulatory context**	
SCo 14.3	**Achieve the training of exposed persons**	5-6
Knowledge		
LO K 14.3.1		5-6
Relying on his knowledge in radiation protection in order to achieve a training		
Skills		
LO S 14.3.1		4-5
Organize and conduct a training session		
Attitude		
LO A 14.3.1		5-6
Provide information tailored to the audience		

ID	Description	Grd
12	**Natural sources of ionizing radiation**	
Co 15	**List the natural sources of ionizing radiations**	5-6
SCo 15.1	**Identifying the natural sources of ionizing radiations**	5-6
Knowledge		
LO K 15.1.2		5-6
List the public exposure situations (environmental, medical, accident…)		
Skills		
LO S 15.1.1		5-6
Prioritize the relative contribution of natural sources to the individual dose		
LO S 15.1.2		5-6
Give the magnitude of the average annual dose		
SCo 15.2	**Manage the public and environmental radiation protection**	5-6
Knowledge		
LO K 15.2.1		4-5
Apply the principles of dispersion models (air and water)		
Skills		
LO S 15.2.1		
Make calculation using dispersion models		
13	**Public and environmental radiation protection**	
Co 15		

ID	Description	Grd
14	**Ethical considerations**	
Co 16	**Incorporate ethical considerations**	5-6
SCo 16.1	**Integrate ethical considerations in the medical field**	5-6
Knowledge		
LO K 16.1.1		5-6
Explain the absence of dose limiting for patients but dose optimization		
Attitude		
LO A 16.1.1		5-6
Lead a discussion with medical staff exposed		
LO A 16.1.2		5-6
Integrate and enhance the feedback (dose management by example or NRD)		

ID	Description	Grd
14	**Ethical considerations**	
SCo 16.2	**Integrate ethical considerations in the industrial field**	5-6
Knowledge		
LO K 16.2.1		5-6
Explain the justification principle LO K 16.2.2		5-6
Discuss the distribution of doses between operator and subcontractors LO K 16.2.3		5-6
Attitude		
LO A 16.2.1		5-6
Keep in mind that if the exposure is low doesn't mean that the job is not corretly perform (old attitude) LO A 16.2.2		5-6
Adopt an attitude where the efficiency of a work is driven by an optimised dose (ALARA) LO A 16.2.3		5-6
Keep informed about the annual dosimetry results LO A 16.2.4		5-6
SCo 16.3	**Communicate information between RPE**	5-6

8.1.3 Unit 3 - Module 3

ID	Description	Grd
15	**Transport**	
Co 17	**Implement the regulatory measures for transport of radioactive material (Class 7)**	
SCo 17.1	**Apply the repository**	5-6
Knowledge		
LO K 17.1.1		5-6
List the variables to be monitored (Dose rate, Bq/cm2 ...)		
LO K 17.1.2		5-6
Apply the labeling of the truck and the package		
LO K 17.1.3		5-6
Skills		
LO S 17.1.1		5-6
Measure the dose equivalent (contact and 1m)		
LO S 17.1.2		5-6
Measure the level of contamination of the package		
LO S 17.1.3		5-6
Attitude		
LO A 17.1.1		5-6
Exchange with the counselor transport Class 7 of the company		

ID	Description	Grd
16	**Design Issues**	
Co 18	**Design a facility based on the source term**	
SCo 18.1	**Design an installation with sealed sources**	5-6
Knowledge		
LO K 18.1.1		5-6
List the rules for shielding		
LO K 18.1.2		5-6
List the control procedures		
Skills		
LO S 18.1.1		5-6
Apply the rules of shielding		
LO S 18.1.2		5-6
Apply control procedures		
Attitude		
LO A 18.1.1		5-6
Take into account the human factor (incident, accident, malicious ...)		

ID	Description	Grd
16	**Design Issues**	
SCo 18.2	**Design an installation with unsealed sources**	5-6
Knowledge		
LO K 18.2.1		5-6
List the control procedures (not contamination)		
LO K 18.2.2		5-6
List the rules of containment (ventilation, gloves box ...)		
Skills		
LO S 18.2.1		5-6
Implement control procedures (not contamination)		
LO S 18.2.2		5-6
Apply the rules of containment (ventilation, gloves box ...)		

ID	Description	Grd
17	**Accidents and emergency Issues**	
Co 19	**Study the accidental / incidental situations**	
SCo 19.1	**Use the feedback of accidental / incidental situations**	
Knowledge		
LO K 19.1.1		5-6
Knowing the process of reporting to authorities		
LO K 19.1.2		5-6
To evaluate the release		
Skills		
LO S 19.1.1		5-6
Evaluate the predictive dosimetry in accidental / incidental situations		
LO S 19.1.2		5-6
Provide and maintain the register of sources based on the perimeter of ERR		
Attitude		
LO A 19.1.1		5-6
Keep available to teams (information, source term ...)		

ID	Description	Grd
18	**Safety Culture**	
Co 20	**Being involved in the interface safety - Radiation**	
SCo 20.1	**Consider applications from authority**	5-6
Knowledge		
LO K 20.1.1		5-6
Explain the transfer of dose between populations		
LO K 20.1.2		5-6
Characterize the safety analysis vs RP analysis		
Skills		
LO S 20.1.1		5-6
Dose quantification following a request from authority		
Attitude		
LO A 20.1.1		
Adopt and develop the interrogative attitude		
SCo 20.2	**Analyze safety report in terms of radiation protection**	5-6
Skills		
LO S 20.2.1		
Follow and write complementary RP report		

ID	Description	Grd
19	**Waste management**	
Co 21	**Take account of radiation protection issues for waste generated by the installation and during decommissioning**	
SCo 21.1	**Manage waste for an operation**	5-6
Knowledge		
LO K 21.1.1		5-6
Know the clearance levels (Europe vs. France)		
Skills		
LO S 21.1.1		5-6
Conduct a waste zoning		
LO S 21.1.2		5-6
Check the adequacy of RP zoning and waste zoning		
SCo 21.2	**Manage waste generated during decommissionning**	
Knowledge		
LO K 21.2.1		5-6
Define the principles of decommissioning		
LO K 21.2.2		5-6
Define the different strategies for decommissionning		
LO K 21.2.3		5-6
20	**Decommissioning**	
Co 21		

ID	Description	Grd
21	**ALARA culture**	
Co 21.a	**Implement the ALARA principles**	
SCo 21.a.1	**Apply the 3 ALARA principles**	
SCo 21.a.2	**Apply the ALARA procedure**	

8.1.4 Unit 4 - Module 4

ID	Description	Grd
22	**Main types of nuclear reactors'**	
Co 22	**Describe the general principle of operation for NPPs**	
SCo 22.1	**List the issues of radiation protection for nuclear power plant**	5-6
Knowledge		
LO K 22.1.1		5-6
List the different types of reactors (included fusion tokamak)		
LO K 22.1.2		5-6
Describe the various maintenance operations performed		
Co 23	**Apply the RP reference of an installation or for an operator**	
SCo 23.1	**Know the issues of radiation protection in the various steps of the fuel cycle**	5-6
Knowledge		
LO K 23.1.1		5-6
List and identify the predominant radiation risks for each steps of the fuel cycle		
Attitude		
LO A 23.1.1		5-6
Show strength of conviction and persuasion		
Co 24	**Advice on radiation protection actions to be implemented in normal operation**	

ID	Description	Grd
22	**Main types of nuclear reactors'**	
SCo 24.1	**Apply radiation protection in the installation**	5-6

ID	Description	Grd
22	**Main types of nuclear reactors'**	
Knowledge		
LO K 24.1.1		5-6
Knowing and apply the radiation protection procedures of the operator LO K 24.1.2		5-6
Apply the radiation protection procedures of the operator LO K 24.1.3		5-6
Enforce radiation protection procedures of the operator LO K 24.1.4		5-6
Illustrate the problem of gammagraphy LO K 24.1.5		5-6
Know and implement the program of regulatory controls LO K 24.1.6		5-6
Skills		
LO S 24.1.1		5-6
Know the RP actors at the national level LO S 24.1.2		5-6
Know the local actors RP LO S 24.1.3		5-6
Advice on protective equipment, dosimeter, detection equipment - calculation of DT, DL LO S 24.1.4		5-6
Assessing the quality of training in the sub contractor (QCM) LO S 24.1.5		5-6
A workplace study for job-related to gammagraphy LO S 24.1.6		5-6

22 Main types of nuclear reactors'

LO S 24.1.7 5-6

Write an intervention file

LO S 24.1.8 5-6

Analyze an intervention file

Attitude

LO A 24.1.1 5-6

Conduct discussions with the sub-contractor

LO A 24.1.2 5-6

Participate in the representative bodies

LO A 24.1.3

Participate in inspections

LO A 24.1.4

SCo 24.2 Monitor the workplace 5-6

Knowledge

LO K 24.2.1 5-6

Implement monitoring devices at the workplace

Skills

LO S 24.2.1

Implement monitoring devices at the workplace

ID	Description	Grd
22	**Main types of nuclear reactors'**	
SCo 24.3	**Follow the evolution of the nuclear installation (Safety + RP aspects)**	5-6
Knowledge		
LO K 24.3.1		5-6
Manage changes in the installation in relation to radiation protection		
Skills		
LO S 24.3.1		5-6
Carry out workplace study after modification		

ID	Description	Grd
22	**Main types of nuclear reactors'**	
SCo 24.4	**Be Prepared for interventions**	5-6
Knowledge		
LO K 24.4.1		5-6
Know the national and local stakeholders for nuclear emergency LO K 24.4.2		5-6
Define the roles and function of the channel response LO K 24.4.3		5-6
Apply the procedures for environmental monitoring during accidental / incidental situation LO K 24.4.4		5-6
Know the procedures for incidental situations LO K 24.4.5		5-6
Apply the procedures for incidental situations LO K 24.4.6		5-6
Skills		
LO S 24.4.1		5-6
Propose scenarii of incidents / accidents LO S 24.4.2		5-6
Participate in exercises LO S 24.4.3		5-6
Participate / write emergency response LO S 24.4.4		5-6
Attitude		
LO A 24.4.1		
Communicate with the public in accidental / incidental situation		

ID	Description	Grd
22	**Main types of nuclear reactors'**	
SCo 24.5	**Ensure the application of optimization principle (ALARA)**	5-6
Knowledge		
LO K 24.5.1		5-6
Define the collective dose, the monetary value of the	person Sievert, exposed work time…	
Skills		
LO S 24.5.1		5-6
Calculate provisional dosimetry		
LO S 24.5.2		5-6
Make a calculation of dosimetry and economy factor of a radiation protection action		
LO S 24.5.3		5-6
Select the optimal option		
LO S 24.5.4		5-6
23	**The fuel cycle**	
Co		
24	**Dose monitoring and regulatory controls**	
Co		
25	**Interface safety culture and ALARA culture**	
Co		

ID	Description	Grd
26	**Accidental situations**	
Co		
27	**Interface safety culture and ALARA culture**	
Co		

8.1.5 Unit 5 - Module 5

ID	Description	Grd
28	**Decommissioning**	
Co 25	**Ensure the technical support function to the dismantler**	5-6
SCo 25.1	**Be involved in the drafting of specifications**	5-6
Knowledge		
LO K 25.1.1		5-6
Knowing the initial radiological condition/state of the installation		
LO K 25.1.2		5-6
List the different decommissioning strategies		
Skills		
LO S 25.1.1		5-6
Analyzing data from the radiological past		
LO S 25.1.2		5-6
Propose additional actions related to radiation protection		
Attitude		
LO A 25.1.1		5-6
Interact with the technicians on the radiological history of the installation		
SCo 25.2	**Know the regulatory reference for dismantling**	5-6
Knowledge		
LO K 25.2.1		4-5
Knowing the structure of the dismantling document		
LO K 25.2.2		4-5
Know the criteria for radiological cleanliness		
LO K 25.2.2		4-5

ID	Description	Grd
28	**Decommissioning**	
SCo 25.3	**Be involved in the validation of decommissioning procedures**	5-6

ID	Description	Grd
28	**Decommissioning**	
Knowledge		
LO K 25.3.1		5-6
Analyze the interventional conditions for selected scenarii LO K 25.3.2		5-6
Advise on working suits and personal protective equipment LO K 25.3.3		5-6
Know the principles of nuclear ventilation LO K 25.3.4		5-6
Know the rules of art to achieve a static containment (assembling sas) LO K 25.3.5		5-6
Know the rules of art to achieve a dynamic containment LO K 25.3.6		5-6
Advise on cutting techniques (saber sawvs grinder) and the type of environment (sealed or not) to generate the least amount of aerosol		5-6
Know the guidelines for the control of the work area LO K 25.3.9		5-6
Give the magnitudes of surface contamination levels and / or air contamination		
Skills		
LO S 25.3.1		5-6
Enforce best practices LO S 25.3.2		5-6
Check the installation of a sas LO S 25.3.3		5-6

ID	Description	Grd
28	**Decommissioning**	
Attitude		
LO A 25.3.1		5-6
Integrate feedback LO A 25.3.2		5-6
Adopt a forward-looking to ensure technological evolutions LO A 25.3.3		5-6
Exchange with stakeholders on good practices LO A 25.3.4		
Have interpersonal skills adapted to non-traditional work situations (dismantling, breakage, dust...) LO A 25.3.5		
Awareness rule on dressing / undressing LO A 25.3.6		

ID	Description	Grd
28	**Decommissioning**	
SCo 25.4	**Manage (or have managed) the operational dosimetry**	5-6
Knowledge		
LO K 25.4.1		5-6
Know the projected dose at the different stages of the dismantling project		
LO K 25.4.2		5-6
Know the factors influencing the doserate		
LO K 25.4.3		5-6
Skills		
LO S 25.4.1		5-6
Conduct or make somebody a calculation of estimated dose		
LO S 25.4.2		
Analyze the estimated dosimetry		
LO S 25.4.3		5-6
Conduct cartographies of the site		
LO S 25.4.4		
Attitude		
LO A 25.4.1		5-6
Exchange and make proposals for the ALARA implementation		
LO A 25.4.2		5-6
Propose ways to improve the optimisation of collective doses		

ID	Description	Grd
28	**Decommissioning**	
SCo 25.5	**Monitor the work place in terms of radiation protection**	5-6
Knowledge		
LO K 25.5.1		5-6
Know the operational characteristics of dosimeters used		
Skills		
LO S 25.5.1		4-5
Equip workers with adapted operational dosimeters		
LO S 25.5.2		5-6
Implement and enforce the rules of the art of radiation protection for dressing / undressing for protection suits		
Attitude		
LO A 25.5.1		5-6
Adopt a strict attitude regarding the regulation		
SCo 25.6	**Manage waste in terms of radiation protection**	5-6
Knowledge		
LO K 25.6.1		5-6
List the different flux of waste disposal available		
LO K 25.6.2		
Traceability of waste		
Attitude		
LO A 25.6.1		5-6
Posture to advise the operator/subcontractor		
LO A 25.6.2		5-6
Posture to support the operator/subcontractor		

ID	Description	Grd
28	**Decommissioning**	
SCo 25.7	**Ensure the transport of radioactive materials (radiation protection aspects)**	5-6
Knowledge		
LO K 25.7.1		4-5
Know the ADR and carriage regulations		
Skills		
LO S 25.7.1		5-6
Measured dose rates at contact and at 1 m of package		
LO S 25.7.2		5-6
Measure contamination levels of packages		
LO S 25.7.3		5-6
Perform marking and labelling of packages		5-6
Find a specific topic in ADR		

ID	Description	Grd
28	**Decommissioning**	
SCo 25.8	**Perform radiation monitoring of storage areas**	4-5
Knowledge		
LO K 25.8.1		5-6
Know the rules for designing storage area		
Skills		
LO S 25.8.1		5-6
Achieve the mapping of dose rates storae areas		
LO S 25.8.2		5-6
Achieve controls for lack of contamination		
LO S 25.8.3		5-6
Attitude		
LO A 25.8.1		5-6
Developing a pedagogical attitude to inform and train		
29	**Nuclear ventilation and filtration**	
Co		
30	**Waste management**	
Co		
31	**Transport of radioactive waste**	
Co		

8.1.6 Unit 7 - Module 7

ID	Description	Grd
32	**Medical workplace study and rik analysis**	
SCo 26.1	**Carry out work place study**	5-6

ID	Description	Grd
32	**Medical workplace study and risk analysis**	
Knowledge		
LO K 26.1.1		5-6
Know the various medical techniques LO K 26.1.2		5-6
Knowing the actions of practitioners in relation to the use of ionizing radiation sources LO K 26.1.3		5-6
Knowing the methodology of work place study LO K 26.1.4		5-6
Knowledge of international/national regulations LO K 26.1.5		5-6
Know the measurement techniques LO K 26.1.6		5-6
Know the limitations of devices (i.e. for pulsed field)		5-6
Skills		
LO S 26.1.1		5-6
Apply regulatory dispositon LO S 26.1.2		5-6
Carry out measurements of dose rate LO S 26.1.3		5-6
Perform measurements of contamination LO S 26.1.4		5-6
Perform calculations of protective shielding LO S 26.1.5		5-6

ID	Description	Grd
32	**Medical workplace study and rik analysis**	
LO S 26.1.6		5-6
Perform calculations for individual and collective dosimetry		
LO S 26.1.7		5-6
Know how to schedule measurements campaigns without disrupting service		
Attitude		
LO A 26.1.1		5-6
Discuss with the health staff on the usefulness and relevance of work place study		
LO A 26.1.2		5-6
Exchange with the medical doctors to schedule measurements campaigns without disrupting service		

ID	Description	Grd
32	**Medical workplace study and rik analysis**	
SCo 26.2	**Conduct a risk analysis (all types)**	5-6

ID	Description	Grd
32	**Medical workplace study and rik analysis**	
Knowledge		
LO K 26.2.1		5-6
Know the methodology for conducting a radiological work place zoning LO K 26.2.2		5-6
Know the general and dedicated RP regulations LO K 26.2.3		5-6
Know the measurement techniques LO K 26.2.4		5-6
Synthesize the various technologies of detection devices LO K 26.2.5		5-6
List the individual and collective equipments LO K 26.2.6		5-6
Understand the issues related to nuclear ventilation and air contamination in nuclear medicine LO K 26.2.7		
Knowing the limits of detection devices in a pulsed field		
Skills		
LO S 26.2.1		5-6
Propose a suitable dosimetry LO S 26.2.1		
Conduct/undertake decontamination procedures LO S 26.2.2		5-6
Propose a suitable collective dosimetry LO S 26.2.3		5-6

32 Medical workplace study and rik analysis

LO S 26.2.4	5-6
Apply monitoring of individual and collective exposures LO S 26.2.5	5-6
Perform a technology watch for personal protective equipment, dosimeters… LO S 26.2.6	5-6
Consider the problem of hygiene (sterilization FLi rings) in relation to the health service LO S 26.2.7	5-6
Make proposals for new personal protective equipment LO S 26.2.8	5-6
Measure the air turnover time LO S 26.2.9	5-6

Attitude

LO A 26.2.1	5-6
Inform on Radiation Protection issues LO A 26.2.2	5-6
Train on radiation protection fiels LO A 26.2.3	5-6
Argue and exchange ideas about hygiene protocols LO A 26.2.4	5-6

Attitude of technological and testing (glass, lead apron, leaded glass, gloves, surgical sterile and sealed ...)
Exchange with the physicists, but distinction between patient dosimetry (not RPE) and dosimetry of workers and the public

ID	Description	Grd
33	**Implementation of new medical activities**	
SCo 26.3	**Perform staff training**	
Skills		
LO S 26.3.1		5-6
Create a training sequence		
LO S 26.3.2		5-6
Appropriate training techniques based on assistance profile		
Attitude		
LO A 26.3.1		5-6
Communicate effectively with staff		
SCo 26.4	**Participate in the design of new activities**	5-6
Skills		
LO S 26.4.1		5-6
Perform shielding and predictive dosimetry calculations		
LO S 26.4.2		5-6
Quantify the environmental impact (nuclear medicine)		
Attitude		
LO A 26.4.1		5-6
Educate staff in relation to new techniques (psychological)		

ID	Description	Grd
33	**Implementation of new medical activities**	
SCo 26.5	**Analyze new situation of occupational exposure (exposed workers or not) in the case of new techniques (i.e. Samarium co**	5-6
Knowledge		
LO K 26.5.1	5-6	
Know the decontamination techniques		
Skills		
LO S 26.5.1	5-6	
Decontaminate or to commission a decontaminating of surface (eg urine reversed)		
Attitude		
LO A 26.5.1	5-6	
Adopt a reactive attitude		
SCo 26.6	**Manage solid/liquid and gazeous waste**	5-6
Knowledge		
LO K 26.6.1	5-6	
Know the regulation relating to discharges		
Co 27	**Know the organization of the hospital (local) and relationship with the head of the establishment**	5-6
SCo 27.1	**Organize the hospital security (security guard) in case of fire in relation to the presence of radioactive sources**	5-6
Skills		
LO S 27.1.1	5-6	
Informe and train of such personnel		
Attitude		
LO A 27.1.1	5-6	
Adopt an open minded attitude (i.e. to know who does what in the hospital…)		

ID	Description		Grd
33	**Implementation of new medical activities**		
SCo 27.2	**Organize the intervention of Technical Services (i.e. clogged toilets and presence of I131)**		5-6
Skills			
	LO S 27.2.1	5-6	
	Informe and train of such personnel		
SCo 27.3	**Know all actors involved directly and indirectly by radioactive sources**		5-6
SCo 27.4	**Manage relations with the occupational medicine service**		5-6
SCo 27.5	**Manage personal dosimetry service and dose recording procedure**		5-6
SCo 27.6	**Manage the radiation accidents and incident**		5-6
Knowledge			
	LO K 27.6.1		
	Know the medical radiation accidents and incidents		
Skills			
	LO S 27.6.1		
	Planning the medical response to radiological accidents and incidence		
Attitude			
	LO A 27.6.1		
	Communication in the case of radiological accidents with staff and patients		
34	**Hospital organisation and RP roles and duties**		
Co			

ID	Description	Grd
35	**Stakeholders interactions**	
Co 28	**Manage the interaction with stakeholders**	
SCo 28.1	**Manage relationships with the regulatory body**	
SCo 28.2	**Manage the autorisation to possess radioactives sources**	
Knowledge		
LO K 28.2.1		5-6
Understand the interactions with the health authority (national and regional)		
Skills		
LO S 28.2.1		5-6
Implement the technical aspects of the Waste Management (liquid, gaseous and solid)		
LO S 28.2.2		5-6
Manage discharge permits		
SCo 28.3	**Manage the declaration statements to possess radioactives sources**	
SCo 28.4	**Manage the changes of installation file**	
SCo 28.5	**Manage records for the implementation of new technics / installation (eg for intraoperative breast cancer)**	
Attitude		
LO A 28.5.1		5-6
Adviser in relation to regulations		

ID	Description	Grd
35	**Stakeholders interactions**	
SCo 28.6	**Adapt existing installation (or old) to changes in regulation**	
Skills		
LO S 28.6.1		5-6
Manage relationships with recognized organizations		
LO S 28.6.2		5-6
Manage internal and external RP controls		
LO S 28.6.3		5-6

ID	Description	Grd
36	**Quality control and quality assurance in medical sector**	
Co		5-6
Co 1	**Describe the phenomenon of radioactivity**	5-6
SCo 1.1	**Define nuclei property**	5-6
Knowledge		
LO K 1.1.1		5-6
Explain the different modes of disintegration and desexcitation		
LO K 1.1.2		5-6
Describe the different type of radiations emitted and their features		
Skills		
LO S 1.1.1		5-6
Give/predict the type of decay depending on the position of radionucleide over the valley of stability.		
LO S 1.1.2		5-6
Calculate the activity of a source at any time by using the radioactive decay equation		
Attitude		
LO A 1.1.1		5-6
React properly in function of radionucleide (Energy, activity, desintegration mode, half-life …)		

ID	Description	Grd
37	**Quality control and quality assurance in medical sector**	
Co 29	**Manage the Quality Control/Quality Assurance and dosimetric assessment of radiation equipment and devices (for radiolog**	
SCo 29.1	**Perform the dosimetric assessment of radiation equipment: 1) radiology: measurements of KAP/DAP, ESD/ESAK, ID, CTDI, e**	
Knowledge		
	LO K 29.1.1	
	Knowledge of the dosimetric quantities and associated relevant concepts (backscattering factors, etc.)	
	LO K 29.1.2	
	Knowledge of the X-ray equipment (including filters collimators), radiation/dose meters (DAP/KAP meters, ionization chambers)	
	LO K 29.1.3	
	Knowledge of the linear accelerator technology, including associated equipment (filters, collimators, etc.)	
	LO K 29.1.4	
	Knowledge of measurement phantoms (mammography phantoms, CTDI phantoms, water phantoms, etc.) and	
Skills		
	LO S 29.1.2	
	Perform measurements of DAP, CTDI, etc.	
	LO S 29.1.4	
	Perform measurements of PDD, dose radial profiles, etc.	
Attitude		
	LO A 29.1.1	
	Promote every effort to enhance and promote the radiation protection of the patient	

8.2 ENETRAP Forms

8.2.1 Unit 1 – Module 1

ENETRAP-II

COMMON BASIS

Indicatieve ECVET points for module:

Module name: 1 Basics

Coursedescription1 1 Radioactivity and nuclear physics

Course N°:	Lecture (indicative hours)	Tutorial/PW/OJT (indicative hours)	Prerequisite:	Lecturer:
1		3		

COMMON BASIS module deals with physical aspect of ionising radiations, biological bases of radiological protection, principal type of radiation detectors, different usages of ionizing radiations in different domains and finally type and

Course objectives:

Making learners familiar with the basic properties of atomic nuclei, quantities characterising nuclei, acting forces, and principal ideas of basic nuclear models, which will serve as a background for explanation of dynamic processes in nuclear and radiation physics

Key words:

Nuclear decay - natural radioactivity - artificial radioactivity - mechanisms of nuclear reactions - types of nuclear reactions - atomic nucleus - nuclear models

Teaching and learning approach

Lectures which aim to enrich the knowledge and concepts of radiation protection.

In addition, tutorial sessions are also included for further consolidating the knowledge discussed in lectures

Assessment method

(to be defined) learners will be assessed by written assignments, quizzes and written examination.

Key competence(s) and Learning Outcomes

On successful completion of this subject, learners are expected to be able to:

Co 1 **Describe the phenomenon of radioactivity** 5-6 *Grd*

SCo 1.1 **Define nuclei property** 5-6 *Grd*

Knowledge

LO K 1.1.1 5-6

Explain the different modes of disintegration and desexcitation

LO K 1.1.2 5-6

Describe the different type of radiations emitted and their features

Skills

LO S 1.1.1 5-6

Give/predict the type of decay depending on the position of radionucleide over the valley of stability.

LO S 1.1.2 5-6

Calculate the activity of a source at any time by using the radioactive decay equation

Attitude

LO A 1.1.1 5-6

React properly in function of radionucleide (Energy, activity, desintegration mode, half-life …)

SCo 1.2 **Explain principal concept of basics nuclear model** 5-6 *Grd*

Knowledge

LO K 1.2.1 2-3

Give the main characteristics of atoms (electrical charge, nuclei, mass and dimension)

Skills

LO S 1.2.1 5-6

Give the composition of any nuclei (p, n and e)

SCo 1.3 **Define quantities characterising nuclei** 5-6 *Grd*

Knowledge

LO K 1.3.1 5-6

Define the notions of activity, intensity of radiation, half-life

Skills

LO S 1.3.1 5-6

Use the chart of nuclides and nuclear data and find important constants

References:

- Lapp, R.E. - Andrews, H.L.: Nuclear Radiation Physics. Engelwood Cliffs (N.J.), Prentice Hall 1972.
- Turner, J.E.: Atoms, Radiation and Radiation Protection. New York, Pergamon Press 1986.
- Liley, J.: Nuclear Physics. Principles and Applications. Chichester, Wiley 2001.
- G.F.Knoll Radiation detection and measurement, Hardcover 1979
- Povh, B. - Rith, K. - Scholz, Ch. - Zetschke, F.: Particles and Nuclei. Springer, Berlin 1999.
- Magill, J. - Gally, J.: Radioactivity, Radionuclides, Radiation. Springer, Berlin 2005.
- Martin, B.R.: Nuclear and Particle Physics. Wiley, Chichester (U.K.) 2006.
- Podgorsak, E.B.: Radiation Physics for Medical Physicists. Springer, Berlin 2006.
- Loveland, W.D. - Morrissey, D.J. - Seaborg, G.T.: Modern Nuclear Chemistry.
- Wiley, Hoboken (New Jersey) 2006.
- Hussein, E.M.A.: Radiation Mechanics - Principles and Practice. Elsevier, Oxford 2007.
- B Firestone, Table of isotopes, Jul 19, 1999
- K.S. Krane, Introductory Nuclear Physics Wiley; 3rd edition (October 22, 1987.
- P.E Hodgson, Introductory Nuclear Physics, Oxford University Press, 1997).
- G.G Eichholz, Principle of nuclear radiation protection.
- D. Blanc, Physique nucléaire, Masson, 1980.
- V.V.Balashov Interaction of particles and radiation with matter, Springer 1997.
- N. Tsoulfanidis "Measurements and Detection of Radiation" Hemisphere Publishing Corporation New York USA 1983
- H. Elford Johns and J. Robert Cunningham "The Physics of Radiology" Charles C Thomas Publisher 4th edition Springfield Illinois USA 1983

- M. Pelliccioni "Fondamenti Fisici della Radioprotezione" Pitagora Editrice Bologna Italia 1993
- R. Fedele Laitano "Fondamenti di Dosimetria delle radiazioni ionizzanti" ENEA Roma Italia 2010

Detailed course content:

1.2.1. Alpha decay

1.2.2. Beta minus decay

1.2.4. Electronic shell rearrangement
1.2.5. Gamma emission and internal conversion
1.2.6. Evolution of the activity
1.2.7. Producing radionuclides by nuclear reaction

ENETRAP-II

COMMON BASIS

Module name: 1 Basics

Coursedescription1.l 2 Interaction of radiations with matter

Indicatieve ECVET points for module:

Course N°:	Lecture (indicative hours)	Tutorial/PW/OJT (indicative hours)	Prerequisite:	Lecturer:
2	4	2		

COMMON BASIS module deals with physical aspect of ionising radiations, biological bases of radiological protection, principal type of radiation detectors, different usages of ionizing radiations in different domains and finally type and

Course objectives:

Making learners familiar with the interactions of ionising radiation with matter caused by charged or uncharged particle radiation.

Key words:

Direct ionisation - indirect ionisation

Teaching and learning approach

Lectures which aim to enrich the knowledge and concepts of radiation protection.

In addition, tutorial sessions are also included for further consolidating the knowledge discussed in lectures

Assessment method

(to be defined) learners will be assessed by written assignment

Key competence(s) and Learning Outcomes

On successful completion of this subject, learners are expected to be able to:

Co 2 **Describe the interaction of ionising radiation with matter** 5-6 *Grd*

SCo 2.1 **Explain the main type of interactions with matter in function of nature and energy** 5-6 *Grd*

Knowledge

LO K 2.1.1 5-6

Define different type of interaction (charged and uncharged particles)

LO K 2.1.2 5-6

Describe ionisation and excitation phenomenon

LO K 2.1.3 5-6

Interpret attenuation of gamma radiation as a function of thickness and Z 5-6

Know the range of different radiation (alpha, beta, neutron, X and gamma)

LO K 2.1.5 5-6

List the different photons interaction effects

LO K 2.1.6 5-6

Estimate the energy range of different effects (photoelectric effect, Compton scattering and pair production)

Skills

LO S 2.1.1 5-6

Calculate the range of a beta radiation and the attenuation of a radiation using curves

LO S 2.1.2 5-6

Calculate thickness of shielding in function of component (Z) and energy

LO S 2.1.3 5-6

Attitude

LO A 2.1.1

security and caution to use adequate shielding

SCo 2.2 **Compare with the neutron interactions** 4-5 *Grd*

Knowledge

LO K 2.2.1 5-6

List the different neutrons interaction effects

LO K 2.2.2 4-5

Outline the specificities of absorption and moderation of neutrons source

Skills

LO S 2.2.1 5-6

Calculate shielding manually and by using calculation code

SCo 2.3 **Differentiate the efficiency of different shielding for different radiations** 5-6 *Grd*

Knowledge

LO K 2.3.1 5-6

Apply shielding properties (backscattering, build-up..)

References:

- Lapp, R.E. - Andrews, H.L.: Nuclear Radiation Physics. Engelwood Cliffs (N.J.), Prentice Hall 1972.
- Turner, J.E.: Atoms, Radiation and Radiation Protection. New York, Pergamon Press 1986.
- Liley, J.: Nuclear Physics. Principles and Applications. Chichester, Wiley 2001.
- G.F.Knoll Radiation detection and measurement, Hardcover 1979
- Povh, B. - Rith, K. - Scholz, Ch. - Zetschke, F.: Particles and Nuclei. Springer, Berlin 1999.
- Magill, J. - Gally, J.: Radioactivity, Radionuclides, Radiation. Springer, Berlin 2005.
- Martin, B.R.: Nuclear and Particle Physics. Wiley, Chichester (U.K.) 2006.
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- Loveland, W.D. - Morrissey, D.J. - Seaborg, G.T.: Modern Nuclear Chemistry.
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- Hussein, E.M.A.: Radiation Mechanics - Principles and Practice. Elsevier, Oxford 2007.
- B Firestone, Table of isotopes, Jul 19, 1999
- K.S. Krane, Introductory Nuclear Physics Wiley; 3rd edition (October 22, 1987.
- P.E Hodgson, Introductory Nuclear Physics, Oxford University Press, 1997).
- G.G Eichholz, Principle of nuclear radiation protection.
- D. Blanc, Physique nucléaire, Masson, 1980.
- V.V.Balashov Interaction of particles and radiation with matter, Springer 1997.
- N. Tsoulfanidis "Measurements and Detection of Radiation" Hemisphere Publishing Corporation New York USA 1983
- H. Elford Johns and J. Robert Cunningham "The Physics of Radiology" Charles C Thomas Publisher 4th edition Springfield Illinois USA 1983

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- R. Fedele Laitano "Fondamenti di Dosimetria delle radiazioni ionizzanti" ENEA Roma Italia 2010

Detailed course content:

1.3.1. Directly ionising radiations
1.3.2. Non directly ionising radiations

COMMON BASIS

Module name: 1 Basics

Coursedescription1.1 3 Dosimetry: quantities and units

Indicatieve ECVET points for module:

Course N°:	Lecture (indicative hours)	Tutorial/PW/OJT (indicative hours)	Prerequisite:	Lecturer:
3	4	0		

COMMON BASIS module deals with physical aspect of ionising radiations, biological bases of radiological protection, principal type of radiation detectors, different usages of ionizing radiations in different domains and finally type and

Course objectives:

Making learners familiar with the physical principles at the origin of the deposits of energy in the materials and issues resulting of exposure to ionizing radiations and their consequences.

Key words:

radiation protection dosimetry - quantity - units

Teaching and learning approach

Lectures which aim to enrich the knowledge and concepts of radiation protection.

In addition, tutorial sessions are also included for further consolidating the knowledge discussed in lectures

Assessment method

(to be defined) learners will be assessed by oral

Key competence(s) and Learning Outcomes

On successful completion of this subject, learners are expected to be able to:

Co 3 **Differentiate between exposure, Kerma and apply the dosimetric concepts** 5-6 *Grd*

SCo 3.1 **Assess and interpret external dosimetry** 5-6 *Grd*

Knowledge

LO K 3.1.1 5-6

Assess individual dose for both external and internal exposure,

LO K 3.1.2 5-6

Determine the features of a dose monitoring program (area and individual),

SCo 3.2	**Evaluate internal and/or superficial dosimetry**	4-5	*Grd*
Knowledge			
LO K 3.2.1		4-5	
Descibe biokinetic models used (ICRP)			
Skills			
LO S 3.2.1		5-6	
Calculate a commited effective dose			
Co 4	**Apply the different operational quantities used for dosimetry**	5-6	*Grd*
SCo 4.1	**Describe dosimetric quantities**	5-6	*Grd*
Knowledge			
LO K 4.1.1		4-5	
Define the deposition and energy transfer			
LO K 4.1.2		4-5	
Define the Relative Biological Effectiveness (RBE)			
LO K 4.1.3		4-5	
Define the LET concept			
LO K 4.1.4		5-6	
Skills			
LO S 4.1.1		5-6	
Establish relationship between absorbed dose and the source activity			

References:

- Lapp, R.E. - Andrews, H.L.: Nuclear Radiation Physics. Engelwood Cliffs (N.J.), Prentice Hall 1972.
- Turner, J.E.: Atoms, Radiation and Radiation Protection. New York, Pergamon Press 1986.
- Liley, J.: Nuclear Physics. Principles and Applications. Chichester, Wiley 2001.
- G.F.Knoll Radiation detection and measurement, Hardcover 1979
- Povh, B. - Rith, K. - Scholz, Ch. - Zetschke, F.: Particles and Nuclei. Springer, Berlin 1999.
- Magill, J. - Gally, J.: Radioactivity, Radionuclides, Radiation. Springer, Berlin 2005.
- Martin, B.R.: Nuclear and Particle Physics. Wiley, Chichester (U.K.) 2006.
- Podgorsak, E.B.: Radiation Physics for Medical Physicists. Springer, Berlin 2006.
- Loveland, W.D. - Morrissey, D.J. - Seaborg, G.T.: Modern Nuclear Chemistry.
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- B Firestone, Table of isotopes, Jul 19, 1999
- K.S. Krane, Introductory Nuclear Physics Wiley; 3rd edition (October 22, 1987.
- P.E Hodgson, Introductory Nuclear Physics, Oxford University Press, 1997).
- G.G Eichholz, Principle of nuclear radiation protection.
- D. Blanc, Physique nucléaire, Masson, 1980.
- V.V.Balashov Interaction of particles and radiation with matter, Springer 1997.
- N. Tsoulfanidis "Measurements and Detection of Radiation" Hemisphere Publishing Corporation New York USA 1983
- H. Elford Johns and J. Robert Cunningham "The Physics of Radiology" Charles C Thomas Publisher 4th edition Springfield Illinois USA 1983

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- R. Fedele Laitano "Fondamenti di Dosimetria delle radiazioni ionizzanti" ENEA Roma Italia 2010

Detailed course content:

1.4.1 Physical and dosimetric quantities
1.4.2 Radiation protection dosimetry

COMMON BASIS

Module name: 1 Basics

Coursedescription1.1 4 Biological effects of radiations

Indicatieve ECVET points for module:

Course N°:	Lecture (indicative hours)	Tutorial/PW/OJT (indicative hours)	Prerequisite:	Lecturer:
4	3	0		

COMMON BASIS module deals with physical aspect of ionising radiations, biological bases of radiological protection, principal type of radiation detectors, different usages of ionizing radiations in different domains and finally type and

Course objectives:

Making learners familiar with different types of biological effects induced by ionizing radiations are described and their mechanisms and consequences at different scales of human body are explained.

Key words:

biology - cellular effects - tissue lesions - deterministic effects - stochastic effects

Teaching and learning approach

Lectures which aim to enrich the knowledge and concepts of radiation protection.

In addition, tutorial sessions are also included for further consolidating the knowledge discussed in lectures

Assessment method

(to be defined) learners will be assessed by written assignment

Key competence(s) and Learning Outcomes

On successful completion of this subject, learners are expected to be able to:

Co 5 **Identify the biological effects of ionising radiations** 5-6 *Grd*

SCo 5.1 **Classify the different biological effects (deterministic, stochastic and hereditary eff** 5-6 *Grd*

Knowledge

LO K 5.1.1 5-6

List various biological effects (tissue, cellular ...)

LO K 5.1.2 5-6

Give and comment the ICRP risk factors

LO K 5.1.3 5-6

Estimate the dose rate to different distances from a radioactive point source (beta or photon),

LO K 5.1.4 5-6

Skills

LO S 5.1.1 5-6

Present the different mechanisms to a non-specialist public (cell reparation, cell death ...)

LO S 5.1.2 5-6

Present the various biological effects to a non-specialist public

Co 6 **Analyse/understand an epidemiological study** 5-6 *Grd*

SCo 6.1 **Assess of the risks linked to doses** 4-5 *Grd*

Knowledge

LO K 6.1.1 4-5

Interpret epidemiological result

LO K 6.1.2 4-5

Describe the concept of radiation detriment by using Wtissue and Wradiation

Skills

LO S 6.1.1 4-5

Make calculation using epidemiological data taken into a specific study

References:

- Lapp, R.E. - Andrews, H.L.: Nuclear Radiation Physics. Engelwood Cliffs (N.J.), Prentice Hall 1972.
- Turner, J.E.: Atoms, Radiation and Radiation Protection. New York, Pergamon Press 1986.
- Liley, J.: Nuclear Physics. Principles and Applications. Chichester, Wiley 2001.
- G.F.Knoll Radiation detection and measurement, Hardcover 1979
- Povh, B. - Rith, K. - Scholz, Ch. - Zetschke, F.: Particles and Nuclei. Springer, Berlin 1999.
- Magill, J. - Gally, J.: Radioactivity, Radionuclides, Radiation. Springer, Berlin 2005.
- Martin, B.R.: Nuclear and Particle Physics. Wiley, Chichester (U.K.) 2006.
- Podgorsak, E.B.: Radiation Physics for Medical Physicists. Springer, Berlin 2006.
- Loveland, W.D. - Morrissey, D.J. - Seaborg, G.T.: Modern Nuclear Chemistry.
- Wiley, Hoboken (New Jersey) 2006.
- Hussein, E.M.A.: Radiation Mechanics - Principles and Practice. Elsevier, Oxford 2007.
- B Firestone, Table of isotopes, Jul 19, 1999
- K.S. Krane, Introductory Nuclear Physics Wiley; 3rd edition (October 22, 1987.
- P.E Hodgson, Introductory Nuclear Physics, Oxford University Press, 1997).
- G.G Eichholz, Principle of nuclear radiation protection.
- D. Blanc, Physique nucléaire, Masson, 1980.
- V.V.Balashov Interaction of particles and radiation with matter, Springer 1997.
- N. Tsoulfanidis "Measurements and Detection of Radiation" Hemisphere Publishing Corporation New York USA 1983
- H. Elford Johns and J. Robert Cunningham "The Physics of Radiology" Charles C Thomas Publisher 4th edition Springfield Illinois USA 1983

- M. Pelliccioni "Fondamenti Fisici della Radioprotezione" Pitagora Editrice Bologna Italia 1993
- R. Fedele Laitano "Fondamenti di Dosimetria delle radiazioni ionizzanti" ENEA Roma Italia 2010

Detailed course content:

1.5.1 Basic biology
1.5.2 Cellular and molecular effects, Tissue lesions
1.5.3 Deterministic effects
1.5.4 Stochastic effects
1.5.5 Exposure of the pregnant woman and exposure of the fœtus
1.5.6 Epidemiology

COMMON BASIS

Module name: 1 Basics

Coursedescription1 5 Physical principles of detection

Indicatieve ECVET points for module:

Course N°:	Lecture (indicative hours)	Tutorial/PW/OJT (indicative hours)	Prerequisite:	Lecturer:
5	9	2		

COMMON BASIS module deals with physical aspect of ionising radiations, biological bases of radiological protection, principal type of radiation detectors, different usages of ionizing radiations in different domains and finally type and

Course objectives:

Making learners familiar with the principles of detection of ionising radiations. These topics are highlighted in this module: General principles of detection, ionisation of gas, luminescence phenomenon, ionisation into solids, physical and chemical phenomenon, detector functioning and calibration

Key words:

detection - ionisation of gas - liminescence - calibration

Teaching and learning approach

Lectures which aim to enrich the knowledge and concepts of radiation protection.

In addition, tutorial sessions are also included for further consolidating the knowledge discussed in lectures

Assessment method

(to be defined) learners will be assessed by written assignment

Key competence(s) and Learning Outcomes

On successful completion of this subject, learners are expected to be able to:

Co 7 **Use different detection devices** 5-6 *Grd*

SCo 7.1 Make measurement 5-6 *Grd*

Knowledge

LO K 7.1.1 5-6

Describe processes of detection

Skills

LO S 7.1.1 5-6

Have attitude adapted to the probe used (probe displacement speed)

LO S 7.1.2 5-6

Know the distances of detection for different type of nuclei

Attitude

LO A 7.1.1 5-6

React appropriately when a device indicates a measure (e.g. panic linked to the sound)

SCo 7.2 Use the appropriate device 5-6 *Grd*

Knowledge

LO K 7.2.1 5-6

Know the different kind of probe adapted to one (or more) type of radiation

Skills

LO S 7.2.1 5-6

Identify an unknown source

SCo 7.3 Be able to advice on adapted devices for a situation 5-6 *Grd*

Knowledge

LO K 7.3.1 5-6

Know the different providers of detection equipment

Attitude

LO A 7.3.1 5-6

Ensure a technology watch on detection devices

SCo 7.4 Know limit of detection 5-6 *Grd*

Skills

LO S 7.4.1 5-6

Calculate a detection limit

References:

- Lapp, R.E. - Andrews, H.L.: Nuclear Radiation Physics. Engelwood Cliffs (N.J.), Prentice Hall 1972.
- Turner, J.E.: Atoms, Radiation and Radiation Protection. New York, Pergamon Press 1986.
- Liley, J.: Nuclear Physics. Principles and Applications. Chichester, Wiley 2001.
- G.F.Knoll Radiation detection and measurement, Hardcover 1979
- Povh, B. - Rith, K. - Scholz, Ch. - Zetschke, F.: Particles and Nuclei. Springer, Berlin 1999.
- Magill, J. - Gally, J.: Radioactivity, Radionuclides, Radiation. Springer, Berlin 2005.
- Martin, B.R.: Nuclear and Particle Physics. Wiley, Chichester (U.K.) 2006.
- Podgorsak, E.B.: Radiation Physics for Medical Physicists. Springer, Berlin 2006.
- Loveland, W.D. - Morrissey, D.J. - Seaborg, G.T.: Modern Nuclear Chemistry.
- Wiley, Hoboken (New Jersey) 2006.
- Hussein, E.M.A.: Radiation Mechanics - Principles and Practice. Elsevier, Oxford 2007.
- B Firestone, Table of isotopes, Jul 19, 1999
- K.S. Krane, Introductory Nuclear Physics Wiley; 3rd edition (October 22, 1987.
- P.E Hodgson, Introductory Nuclear Physics, Oxford University Press, 1997).
- G.G Eichholz, Principle of nuclear radiation protection.
- D. Blanc, Physique nucléaire, Masson, 1980.
- V.V.Balashov Interaction of particles and radiation with matter, Springer 1997.
- N. Tsoulfanidis "Measurements and Detection of Radiation" Hemisphere Publishing Corporation New York USA 1983
- H. Elford Johns and J. Robert Cunningham "The Physics of Radiology" Charles C Thomas Publisher 4th edition Springfield Illinois USA 1983

- M. Pelliccioni "Fondamenti Fisici della Radioprotezione" Pitagora Editrice Bologna Italia 1993
- R. Fedele Laitano "Fondamenti di Dosimetria delle radiazioni ionizzanti" ENEA Roma Italia 2010

Detailed course content:

1.6.1 General principles of detection

1.6.2. Ionisation of gas
1.6.3. Luminescence phenomenon.
1.6.4. Ionisation into solids.
1.6.5. Physical and chemical phenomenon.
1.6.6 Detector functioning
1.6.7 Calibration

ENETRAP II Training Scheme

ENETRAP-II

COMMON BASIS

Module name: 1 Basics

Coursedescription1 6 Application of ionising radiation

Indicatieve ECVET points for module:

Course N°:	Lecture (indicative hours)	Tutorial/PW/OJT (indicative hours)	Prerequisite:	Lecturer:
6	3	0		

COMMON BASIS module deals with physical aspect of ionising radiations, biological bases of radiological protection, principal type of radiation detectors, different usages of ionizing radiations in different domains and finally type and

Course objectives:

Making learners familiar with the wide use of ionizing radiation by presenting different types of radiation sources and explanation of their application: natural and human made radionuclides; consumer products

Key words:

natural sources - medical applications - industrial use

Teaching and learning approach

Lectures which aim to enrich the knowledge and concepts of radiation protection.

In addition, tutorial sessions are also included for further consolidating the knowledge discussed in lectures

Assessment method

(to be defined) learners will be assessed by oral

Key competence(s) and Learning Outcomes

On successful completion of this subject, learners are expected to be able to:

Co 8 **Describe the main uses of radiation in various fields** 5-6 *Grd*

SCo 8.1 **Categorise different types of radiation sources** 5-6 *Grd*

Knowledge

LO K 8.1.1 5-6

Raise a panorama of usages of ionizing radiations in different domains

LO K 8.1.2 5-6

Know the order of magnitude of the activities related to these radioactive sources

Skills

LO S 8.1.1 5-6

Recognise a situation of exposure by seeing a source (picture, video or directly)

SCo 8.2 **Explain application of radiation sources (natural and human made radionuclides; co** 5-6 *Grd*

Knowledge

LO K 8.2.1

References:

- Lapp, R.E. - Andrews, H.L.: Nuclear Radiation Physics. Engelwood Cliffs (N.J.), Prentice Hall 1972.
- Turner, J.E.: Atoms, Radiation and Radiation Protection. New York, Pergamon Press 1986.
- Liley, J.: Nuclear Physics. Principles and Applications. Chichester, Wiley 2001.
- G.F.Knoll Radiation detection and measurement, Hardcover 1979
- Povh, B. - Rith, K. - Scholz, Ch. - Zetschke, F.: Particles and Nuclei. Springer, Berlin 1999.
- Magill, J. - Gally, J.: Radioactivity, Radionuclides, Radiation. Springer, Berlin 2005.
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- Wiley, Hoboken (New Jersey) 2006.
- Hussein, E.M.A.: Radiation Mechanics - Principles and Practice. Elsevier, Oxford 2007.
- B Firestone, Table of isotopes, Jul 19, 1999
- K.S. Krane, Introductory Nuclear Physics Wiley; 3rd edition (October 22, 1987.
- P.E Hodgson, Introductory Nuclear Physics, Oxford University Press, 1997).
- G.G Eichholz, Principle of nuclear radiation protection.

Detailed course content:

1.7.1. Review of Natural sources of exposure

1.7.2 Medical applications of ionising radiation

8.3 Appendix 7 - Bloom Taxonomy

Adapted for RPE (including Anderson taxonomy action verbs)

COGNITIVE DOMAIN (THINKING, KNOWLEDGE)

	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Definition	*Remembers previously learned material*	*Grasps the meaning of material (lowest level of understanding)*	*Uses learning in new and concrete situations (higher level of understanding).*	*Understands both the content and structure of material.*	*Formulates new structures from existing knowledge and skills.*	*Judges the value of material for a given purpose.*
Example Verbs	▪ define ▪ identify ▪ label ▪ list ▪ name ▪ recall ▪ state	▪ describe ▪ discuss ▪ explain ▪ locate ▪ paraphrase ▪ give example ▪ translate	▪ apply ▪ carry out ▪ demonstrate ▪ illustrate ▪ prepare ▪ solve ▪ use	▪ analyze ▪ categorize ▪ compare ▪ contrast ▪ differentiate ▪ discriminate ▪ outline	▪ combine ▪ construct ▪ design ▪ develop ▪ generate ▪ plan ▪ propose	▪ assess ▪ conclude ▪ evaluate ▪ interpret ▪ justify ▪ select ▪ support

PSYCHOMOTOR DOMAIN (doing, skills)

	Perception	Set	Guided Response	Mechanism	Compete overt response	Adaption	Organization
Definition	*Senses cues that guide motor activity*	*Is mentally, emotionally, and physically ready to act.*	*Imitates and practices skills, often in discrete steps.*	*Performs acts with increasing efficiency. confidence, and proficiency.*	*Performs automatically.*	*Adapts skills sets to meet a problem situation.*	*Creates new patterns for specific situations.*
Example Verbs	▪ detect ▪ hear ▪ listen, ▪ observe ▪ perceive ▪ recognize ▪ see ▪ sense ▪ smell ▪ taste ▪ view ▪ watch	▪ achieve a posture ▪ assume a body stance ▪ establish ▪ a body position ▪ place hands, arms, etc ▪ position the body ▪ sit ▪ stand ▪ station	▪ copy ▪ duplicate ▪ imitate ▪ manipulate with guidance ▪ operate under supervision ▪ practice ▪ repeat ▪ try	▪ complete with confidence ▪ conduct ▪ demonstrate ▪ execute ▪ improve efficiency ▪ increase speed ▪ make ▪ pace ▪ produce ▪ show dexterity	▪ act habitually ▪ advance with, assurance ▪ control ▪ direct ▪ excel ▪ guide ▪ maintain efficiency ▪ manage ▪ master ▪ organize ▪ perfect ▪ perform automatically ▪ proceed	▪ adapts ▪ reorganizes ▪ alters ▪ revises ▪ changes	▪ designs ▪ originates ▪ combines ▪ composes ▪ constructs

AFFECTIVE DOMAIN (Feeling, attitudes)

	Receiving	Responding	Valuing	Organisation	Internalizing
Definition	*Selectively attends to stimuli.*	*Responds to stimuli.*	*Attaches value or worth to something.*	*Conceptualizes the value and resolves conflict between fend other values.*	*Integrates the value into a value system that controls behavior*
Example Verbs	▪ accept ▪ acknowledge ▪ be aware ▪ listen ▪ notice ▪ pay attention ▪ tolerate	▪ agree to ▪ answer freely ▪ assist ▪ care for ▪ communicate ▪ comply ▪ conform ▪ consent ▪ contribute ▪ cooperate ▪ follow ▪ obey ▪ participate willingly ▪ read voluntarily ▪ respond ▪ visit ▪ volunteer	▪ adopt ▪ assume .responsibility ▪ behave according to ▪ choose ▪ commit ▪ desire ▪ exhibit loyalty ▪ express ▪ initiate ▪ prefer ▪ seek ▪ show concern ▪ show continual ▪ desire to ▪ use resources to	▪ adapt ▪ adjust ▪ arrange ▪ balance ▪ classify ▪ conceptualize ▪ formulate ▪ group ▪ organize ▪ rank ▪ theorize	▪ al upon ▪ advocate ▪ defend ▪ exemplify ▪ influence ▪ justify behavior ▪ maintain ▪ serve ▪ support