



EUROPEAN  
COMMISSION

Community Research



## WP4.2: Report December 2012

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Grant Agreement number: 232620

Project Acronym: ENETRAP II

WP 4 title: Define Requirements and methodology for recognition of RPEs

WP 4 leader: CEA - INSTN

WP 4 partners: BfS, ENEA, CIEMAT, HPA, ITN and UPB

Period Covered by the report: November 2011 to December 2012



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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.

<b>Level</b>	<b>Knowledge</b>	<b>Skills</b>	<b>Competence</b>
<b>Level 1</b>	Basic general knowledge	basic skills required to carry out simple tasks	work or study under direct supervision in a structured context
<b>Level 2</b>	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

<b>Level 3</b>	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
<b>Level 4</b>	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
<b>Level 5</b>	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
<b>Level 6</b>	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
<b>Level 7</b>	- 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
<b>Level 8</b>	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 that 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.

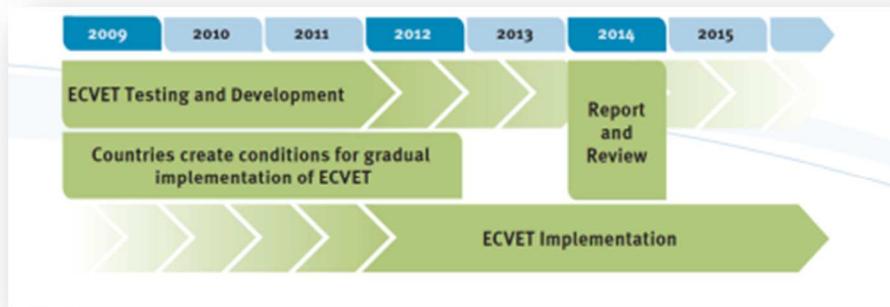


FIGURE 4: ECVET SCHEDULE AND PROGRESSIVE IMPLEMENTATION

### 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.

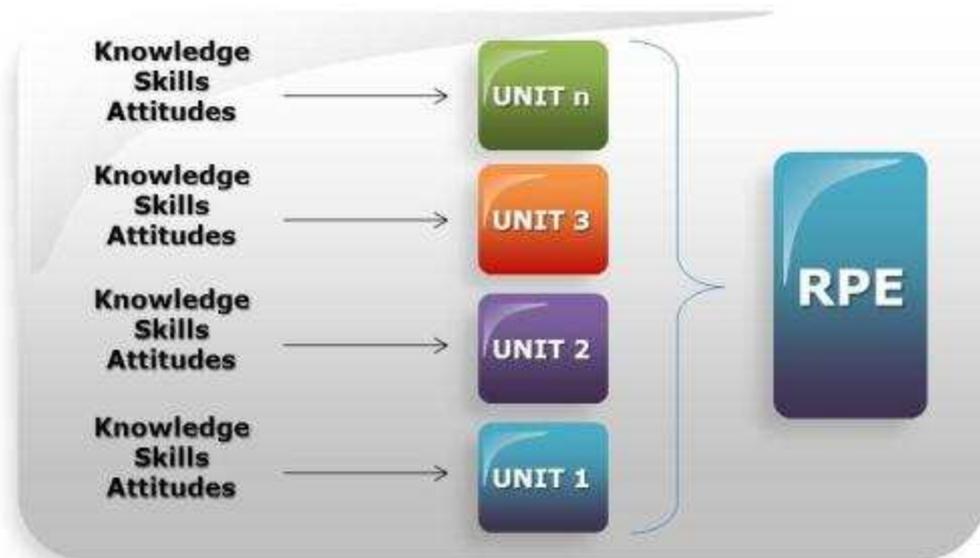


FIGURE 6: ECVET - A TOOL FOR PROMOTING THE TRANSFER, ACCUMULATION AND RECOGNITION OF CREDIT FOR VET

### 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.

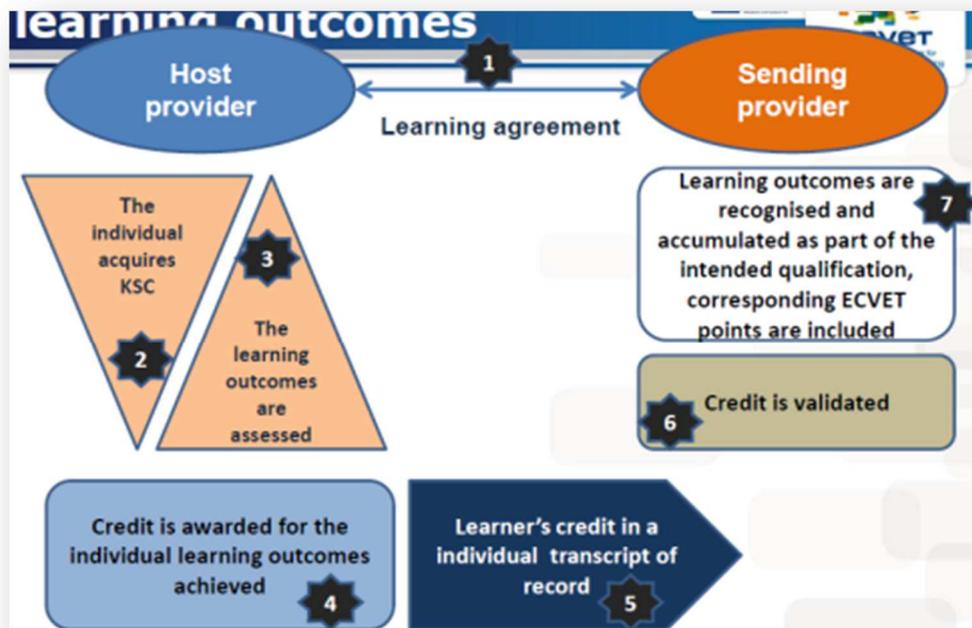


FIGURE 7: TRANSFER AND ACCUMULATION SERVING EUROPEAN MOBILITY

### 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.

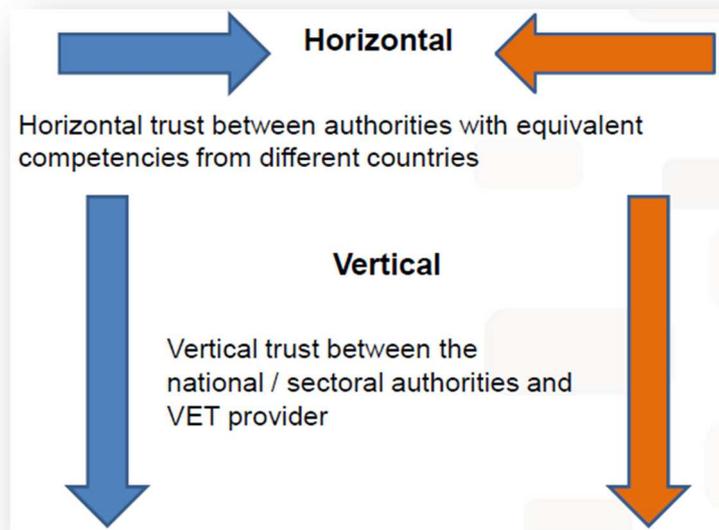


FIGURE 8: MOU HORIZONTAL AND VERTICAL TRUST

### 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.<sup>1</sup>*

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

<sup>1</sup> [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.

KC= description of key competence			AC= description of Activity			KLO= description of Learning Outcomes for knowledge			KLO= description of Learning Outcomes for Skills			KLO= description of Learning Outcomes for Attitudes					
KCR	Key Competence	Grd.	ACR	Activities	Grd.	KLO #	Knowledge LO	Grd.	SLO#	LO Skills	Grd.	ALOP	LO Attitudes	Grd.			
K01	Apply physical dosimetry systems	3	9.1	List the passive dosimetry devices	3	9.1.1	Categorize the different systems of passive dosimetry (alpha, beta, gamma and X, including neutrinos)	3	9.1.1	Choose the appropriate passive dosimeter	3	9.1.1	Keeping informed of changes in technology for passive dosimeter	3			
				Differentiate the dosimetry of trees (if needed)	3												
				Categorize the various active dosimetry systems (alpha, beta, gamma and X, including neutron)	3	9.2.1	Choose the appropriate active dosimeter	3	9.2.1	Keeping informed of changes in technology for active dosimeters	3						
			9.2	List the active dosimetry devices	3	9.3.1	Describe the physical and/or chemical aspects (particle size) and kinetic modifiability	3	9.3.1	Calculate committed doses	3	9.3.1	Discuss with occupational physician on a case of contamination	3			
				Explain the principles of internal dosimetry	3												
			9.3														

Graduation  
3 = very important  
1 = less important

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.*

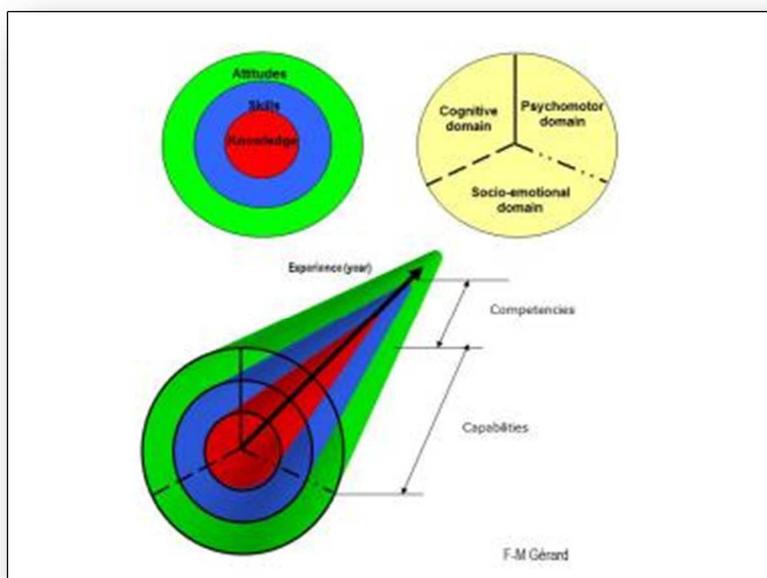


FIGURE 10: REPRESENTATION OF COMPETENCE, KNOWLEDGE, SKILLS AND ATTITUDES (F-M GÉRARD)

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

The screenshot shows a software interface with a table of course units. The table has several columns: 'Unit name', 'Course description', 'Course identification', 'Estimated duration', and 'Details of Course description'. A 'Details' dialog box is open on the right side of the table, showing a 'Choose your option' section with buttons for 'Add courses', 'Add module content', 'Add bibliography', 'Add content', 'Add learning resources', 'Report completion', and 'Report learning outcomes'. The table contains multiple rows of course units, each with a unique identifier and a detailed description.

FIGURE 13: COURSE TABLE DESCRIPTION

The screenshot shows a software interface with a course form. The form has several sections: 'Course identification', 'Enetrapp II Module name', 'Course description', 'Course details', and 'Links to modules courses'. The 'Course description' section contains a text area with the following text: 'Introduction and nuclear physics'. The 'Course details' section contains a text area with the following text: 'Making learners familiar with the basic properties of atoms nuclei, equilibrium nuclear decay - natural radioactivity - artificial radioactivity - mathematics of its written assignments, spectra and written examination'. The 'Links to modules courses' section contains a text area with the following text: 'Introduction and nuclear physics'. The form also includes buttons for 'Add course', 'Add module content', 'Add bibliography', 'Add content', 'Add learning resources', 'Report completion', and 'Report learning outcomes'.

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.

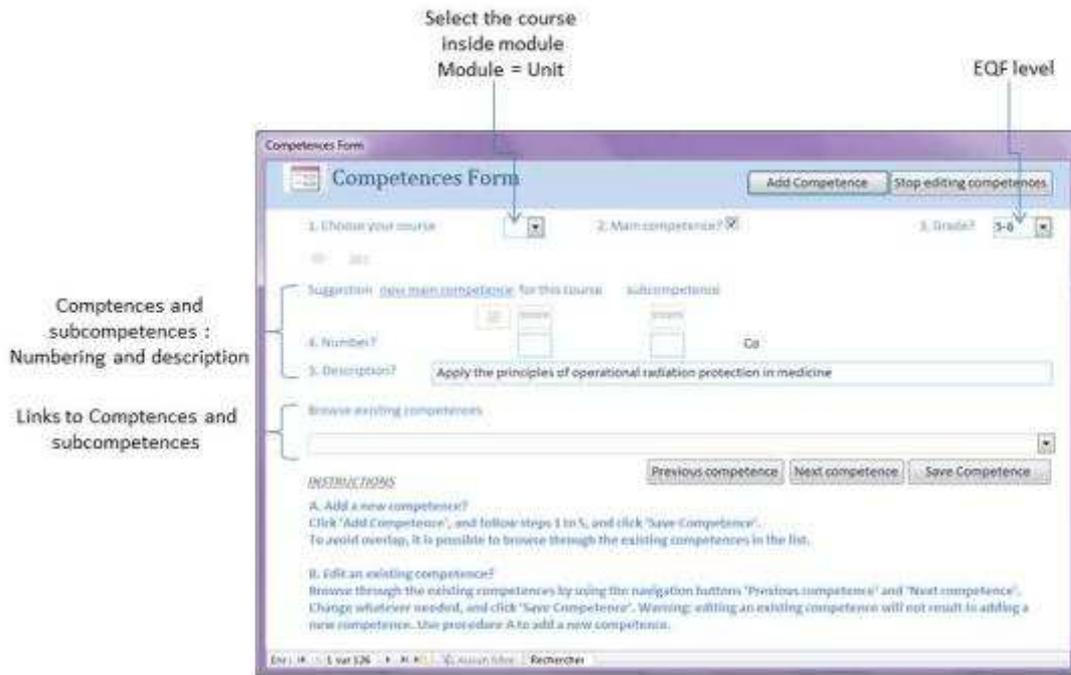


FIGURE 15: COMPETENCE FORM DESCRIPTION

### 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.

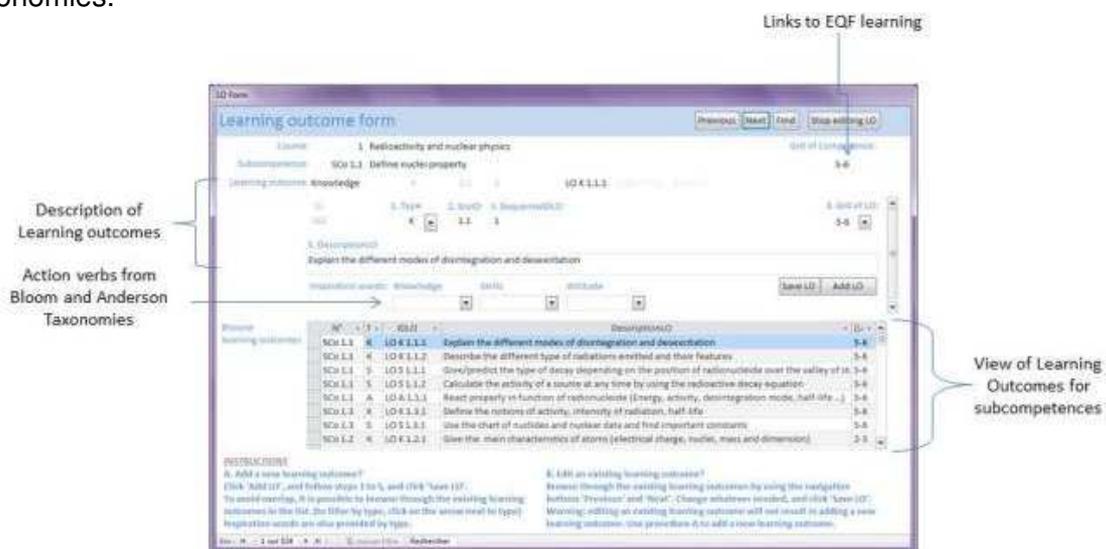


FIGURE 16: LEARNING OUTCOMES FORM DESCRIPTION

### **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<sup>2</sup>.

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 abilities.

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<sup>2</sup> 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 appendix 8.2, 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

**Visualisation of the module in the ERPTS**

*RPE - Course Description Form*

**ENETRAP-II**

**COMMON BASIS**

Module name: 1. Basics  
 Subject title: 1.2. Radioactivity and nuclear physics

Indicative ECVET points for module: 4

N° course	Lecture (nd h.)	Tutorial/EW (nd h.)	Prerequisite	Lecturer
1.2.	5	3		

COMMON BASIS module deals with physics related to ionising radiation, e.g. radioactivity and nuclear physics, interaction of radiations with matter, quantities and units, biological effects of radiation and detection.

**Description of the module**

**Courses 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.

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.

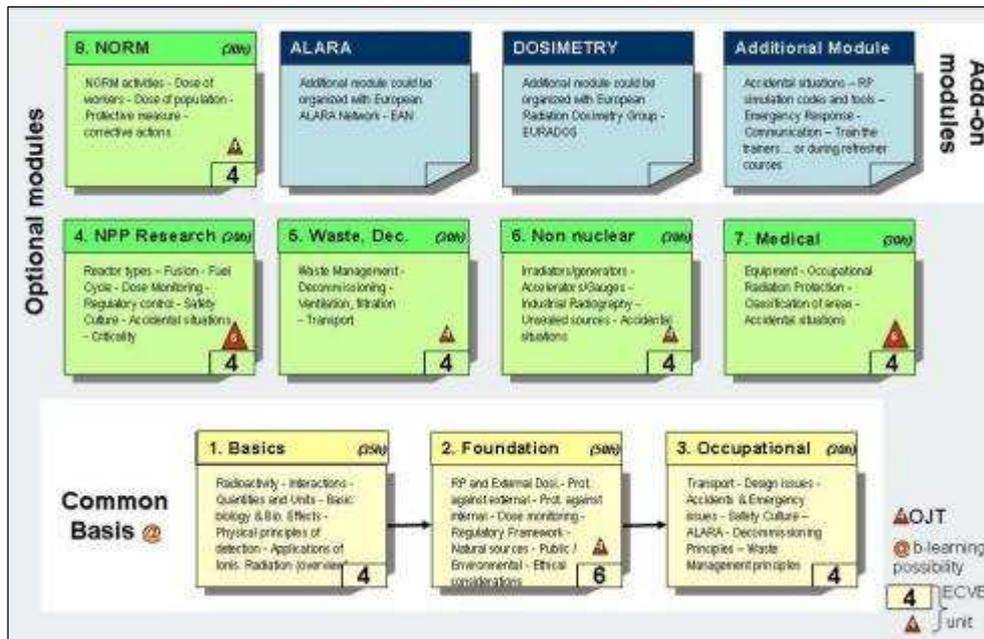


FIGURE 19: ENETRAP II, THE RPE TRAINING SCHEME

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](http://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.

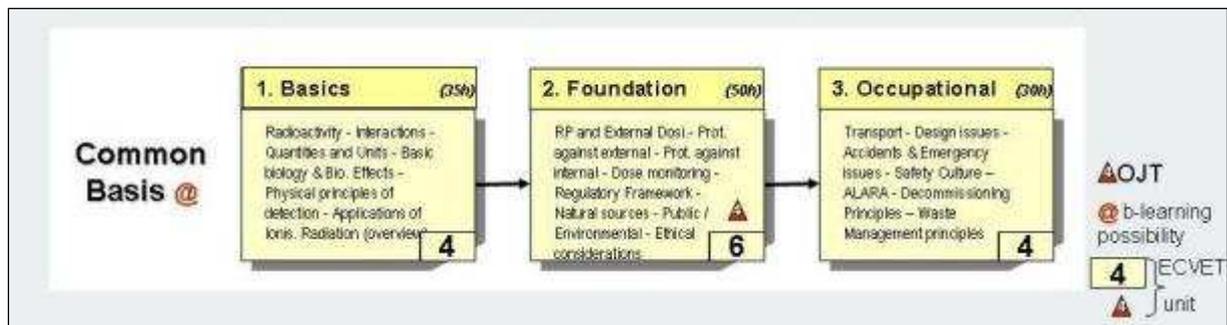


FIGURE 20: ENETRAP II; THE COMMON BASIS WITH 3 MODULES

#### 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.

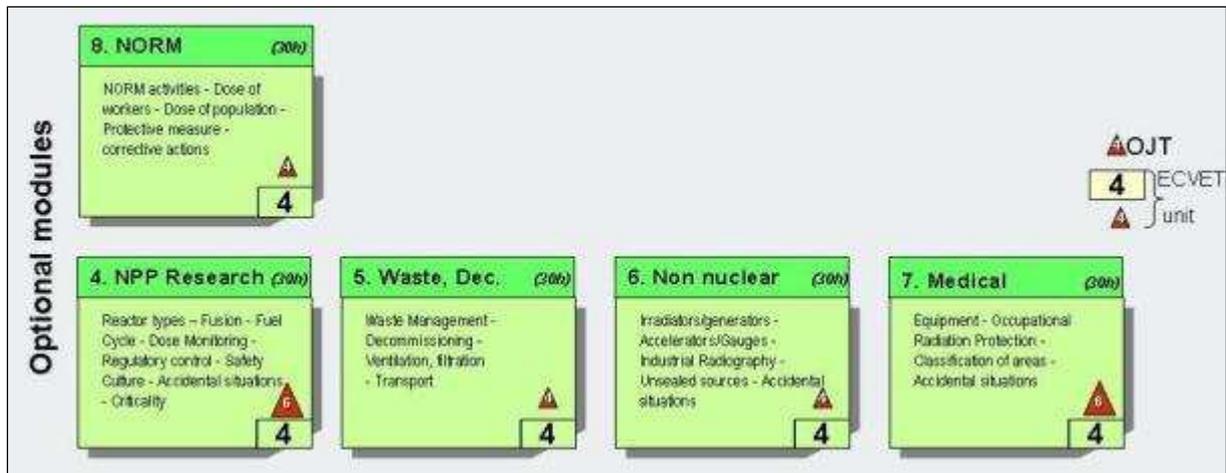


FIGURE 21: ENETRAP II; THE OPTIONAL MODULES

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
Ensure the technical support function to the dismantler

List of RPE sub competences
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
Apply the principles of operational radiation protection in medicine
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)

List of RPE sub competences
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

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.

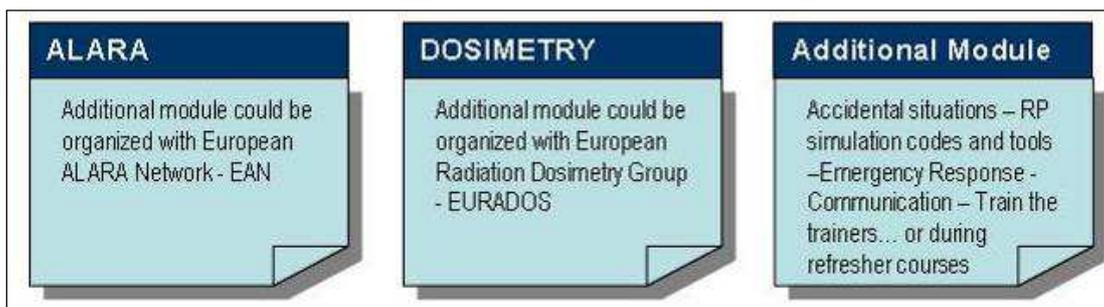


FIGURE 22: ENETRAP II; THE COMPLEMENTARY MODULES

## 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 seem 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 sets 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

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

## 7 Reference

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## **8 Appendix**

### ***8.1 List of Competences, sub competences and Learning Outcomes***

#### **8.1.1 Unit 1 - Module 1**

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

<b>2</b>	<b><u>Interaction of radiations with matter</u></b>	
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<b>Co 2</b>	<b>Describe the interaction of ionising radiation with matter</b>	5-6
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<b>SCo 2.1</b>	<b>Explain the main type of interactions with matter in function of nature and energy of radiations</b>	5-6
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<b>Knowledge</b>		
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LO K 2.1.1		5-6
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Define different type of interaction (charged and uncharged particles)

LO K 2.1.2		5-6
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Describe ionisation and excitation phenomenon

LO K 2.1.3		5-6
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Interpret attenuation of gamma radiation as a function of thickness and Z		5-6
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Know the range of different radiation (alpha, beta, neutron, X and gamma)

LO K 2.1.5		5-6
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List the different photons interaction effects

LO K 2.1.6		5-6
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Estimate the energy range of different effects (photoelectric effect, Compton scattering and pair production)

<b>Skills</b>		
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LO S 2.1.1		5-6
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Calculate the range of a beta radiation and the attenuation of a radiation using curves

LO S 2.1.2		5-6
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Calculate thickness of shielding in function of component (Z) and energy

LO S 2.1.3		5-6
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<b>Attitude</b>		
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LO A 2.1.1		
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security and caution to use adequate shielding

<b><u>2</u></b>	<b><u>Interaction of radiations with matter</u></b>	
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<b>SCo 2.2</b>	<b>Compare with the neutron interactions</b>	4-5
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<b>Knowledge</b>		
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LO K 2.2.1		5-6
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List the different neutrons interaction effects

LO K 2.2.2		4-5
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Outline the specificities of absorption and moderation of neutrons source

<b>Skills</b>		
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LO S 2.2.1		5-6
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Calculate shielding manually and by using calculation code

<b>SCo 2.3</b>	<b>Differentiate the efficiency of different shielding for different radiations</b>	5-6
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<b>Knowledge</b>		
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LO K 2.3.1		5-6
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Apply shielding properties (backscattering, build-up..)

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

<b>3</b>	<b><u>Dosimetry: quantities and units</u></b>	
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<b>SCo 4.1</b>	<b>Describe dosimetric quantities</b>	5-6
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<b>Knowledge</b>		
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LO K 4.1.1	Define the deposition and energy transfer	4-5
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LO K 4.1.2	Define the Relative Biological Effectiveness (RBE)	4-5
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LO K 4.1.3	Define the LET concept	5-6
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LO K 4.1.4	Establish relationship between absorbed dose and the source activity	5-6
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<b>Skills</b>		
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<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b>4</b>	<b><u>Biological effects of radiations</u></b>	
<b>Co 5</b>	<b>Identify the biological effects of ionising radiations</b>	5-6
<b>SCo 5.1</b>	<b>Classify the different biological effects (deterministic, stochastic and hereditary effects)</b>	5-6
	<b>Knowledge</b>	
	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	
	<b>Skills</b>	
	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
<b>Co 6</b>	<b>Analyse/understand an epidemiological study</b>	5-6

<b>4</b>	<b><u>Biological effects of radiations</u></b>	
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<b>SCo 6.1</b>	<b>Assess of the risks linked to doses</b>	4-5
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<b>Knowledge</b>		
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LO K 6.1.1	Interpret epidemiological result	4-5
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LO K 6.1.2	Describe the concept of radiation detriment by using $W_{tissue}$ and $W_{radiation}$	4-5
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<b>Skills</b>		
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LO S 6.1.1	Make calculation using epidemiological data taken into a specific study	4-5
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<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b>5</b>	<b><u>Physical principles of detection</u></b>	
<b>Co 7</b>	<b>Use different detection devices</b>	5-6
<b>SCo 7.1</b>	<b>Make measurement</b>	5-6
	<b>Knowledge</b>	
	LO K 7.1.1	5-6
	Describe processes of detection	
	<b>Skills</b>	
	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	
	<b>Attitude</b>	
	LO A 7.1.1	5-6
	React appropriately when a device indicates a measure (e.g. panic linked to the sound)	
<b>SCo 7.2</b>	<b>Use the appropriate device</b>	5-6
	<b>Knowledge</b>	
	LO K 7.2.1	5-6
	Know the different kind of probe adapted to one (or more) type of radiation	
	<b>Skills</b>	
	LO S 7.2.1	5-6
	Identify an unknown source	

<b>5</b>	<b><u>Physical principles of detection</u></b>	
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<b>SCo 7.3</b>	<b>Be able to advice on adapted devices for a situation</b>	5-6
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<b>Knowledge</b>		
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LO K 7.3.1	5-6	
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Know the different providers of detection equipment		
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<b>Attitude</b>		
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LO A 7.3.1	5-6	
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Ensure a technology watch on detection devices		
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<b>SCo 7.4</b>	<b>Know limit of detection</b>	5-6
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<b>Skills</b>		
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LO S 7.4.1	5-6	
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Calculate a detection limit		
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<b>6</b>	<b><u>Application of ionising radiation</u></b>	
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Co 8	Describe the main uses of radiation in various fields	5-6
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SCo 8.1	Categorise different types of radiation sources	5-6
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<b>Knowledge</b>		
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LO K 8.1.1		5-6
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Raise a panorama of usages of ionizing radiations in different domains

LO K 8.1.2		5-6
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Know the order of magnitude of the activities related to these radioactive sources

<b>Skills</b>		
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LO S 8.1.1		5-6
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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
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<b>Knowledge</b>		
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LO K 8.2.1		
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<b>7</b>	<b><u>Radiation protection</u></b>	
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Co 9	Apply physical dosimetry systems for external and internal exposures	5-6
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**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

**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

<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b>9</b>	<b><u>Protection against external exposure</u></b>	
<b>Co 10</b>	<b>Apply the three means of protection against ionising radiation (time, display, distance)</b>	5-6
<b>SCo 10.1</b>	<b>Apply radiation protection by setting up shielding</b>	5-6
	<b>Knowledge</b>	
	LO K 10.1.1	5-6
	Knowing the properties and different shielding materials	
	<b>Skills</b>	
	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	
	LO S 10.1.2	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)	
	LO S 10.1.4	0
	<b>Attitude</b>	
	LO A 10.1.1	5-6
	Know the rules of implementation of protection in relation to the source (to protect themselves during installation)	

**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 increase 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

<b><u>9</u></b>	<b><u>Protection against external exposure</u></b>	
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<b>SCo 10.4</b>	<b>Estimate collective dose</b>	<b>5-6</b>
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<b>Knowledge</b>		
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LO K 10.4.1	5-6
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Give the average collective dose in main situation e.g reactor shutdown...	
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<b>Skills</b>		
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LO S 10.4.2	5-6
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Calculate a previsual collective dose for an exposed situation	
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LO S 10.4.3	5-6
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List methods to decontaminate	
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<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b><u>10</u></b>	<b><u>Dose monitoring</u></b>	
<b>Co 11</b>	<b>Apply the rules of the workplace dosimetry</b>	5-6
<b>S Co 11.1</b>	<b>Know the regulatory arrangements put in place (zone dosimetry)</b>	5-6
<b>Knowledge</b>		
LO K 11.1.1	Describe the workplace dosimetry devices	
<b>Skills</b>		
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
<b>Attitude</b>		
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 ...)	

**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)

<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b>10</b>	<b><u>Dose monitoring</u></b>	
<b>SCo 11.3</b>	<b>Explain the risk of criticality</b>	5-6
	<b>Knowledge</b>	
	LO K 11.3.1	3-4
	Rebuilding effective doses following a criticality accident	
	<b>Skills</b>	
	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	
<b>Co 12</b>	<b>Characterize a workplace</b>	5-6
<b>SCo 12.1</b>	<b>Supervise a workplace study</b>	5-6
	<b>Knowledge</b>	
	LO K 12.1.1	
	Know and apply the methodological guide	
	<b>Skills</b>	
	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	
	<b>Attitude</b>	
	LO A 12.1.1	5-6
	Integrate the multirisk approach (radiological and other occupational hazards) EvRP	

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

**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

<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b><u>12</u></b>	<b><u>Natural sources of ionizing radiation</u></b>	
<b>Co 15</b>	<b>List the natural sources of ionizing radiations</b>	5-6
<b>SCo 15.1</b>	<b>Identifying the natural sources of ionizing radiations</b>	5-6
	<b>Knowledge</b>	
	LO K 15.1.2	5-6
	List the public exposure situations ( environmental, medical, accident...)	
	<b>Skills</b>	
	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	
<b>SCo 15.2</b>	<b>Manage the public and environmental radiation protection</b>	5-6
	<b>Knowledge</b>	
	LO K 15.2.1	4-5
	Apply the principles of dispersion models (air and water)	
	<b>Skills</b>	
	LO S 15.2.1	
	Make calculation using dispersion models	
<b><u>13</u></b>	<b><u>Public and environmental radiation protection</u></b>	
<b>Co 15</b>		

<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b>14</b>	<b><u>Ethical considerations</u></b>	
<b>Co 16</b>	<b>Incorporate ethical considerations</b>	5-6
<b>SCo 16.1</b>	<b>Integrate ethical considerations in the medical field</b>	5-6
	<b>Knowledge</b>	
	LO K 16.1.1	5-6
	Explain the absence of dose limiting for patients but dose optimization	
	<b>Attitude</b>	
	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)	

**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**

**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/cm<sup>2</sup> ...)

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

**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 ...)

**16** **Design Issues**

**S Co 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 ...)

**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 EPR

**Attitude**

LO A 19.1.1 5-6

Keep available to teams (information, source term ...)

**18** **Safety Culture**

**Co 20** **Being involved in the interface safety - Radiation**

**S Co 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

**S Co 20.2** **Analyze safety report in terms of radiation protection**

5-6

**Skills**

LO S 20.2.1

Follow and write complementary RP report

**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 decommissioning

**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 decommissioning

LO K 21.2.3

5-6

**20** **Decommissioning**

**Co 21**

**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

**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

**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
Define the role of KRS and KRT systems	

**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
Anticipate and plan for regulatory controls (frequency) and the control program (internal and external)	

Management tool for nuclear competences

**22** **Main types of nuclear reactors'**

- LO S 24.1.7 Write an intervention file 5-6
- LO S 24.1.8 Analyze an intervention file 5-6

**Attitude**

- LO A 24.1.1 Conduct discussions with the sub-contractor 5-6
- LO A 24.1.2 Participate in the representative bodies 5-6
- LO A 24.1.3 Participate in inspections
- LO A 24.1.4 Inform and / or train staff of the operator

**SCo 24.2 Monitor the workplace**

5-6

**Knowledge**

- LO K 24.2.1 Implement monitoring devices at the workplace 5-6

**Skills**

- LO S 24.2.1 Implement monitoring devices at the workplace

**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

**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
Enforcement procedures during incidental situations	

**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
participation in environmental monitoring	

**Attitude**

LO A 24.4.1	
Communicate with the public in accidental / incidental situation	

**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

Perform a sensitivity analysis (variation of one or more factors)

**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

<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b>28</b>	<b><u>Decommissioning</u></b>	
<b>Co 25</b>	<b>Ensure the technical support function to the dismantler</b>	5-6
<b>SCo 25.1</b>	<b>Be involved in the drafting of specifications</b>	5-6
<b>Knowledge</b>		
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		
<b>Skills</b>		
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		
<b>Attitude</b>		
LO A 25.1.1		5-6
Interact with the technicians on the radiological history of the installation		
<b>SCo 25.2</b>	<b>Know the regulatory reference for dismantling</b>	5-6
<b>Knowledge</b>		
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
Know the general operation rules of the projected dismantling facility		

*ID*      *Description*

*Grd*

**28**      **Decommissioning**

**SCo 25.3**      **Be involved in the validation of decommissioning procedures**

5-6

**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
Know the cutting techniques	
LO K 25.3.7	5-6
Advise on cutting techniques (saber saws grinder) and the type of environment (sealed or not) to generate the least amount of aerosol	
LO K 25.3.8	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	5-6

**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
Enforce guidelines	

**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	
Explain the relative risk scales to various personnel	

**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
Know the factors influencing the exposed volume of work	

**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	
Apply the ALARA procedure according to the dosimetric impact	

**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	

**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

**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 storage areas

LO S 25.8.2

5-6

Achieve controls for lack of contamination

LO S 25.8.3

Propose storage maps conform to RP zoning

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

**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)	

**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
Perform calculations of exposure time limits according to a source	

**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

<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b><u>32</u></b>	<b><u>Medical workplace study and rik analysis</u></b>	
SCo 26.2	Conduct a risk analysis (all types)	5-6

**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	5-6
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
Apply crystalline and extremity dosimetry	

**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
Locate and position of sampling points for atmospheric and aqueous (liquid effluents discharged to the outfall)	

**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	

**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)

**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 gaseous 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

Inform 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...)

**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

**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

**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

<i>ID</i>	<i>Description</i>	<i>Grd</i>
<b>36</b>	<b><u>Quality control and quality assurance in medical sector</u></b>	
<b>Co</b>		5-6
<b>Co 1</b>	<b>Describe the phenomenon of radioactivity</b>	5-6
<b>SCo 1.1</b>	<b>Define nuclei property</b>	5-6
<b>Knowledge</b>		
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		
<b>Skills</b>		
LO S 1.1.1		5-6
Give/predict the type of decay depending on the position of radionuclide 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		
<b>Attitude</b>		
LO A 1.1.1		5-6
React properly in function of radionuclide (Energy, activity, desintegration mode, half-life ...)		

**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 associated equipment (ionization chambers, radiographic films, etc)

**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**



**COMMON BASIS**

Indicative ECVET

Module name: 1 Basics

points for module:

Course description I 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*

<b>SCo 1.1</b>	<b>Define nuclei property</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	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		
	<b>Skills</b>		
	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		
	<b>Attitude</b>		
	LO A 1.1.1		5-6
	React properly in function of radionucleide (Energy, activity, desintegration mode, half-life ...)		
<b>SCo 1.2</b>	<b>Explain principal concept of basics nuclear model</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	LO K 1.2.1		2-3
	Give the main characteristics of atoms (electrical charge, nuclei, mass and dimension)		
	<b>Skills</b>		
	LO S 1.2.1		5-6
	Give the composition of any nuclei (p, n and e)		
<b>SCo 1.3</b>	<b>Define quantities characterising nuclei</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	LO K 1.3.1		5-6
	Define the notions of activity, intensity of radiation, half-life		
	<b>Skills</b>		
	LO S 1.3.1		5-6
	Use the chart of nuclides and nuclear data and find important constants		

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- M. Pelliccioni "Fondamenti Fisici della Radioprotezione" Pitagora Editrice Bologna Italia 1993
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## 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



**COMMON BASIS**

Indicative ECVET points for module:

- Module name: 1 Basics
- Course description: 2 Interaction of radiations with matter

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.

A focus will be made on directly and indirectly ionising 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

<b>SCo 2.1</b>	<b>Explain the main type of interactions with matter in function of nature and energy</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	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)		
	<b>Skills</b>		
	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
	Taking into account bremsstrahlung and build-up factor in shielding calculation		
	<b>Attitude</b>		
	LO A 2.1.1		
	security and caution to use adequate shielding		
<b>SCo 2.2</b>	<b>Compare with the neutron interactions</b>	4-5	<i>Grd</i>
	<b>Knowledge</b>		
	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		
	<b>Skills</b>		
	LO S 2.2.1		5-6
	Calculate shielding manually and by using calculation code		
<b>SCo 2.3</b>	<b>Differentiate the efficiency of different shielding for different radiations</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	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.
- 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. Tsoufanidis "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
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## Detailed course content:

- 1.3.1. Directly ionising radiations
- 1.3.2. Non directly ionising radiations



COMMON BASIS

Indicative ECVET points for module:

- Module name: 1 Basics
- Course description: 3 Dosimetry: quantities and units

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.

Present the methods used to determine, by calculation and measure, associated operational quantities.

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),

<b>SCo 3.2</b>	<b>Evaluate internal and/or superficial dosimetry</b>	4-5	<i>Grd</i>
	<b>Knowledge</b>		
	LO K 3.2.1		4-5
	Describe biokinetic models used (ICRP)		
	<b>Skills</b>		
	LO S 3.2.1		5-6
	Calculate a committed effective dose		
<b>Co 4</b>	<b>Apply the different operational quantities used for dosimetry</b>	5-6	<i>Grd</i>
<b>SCo 4.1</b>	<b>Describe dosimetric quantities</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	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
	<b>Skills</b>		
	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.
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- 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.
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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.
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## Detailed course content:

- 1.4.1 Physical and dosimetric quantities
- 1.4.2 Radiation protection dosimetry



COMMON BASIS

Indicative ECVET  
points for module:

Module name: 1 Basics  
Course description I 4 Biological effects of radiations

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.

This module introduces the concept of radiation detriment by describing main models used to estimate it.

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

<b>SCo 5.1</b>	<b>Classify the different biological effects (deterministic, stochastic and hereditary eff</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	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
	<b>Skills</b>		
	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		
<b>Co 6</b>	<b>Analyse/understand an epidemiological study</b>	5-6	<i>Grd</i>
<b>SCo 6.1</b>	<b>Assess of the risks linked to doses</b>	4-5	<i>Grd</i>
	<b>Knowledge</b>		
	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 $W_{tissue}$ and $W_{radiation}$		
	<b>Skills</b>		
	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.
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## 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 foetus
- 1.5.6 Epidemiology



**COMMON BASIS**

Indicative ECVET points for module:

- Module name: 1 Basics
- Course description I 5 Physical principles of detection

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 - luminescence - 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

<b>SCo 7.1</b>	<b>Make measurement</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	LO K 7.1.1		5-6
	Describe processes of detection		
	<b>Skills</b>		
	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		
	<b>Attitude</b>		
	LO A 7.1.1		5-6
	React appropriately when a device indicates a measure (e.g. panic linked to the sound)		
<b>SCo 7.2</b>	<b>Use the appropriate device</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	LO K 7.2.1		5-6
	Know the different kind of probe adapted to one (or more) type of radiation		
	<b>Skills</b>		
	LO S 7.2.1		5-6
	Identify an unknown source		
<b>SCo 7.3</b>	<b>Be able to advice on adapted devices for a situation</b>	5-6	<i>Grd</i>
	<b>Knowledge</b>		
	LO K 7.3.1		5-6
	Know the different providers of detection equipment		
	<b>Attitude</b>		
	LO A 7.3.1		5-6
	Ensure a technology watch on detection devices		
<b>SCo 7.4</b>	<b>Know limit of detection</b>	5-6	<i>Grd</i>
	<b>Skills</b>		
	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.
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- Loveland, W.D. - Morrissey, D.J. - Seaborg, G.T.: Modern Nuclear Chemistry.  
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- G.G Eichholz, Principle of nuclear radiation protection.
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- V.V.Balashov Interaction of particles and radiation with matter, Springer 1997.
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## 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



## COMMON BASIS

Indicative ECVET

Module name: 1 Basics

points for module:

Course description: 6 Application of ionising radiation

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.
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- P.E Hodgson, Introductory Nuclear Physics, Oxford University Press, 1997).
- G.G Eichholz, Principle of nuclear radiation protection.
- D. Blanc, Physique nucléaire, Masson, 1980.

**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
<b>Definition</b>	<i>Remembers previously learned material</i>	<i>Grasps the meaning of material (lowest level of understanding)</i>	<i>Uses learning in new and concrete situations (higher level of understanding).</i>	<i>Understands both the content and structure of material.</i>	<i>Formulates new structures from existing knowledge and skills.</i>	<i>Judges the value of material for a given purpose.</i>
<b>Example Verbs</b>	<ul style="list-style-type: none"> <li>▪ define</li> <li>▪ identify</li> <li>▪ label</li> <li>▪ list</li> <li>▪ name</li> <li>▪ recall</li> <li>▪ state</li> </ul>	<ul style="list-style-type: none"> <li>▪ describe</li> <li>▪ discuss</li> <li>▪ explain</li> <li>▪ locate</li> <li>▪ paraphrase</li> <li>▪ give example</li> <li>▪ translate</li> </ul>	<ul style="list-style-type: none"> <li>▪ apply</li> <li>▪ carry out</li> <li>▪ demonstrate</li> <li>▪ illustrate</li> <li>▪ prepare</li> <li>▪ solve</li> <li>▪ use</li> </ul>	<ul style="list-style-type: none"> <li>▪ analyze</li> <li>▪ categorize</li> <li>▪ compare</li> <li>▪ contrast</li> <li>▪ differentiate</li> <li>▪ discriminate</li> <li>▪ outline</li> </ul>	<ul style="list-style-type: none"> <li>▪ combine</li> <li>▪ construct</li> <li>▪ design</li> <li>▪ develop</li> <li>▪ generate</li> <li>▪ plan</li> <li>▪ propose</li> </ul>	<ul style="list-style-type: none"> <li>▪ assess</li> <li>▪ conclude</li> <li>▪ evaluate</li> <li>▪ interpret</li> <li>▪ justify</li> <li>▪ select</li> <li>▪ support</li> </ul>



## PSYCHOMOTOR DOMAIN (doing, skills)

	Perception	Set	Guided Response	Mechanism	Compete overt response	Adaption	Organization
<b>Definition</b>	<i>Senses cues that guide motor activity</i>	<i>Is mentally, emotionally, and physically ready to act.</i>	<i>Imitates and practices skills, often in discrete steps.</i>	<i>Performs acts with increasing efficiency, confidence, and proficiency.</i>	<i>Performs automatically.</i>	<i>Adapts skills sets to meet a problem situation.</i>	<i>Creates new patterns for specific situations.</i>
<b>Example Verbs</b>	<ul style="list-style-type: none"> <li>▪ detect</li> <li>▪ hear</li> <li>▪ listen,</li> <li>▪ observe</li> <li>▪ perceive</li> <li>▪ recognize</li> <li>▪ see</li> <li>▪ sense</li> <li>▪ smell</li> <li>▪ taste</li> <li>▪ view</li> <li>▪ watch</li> </ul>	<ul style="list-style-type: none"> <li>▪ achieve a posture</li> <li>▪ assume a body stance</li> <li>▪ establish</li> <li>▪ a body position</li> <li>▪ place hands, arms, etc</li> <li>▪ position the body</li> <li>▪ sit</li> <li>▪ stand</li> <li>▪ station</li> </ul>	<ul style="list-style-type: none"> <li>▪ copy</li> <li>▪ duplicate</li> <li>▪ imitate</li> <li>▪ manipulate with guidance</li> <li>▪ operate under supervision</li> <li>▪ practice</li> <li>▪ repeat</li> <li>▪ try</li> </ul>	<ul style="list-style-type: none"> <li>▪ complete with confidence</li> <li>▪ conduct</li> <li>▪ demonstrate</li> <li>▪ execute</li> <li>▪ improve efficiency</li> <li>▪ increase speed</li> <li>▪ make</li> <li>▪ pace</li> <li>▪ produce</li> <li>▪ show dexterity</li> </ul>	<ul style="list-style-type: none"> <li>▪ act habitually</li> <li>▪ advance with, assurance</li> <li>▪ control</li> <li>▪ direct</li> <li>▪ excel</li> <li>▪ guide</li> <li>▪ maintain efficiency</li> <li>▪ manage</li> <li>▪ master</li> <li>▪ organize</li> <li>▪ perfect</li> <li>▪ perform automatically</li> <li>▪ proceed</li> </ul>	<ul style="list-style-type: none"> <li>▪ adapts</li> <li>▪ reorganizes</li> <li>▪ alters</li> <li>▪ revises</li> <li>▪ changes</li> </ul>	<ul style="list-style-type: none"> <li>▪ designs</li> <li>▪ originates</li> <li>▪ combines</li> <li>▪ composes</li> <li>▪ constructs</li> </ul>

## AFFECTIVE DOMAIN (Feeling, attitudes)

	<b>Receiving</b>	<b>Responding</b>	<b>Valuing</b>	<b>Organisation</b>	<b>Internalizing</b>
<b>Definitio n</b>	<i>Selectively attends to stimuli.</i>	<i>Responds to stimuli.</i>	<i>Attaches value or worth to something.</i>	<i>Conceptualizes the value and resolves conflict between fend other values.</i>	<i>Integrates the value into a value system that controls behavior</i>
<b>Example Verbs</b>	<ul style="list-style-type: none"> <li>▪ accept</li> <li>▪ acknowledge</li> <li>▪ be aware</li> <li>▪ listen</li> <li>▪ notice</li> <li>▪ pay attention</li> <li>▪ tolerate</li> </ul>	<ul style="list-style-type: none"> <li>▪ agree to</li> <li>▪ answer freely</li> <li>▪ assist</li> <li>▪ care for</li> <li>▪ communicate</li> <li>▪ comply</li> <li>▪ conform</li> <li>▪ consent</li> <li>▪ contribute</li> <li>▪ cooperate</li> <li>▪ follow</li> <li>▪ obey</li> <li>▪ participate willingly</li> <li>▪ read voluntarily</li> <li>▪ respond</li> <li>▪ visit</li> <li>▪ volunteer</li> </ul>	<ul style="list-style-type: none"> <li>▪ adopt</li> <li>▪ assume   responsibility</li> <li>▪ behave according to</li> <li>▪ choose</li> <li>▪ commit</li> <li>▪ desire</li> <li>▪ exhibit loyalty</li> <li>▪ express</li> <li>▪ initiate</li> <li>▪ prefer</li> <li>▪ seek</li> <li>▪ show concern</li> <li>▪ show continual</li> <li>▪ desire to</li> <li>▪ use resources to</li> </ul>	<ul style="list-style-type: none"> <li>▪ adapt</li> <li>▪ adjust</li> <li>▪ arrange</li> <li>▪ balance</li> <li>▪ classify</li> <li>▪ conceptualize</li> <li>▪ formulate</li> <li>▪ group</li> <li>▪ organize</li> <li>▪ rank</li> <li>▪ theorize</li> </ul>	<ul style="list-style-type: none"> <li>▪ al upon</li> <li>▪ advocate</li> <li>▪ defend</li> <li>▪ exemplify</li> <li>▪ influence</li> <li>▪ justify behavior</li> <li>▪ maintain</li> <li>▪ serve</li> <li>▪ support</li> </ul>