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Application of the defined mechanisms to some examples of training material, providers and events

Author(s): **I.H. van Elsäcker-Degenaar, M. Sutmuller and P.G.R Ruiter**

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ENETRAP II WD 5.4

Application of the defined mechanisms to some examples of training material, providers and events

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Author(s):	I.H. van Elsäcker-Degenaar	reviewed:	P.G.R. Ruiter
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Contents

Summary

To maintain a high level of competency in Europe regarding radiation protection and to facilitate harmonisation and (mutual) recognition of Radiation Protection Experts (RPEs) and Officers (RPOs) quality assurance and quality control might play an important role. The ENETRAPII project (FP7-EURATOM) aims at developing European high-quality 'reference standards' and good practices for education and training in radiation protection. In Work Package 5 (WP5) the quality issue is addressed. Therefore, WP5 deals with the development and application of mechanisms for the evaluation of training material, training events and training providers by means of a transparent and objective methodology. The results can be used by regulatory authorities to benchmark their national radiation protection training programme and will be communicated to other networks, e.g. EUTERP[1].

Deliverable WD 5.4 covers the application of the table for comparison of training material and training events developed for deliverable WD5.1 [1] en WD 5.2 [2]. Deliverable 5.1 addresses the methodology and quality assurance protocol for comparison and evaluation of training material, whilst Deliverable 5.2 addresses the methodology and quality assurance protocol for comparison and evaluation of training events. In addition, this deliverable covers the application of the quality criteria to the partner training providers, as developed in Deliverable 5.3 [3].

The table for comparison of training material was filled in by 6 institutes, of which some filled in the table for other levels than RPE alone. We compared all training material with the standard training book developed in WP7 about the development of some course material examples. The contents of this book is described in WD 7.1[4].

The table for comparison of training courses was filled in by 6 institutes of which some filled in the table for other levels than RPE alone. In total we received 13 tables. We compared all training events with the standard training event developed in WP4 about the establishment of the reference standards for RPE training. Contents of this material are described in WD 4.1[5].

Since the end of the ENETRAP2 project, the table with learning outcomes of the ERTS can be used as a list of knowledge, skills and competence based learning outcomes. The EQF grades can be used to define the level of knowledge, skills and competences that is reached by studying the material or with the training event.

[1] EUTERP is an acronym for the EUropean Training and Education

The last part of this report is about the developed quality criteria for training providers. The list consists of 16 quality criteria, which was sent to the WP5 partners. All partners met all but one or two of the criteria, but sometimes proof of meeting the criteria was not written down.

Although the tables of comparison of training material and training events are very useful, it seems that self-assessment is difficult. This problem can be solved by having an independent organization that is assigned to carry out the comparison of training material and training events and evaluate the quality of the training providers. In this organization people have to be able to speak and understand all languages of the European Union, since training material and events are most of the times in the national language. When it takes to much work to carry out the comparison and the evaluation, one can considers to have an independent commission doing some random auditing. Of course, the language problem then still exists.

1 Introduction

Today's challenge in the field of radiation protection involves measures to make the work in radiation protection more attractive for young people and to provide attractive career opportunities. In addition, young students and professionals should be supported in their need to gain and maintain high level knowledge in radiation protection. These objectives can be reached by the development and implementation of a high-quality European standard for initial education and continuous professional development for Radiation Protection Experts (RPEs) and Radiation Protection Officers (RPOs).

The FP7 European Network for Education and Training in Radiation Protection II (ENETRAPII) project is a specific tool for EURATOM policy for E&T implementation in the radiation protection field. In addition, the project is a tool towards a mutual recognition of professional qualifications.
For the purposes of this project the Radiation Protection Expert can be defined as:
"*An individual having the knowledge, training and experience needed to give radiation protection advice in order to ensure effective protection of individuals, whose capacity to act is recognized by the competent authorities.*"
and the Radiation Protection Officer can be defined as:
"*An individual technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant or licensee to oversee the application of the requirement of the Standards*".
These are the definitions as proposed during the second EUTERP workshop in Lithuania in 2008.
To reach high-quality European standards for initial education and continuous professional development, there has to be an agreement between the European countries concerning the duties and responsibilities of both RPEs and the RPOs. These standards are developed in Work Packages 3 and 4 (WP3 and WP4) of the ENETRAPII project.
As soon as these standards are set, each country will be able to access and benchmark their own education and training against the European standards. It will also be possible for a country to benchmark an RPE or RPO, educated and trained in another country, to their national standards. Shortcomings of education and training materials, events and providers, become clear when it is possible to compare national standards of education levels to the European standards. Therefore one of the cornerstone work packages in ENETRAPII is work package 5 (WP5), entitled: Develop and apply mechanisms for the evaluation of training material, events and providers. The first deliverable of WP5 (WD 5.1) is 'develop a methodology and quality assurance protocol for comparison and evaluation of training material'. A comparison tool was developed to indicate the amount of detailed of the subjects covered in the training

material. A table was developed and presented previously (appendix A). In this table all subjects are mentioned that can be covered by training material. In this report the comparison tool is used to compare seven training materials with the standard developed in WP7.

The second deliverable of this work package was ‘develop a methodology and quality assurance protocol for comparison and evaluation of training material’. Two comparison tools are developed that can be used to compare the learning outcomes for an event with the RPE course, developed in WP4. One comparison tool is for comparing the knowledge based learning outcomes, the other one is to compare the skills and competence based outcomes. The learning outcomes of the event can also be part of an portfolio, as meant within the ECVET approach (European Credit transfer system for Vocational Education and Training) [6].

The third deliverable of WP5 (WD 5.3) is ‘develop a methodology and quality assurance protocol for evaluation of training providers’. For this deliverable 16 quality criteria were formulated (Appendix C). The evaluation of the training providers consists all the quality criteria.

2 Material

2.1 Comparison of training material

The comparison system for training material consists of a list of learning outcomes (knowledge based) and a tool for the comparison of the learning outcomes. A list of learning outcomes is presented in Appendix A as subjects that can be covered in a certain extent by studying training material. Training material in WP5 is defined to be a text book, cyberbook or duplicated lecture notes. This list can be used to compare the learning outcomes of training material with the learning outcomes of the standard course material, developed in WP 7. The developed table is divided in main subjects and subdivided in more detail (Appendix A). Each of the subjects are learning outcomes that are known after studying.

ECVET uses learning outcomes instead of spent hours as a basis for a portfolio, with which students of one institute can enter the other institute to finalize their course. The comparison of learning outcomes of training material in this WP 5 is done based on a characterisation / descriptor of the level of detail at which the detailed subjects (learning outcomes) are covered during the training (Table 1) and not on the number of hours spent to study the subject. The advantage of using descriptors above hours spent on the different subjects is that the entrance level of students doesn't have to be set. Theoretically people with different levels can enter all courses.

ECVET uses learning outcomes in three different divisions: the knowledge bases learning outcomes, the skills bases learning outcomes and the competence based learning outcomes. The learning outcomes that are reached by studying course material like text books, cyberbooks or duplicated lecture notes are knowledge based and can hardly be skills based or competence based. Descriptors to compare the subjects in the list are given in the Table below. These descriptors are used to compare knowledge based learning outcomes with each other or to compare knowledge based learning outcomes with that of the standard training material.

At the time of the research to come to a comparison table for the evaluation of material, the EQF was not known by the ENETRAP2 project. Nowadays the EQF grades 1-8 are preferred above the grades in the Dutch reference table.

Table 1 Descriptor at which learning outcomes (knowledge based) are covered in training material

Descriptor	Covered
0	not covered
1	global, qualitative
2	important subjects covered, quantitative
3	Detailed, quantitative

All WP5 partners have received the list of knowledge based learning outcomes and were asked to subscribe the learning outcomes of one or more of their training material with the descriptors in Table 1. At the end of the ENETRAP2 project, the learning outcomes of the European reference training scheme are developed in ECVET style, with grading in EQF numbering (Appendix D). Therefore it makes more sense to use the EQF numbering instead of the grades of Table 1.

2.2 Comparison of training events

The comparison system for training events consists also of two parts. One part is a list of learning outcomes , the other part is a tool for the comparison of the learning outcomes. The learning outcomes of training events are not only knowledge based, but are also skill and competence based. These are the same division as used in the description of learning outcomes within ECVET.
The list of learning outcomes can be used from WD 4.1, where the learning outcomes are described for the European Radiation Protection Training Scheme (ERPTS) for the Radiation Protection Expert (RPE). At time of writing this report not all learning outcomes for the ERPTS were finalized. For the learning outcomes of the Radation Protection Officer (RPO) learning outcomes are defined in WP3. They were also not ready at time of writing. The comparison of the training events is therefore carried out by using only the learning outcomes for Module 1 of the ERPTS (Appendix B).

ECVET uses learning outcomes instead of spent hours as a basis for a portfolio, with which student of one institute can enter the other institute to finalize their course. The comparison of learning outcomes of training material in this WP 5 is done based on a characterisation / descriptor of the level of detail at which the learning outcomes are covered during the training event (Table 2 and Table 3) and not on the number of hours spent to reach the learning outcomes. The advantage of using descriptors instead of hours spent on the different subjects is that the entrance level of students doesn't have to be set. Theoretically people with different levels can enter all courses.

Descriptors to compare the knowledge based learning outcomes are given in Table 2. These descriptors are the same as developed for the comparison of training material, but this time the goal is subscribed, instead of the degree of detail of the description in the training material. However, by using the degree of detail as described in Table 1 one reaches the goals set in Table 2.

Table 2 Descriptors at which subjects are dealt with in knowledge based learning outcomes

Descriptor	Goal
0	-
1	Basic awareness of the subject
2	Understanding of the subject
3	Detailed understanding of the subject

Table 3 Descriptors at which subjects are dealt with in skill and competence based learning outcomes

Grade	Description
yes	Fulfilled
no	Not fulfilled

For skill and competence based learning outcomes one cannot use the descriptor of Table 2, since one does not want to reach awareness with skill and competence based learning outcomes. Other descriptors as fulfilled / not fulfilled are used (Table 3).

All WP5 partners have received the list of learning outcomes of Module 1 of the ERPTS and were asked to describe the learning outcomes of one or more of their training material with the descriptors in Table 2 and Table 3).

At the end of the ENETRAP2 project, the learning outcomes of the European reference training scheme are developed in ECVET style, with grading in EQF numbering (Appendix D). Each learning outcomes in WP4 is assigned to a certain field: knowledge, skills or competences (attitude). Therefore it makes more sense to use the EQF numbering instead of the grades of Table 2 and 3, but at the time of research the EQF levels were not known by the consortium.

2.3 The evaluation of training providers

The evaluation system for training providers consists again of two parts. One part is a list of quality criteria that training evaluators should met. the other part is a tool for the evaluation of the quality criteria.

The list of quality criteria is composed from the most important quality criteria, that the WP5 partners have thought of. Within ECVET no quality criteria for training providers can be found at the time of writing.
The evaluation of training providers is based on the comparison mechanisms of the comparison of skill and competence based learning outcomes, so that not a new mechanism should be taken into account. The descriptors can be found in Table 4**Fout! Verwijzingsbron niet gevonden.**.

Table 4 Descriptors whether the quality criteria for training providers are met.

Grade	Description
yes	Fulfilled
no	Not fulfilled

All WP5 partners have received the list of quality criteria, set up in deliverable WD 5.3 and were asked to state whether they fulfil the quality criteria or not, by using the descriptors of Table 4.

3 Results

3.1 Comparison and evaluation of training material

The table with learning outcomes for material was send out to all WP5 partners. The partners were asked to describe the learning outcomes, which are knowledge based, of their training material, according to Table 1. The description is based on the depth of understanding.

For comparison of training material the institutes choose one or more of their books or other training materials used during the courses for RPE, RPO or radiation worker (RW). Six institutes filled in the table for trial comparisons of material for in total 12 courses. Apart from that the table was filled in by the WP leader of WP 7 for the standard book for RPE training. At the moment of comparing, the book was only written for the first module of the ERPTS.

All the institutes mentioned for which course the material was used. In Table 5 the result is shown for the materials A up to L (for different training material) and in the last column for the ERPTS book. The indication given by the partner can be found on the last row.

Table 5 An excerpt from the filled in learning outcomes list for 12 different materials and the ERPTS book.

Training material →	A	B	C	D	E	F	G	H	I	J	K	L	ERPTS
Composition of matter				3	3	0	1	2	1	1	3	2	2
Proton-Neutron ratio, ionisation, excitation	0	2	2	3	3	0	0	2	1	1	3	2	3
Alpha decay	0	2	2	3	3	0	1	3	1	2	3	2	3
Indication of provider*	W	O	E	E	E	W	W	E	W	O	E	W	E

* W: material for a RW course, O: material for an RPO course, E: material for an RPE course.

The learning outcome of the standard ERPTS training material is met, if the descriptor is at least the same as the one in the last column or higher. For the learning outcome: ‘knowledge about composition of matter’ the ERPTS rated this as 2: important subject covered, quantitative. From Table 5 it can concluded that material D, E, H, K and L meet the learning outcome with the grade of detail as required.

For all institutes, when comparing the descriptors of the training material with those of the ERPTS, it was concluded that there are shortcomings, except for one (training material D). Actually this institute indicated that in their training material D all their learning outcomes as covered detailed and quantitative (score 3). The RW training material deviates in general in more learning outcomes than that or the RPO and RPE, as was expected, since we compared with the RPE course.

Since the end of the ENETRAP2 project, the table with learning outcomes of the ERTS can be used as a list of knowledge based learning outcomes. The EQF grades can be used to define the level of knowledge that is reached by studying the material. The mechanism as described above with using the Dutch reference table and its grades can still be used, when applying the other tables and grades.

3.2 Comparison and evaluation of training events

The table with learning outcomes of the Module 1 of the ERPTS course was send out to all WP5 partners. The learning outcomes were split up in two: on one side knowledge based learning outcomes and on the other side competence / skill bases learning outcomes. The partners were asked to describe the learning outcomes, which are knowledge based, according to Table 2 and those which are skill / competence based, according to Table 3.

For comparison of training events the institutes choose one or more of their courses or other training events for RPE, RPO or RW. Five partners filled in the table for trial comparisons of events for in total eight events. Apart from that the table was filled in by the WP leader of WP 4 for the ERPTS. At the moment of comparing, the learning outcomes of the ERPTS were ready for only module 1.

All the institutes mentioned the level of the training event. In Table 6 the result is shown for the events A up to H (different training events) and in the last column for the ERPTS module 1. The indication given by the partner can be found on the last row.

Table 6 The filled list for knowledge based learning outcomes for 8 different events and the ERPTS.

Training event→	A	B	C	D	E	F	G	H	ERPTS
Explain the different modes of disintegration and desexcitation	2	3	2	3	3	2	1	3	3
Describe the different type of radiations emitted and their features	2	3	2	3	3	3	2	3	3
Define the notions of activity, intensity of radiation, half-life.	2	3	2	3	3	3	2	3	3
Explain the different phenomena of interaction of the radiations with matter (loaded particles, electromagnetic radiations, neutrons)	2	3	2	3	3	3	1	3	3
Define the linear transfer of energy	2	2	1	2	3	2	1	3	3
Interpret attenuation of gamma radiation as a function of thickness and Z	2	2	2	2	3	2	1	3	3
Define the operational quantities and UNITS	2	2	2	3	3	3	3	3	3
Define the absorbed dose, the doserate of absorbed dose	2	2	2	3	3	3	3	3	3
Explain the principle of performance of the detectors used in radioprotection	2	3	2	3	2	2	2	3	3
Indication of provider*	W	O	E	E	E	W	W	E	E

* W: material for a RW course, O: material for an RPO course, E: material for an RPE course.

The knowledge based learning outcome of the standard ERPTS course is met, if the descriptor is at least the same as that in the last column or higher, i.e. in this case the descriptor has to be 3. For all tables it was concluded by comparing the descriptors of the events with the ERPTS that there are shortcomings, except for one (training event H). This institute indicated that in their training event all their learning outcomes as covered detailed and quantitative (score 3).

Table 7 The filled list for competence and skill based learning outcomes for 8 different events and the ERPTS (module 1).

Training event→	A	B	C	D	E	F	G	H	ERPTS
Calculate the activity of a source at any time...	yes	yes	yes	yes	yes	yes	no	yes	yes
Calculate the range of a beta radiation and the attenuation of a radiation using curves	yes	yes	yes	yes	yes	yes	no	yes	yes
Apply relationship between fluence, kerma and absorbed dose	yes	yes	yes	yes	yes	yes	no	yes	yes
Calculate the limit of detection, and others characteristics	no	no	no	yes	yes	yes	no	yes	yes
Use the appropriate detection device and probe vs type of radiations	yes	yes	yes	yes	yes	yes	yes	yes	yes
Indication of provider*	W	O	E	E	E	W	W	E	E

* W: material for a RW course, O: material for an RPO course, E: material for an RPE course.

The competence and skill based learning outcome of the standard ERPTS course is met, if the descriptor is at least the same as that in the last column or higher, i.e. in this case the descriptor has to be “yes”. The descriptor of the ERPTS is “yes”, because we used the learning outcomes of the ERPTS.

If using other learning outcomes, it is possible that the used competence or skill based learning outcome is not preferred by the ERPTS. In that case the descriptor in the column of the ERPTS is “no”. Than the learning outcome is met, when in the column of the comparing event is “yes” or “no”.

For all events, when comparing the descriptors with the ERPTS values, it was concluded that some have shortcomings. Events A, B and C do not deal with the skill: ‘calculation of the limit of detection and other charateristics’. Event G only meets the skill: ‘using the appropriate detection device and probe vs type of radiation’. It is possible that the student however has knowledge about other skills, but is not trained on the skill itself. Therefore learning outcomes should be considered to be not only one type of learning outcome. Learning outcomes as described above, can be both knowledge based and skill or competence based. In a newer version of WD 4.1 [5], this has been done for all learning outcomes.

At the end of the ENETRAP2 project, the table with learning outcomes of the ERPTS, developed in WD4.1 can be used as a list of learning outcomes. The EQF grades can be used to define the level of knowledge, skill or competence (attitude) that is reached by event. The mechanism as described above with using the learning outcomes of ERPTS module 1 together with the grades from the Dutch reference can still be used, when applying the other tables and grades.

3.3 Evaluation of training providers

The list (Appendix C) with quality criteria was send out to all WP5 partners. The partners were asked to state whether they fulfil the quality criteria described in the list, according to Table 4. At this time it was not needed to give proof that the criteria were met.

Six training providers filled in the table for the evaluation, as can be seen for some criteria in Table 8.

Table 8 An excerpt from the filled in list of quality criteria.

Training provider →	A	B	C	D	E	F	ENETRAP2
7. Teachers and practical tutors have demonstrable competences with regard to the topic of their lessons.	no	no	yes	yes	yes	yes	yes
9. Each event is subject of a written evaluation by the participants. Items for evaluations are organisation, teachers, content, materials and facilities.	no	yes	yes	yes	yes	yes	yes
11. Complaint procedures are present.	no	yes	yes	no	yes	yes	yes
12. There is a participant registration associated with a document control system (list of participants, score lists, archive of distributed diplomas and certificates).	no	yes	yes	yes	yes	yes	yes

The quality criterion of the standard set by the WP5 partners is met, if the descriptor is at least the same as that in the last column or higher, i.e. in this case the descriptor has to be “yes”. The descriptor of the ENETRAP2 column is “yes”, as we have chosen these quality criteria as reference.

If using other quality criteria it is possible that the criterion used is not preferred by the ENETRAP2. In that case the descriptor in the column of ENETRAP2 is “no”. Then the criterion is met whatever descriptor is filled in by the training providers. The mechanism can still be used to evaluate training providers, only the quality criteria isn’t one of the 16 criteria set by ENETRAP2.

For all providers it was concluded by comparing the descriptors of the providers with the defined quality criteria that there are some shortcomings. Most providers meet about 14 of the 16 quality criteria. Some of the providers stated that much of the quality system was not written down, but however was functioning informally.

4 Discussion and conclusions

4.1 Comparison and evaluation of training material

The evaluation system consists of a list of knowledge based learning outcomes together with a descriptive system. As it can be found in Chapter 3, training material can be compared and evaluated against the standard ERPTS book. Shortcomings can be noticed and given back by an assessment team to the institute that sent in the material for evaluation.

A remark can be made that this list is too detailed, but it is seen that the more detailed the learning outcomes on the list, the easier it becomes to give the right subscription to the learning outcome.

Point for discussion is the self-assessment (see paragraph 4.4).

Since the end of the ENETRAP2 project, the table with learning outcomes of the ERTS can be used as a list of knowledge based learning outcomes. The EQF grades can be used to define the level of knowledge that is reached by studying the material. The mechanism as described above with using the Dutch reference table and its grades can still be used, when applying the other tables and grades.

4.2 Comparison and evaluation of training events

The ECVET approach can be used to gain learning outcomes in a portfolio. The learning outcomes can be evaluated by the evaluation system for training events, as proposed in this document.

Learning outcomes have to be subdivided in the type of learning outcome: knowledge, skill or competence based, but can be allocated to more than one type. When this allocation is done correctly the proposed approach of a list of learning outcomes and two descriptive systems can be used. Shortcomings can be noticed and given back by an assessment team to the institute that sent in the event for evaluation.

A remark can be made that the list is not very detailed. Therefore it is rather difficult to give the right subscription to the learning outcome. When asking about ‘Calculate the range of a beta radiation and the attenuation of a radiation using curves’ it can be that in the course is dealt with beta radiation but not with gamma radiation. One does not know how to grade this learning outcome.

Point for discussion is the self-assessment (see paragraph 4.4).

At the end of the ENETRAP2 project, the table with learning outcomes of the ERPTS, developed in WD4.1 can be used as a list of learning outcomes. The EQF grades can be used to define the level of knowledge, skill or competence (attitude) that is reached by event. The mechanism as described above with using the learning outcomes of ERPTS module 1 together with the grades from the Dutch reference can still be used, when applying the other tables and grades.

4.3 Comparison and evaluation of training events

Quality criteria are defined by the WP5 partners. The list takes not much effort to be filled in. The descriptive system can be used to evaluate training partners. Shortcomings can be noticed and given back by an assessment team to the training provider.

Point for discussion is the self-assessment (see paragraph 4.4).

4.4 Self-assessment

The evaluations showed that the proposed mechanism are very useful instruments. To make the evaluation as efficient as possible, we suggest to perform the mechanism as a self-assessment. However we than have to take into account that one can fill in the list arbitrarily or choose the wrong descriptor. Self-assessment cannot be done without a certain random auditing of an independent organisation or institute. This organisation can randomly, depending on the time available, judge whether the description of the subjects (learning outcomes or quality criteria) in the different list is carried out in the right way and if there is a certain conformity. In Table 6 can be seen for instance that provider H has assessed all items as a 3. It is possible of course that this is true, but it can also be caused because the provider misunderstood the descriptive system. The same can be seen in Table 5 for provider D.

The organisation should consist of different E&T experts, mastering different languages to understand the content of the training material or the training course. Since the consequence of this auditing is far-reaching, one should not do this task as a volunteer, but one needs to be assigned (and properly paid) to carry out this task.

References

[1] WD 5.1 Methodology and quality assurance protocol for the comparison and evaluation of training material, 107383, NRG Petten, The Netherlands, 2011.
[2] WD 5.2 Methodology and quality assurance protocol for the comparison and evaluation of training events, 111769, NRG Petten, The Netherlands, 2011.
[3] WD 5.3 Methodology and quality assurance protocol for the comparison and evaluation of training providers, 112824, NRG Petten, The Netherlands, 2012.
[4] WD 7.1 Accompanying text for at least one module of the RPE or the RPO training scheme, Concept July 2011, CEA/INSTN, France, 2011.
[5] WD 4.1 Statement of initial and refresher training requirements for RPE, Concept 16-8-2011, CEA/INSTN, France, 2011.
[6] ECVET; http://www.ecvet-team.eu/

Appendix A List for the evaluation of training material

Subjects of basic radiation protection training

grade	**covered**
0	not covered
1	global, quantitative
2	important subjects covered, quantitative
3	Detailed, quantitative

module	**Subject**	**Grade**
module 1	**Basics** Goal of the module: To understand the physical aspect of ionising radiations, the biological bases of radiological protection To describe and use the principal type of radiation detectors To describe the different usages of ionising radiations in the different domains and to know the type and range of used radioactive sources	
1.1	Inaugural conference	
1.2	Radioactivity and nuclear physics	
	Composition of matter	
	Proton-Neutron ratio, ionisation, excitation	
	Alpha decay	
	Beta minus decay	
	- Energy spectrum β-emitter	
	Beta pus decay and electron capture	
	Electronic shell rearrangement	
	- Consequence of a vacancy	
	- Amount of energy available	
	- Consequence of the electron capture	
	Gamma emission and internal conversion	
	Evolution of the activity	
	- Exponential law	
	- Decay chain with two isotopes	
	- Decay chain with one isotopes	
	- Activity law	
	- Activity, special activity and mass activity	
	Producing radionuclides by nuclear reaction	
	-Cross section	
	- Production of artificial radioactive substances	
	- Nuclear fission, fission products	
	Nuclide Chart	
	- Decay schemes and mother - daughter relation	
1.3	Interaction of radiation with matter	
	Directly ionising radiations	
	Heavy charged particles	

module	Subject	Grade
	- Range	
	- Nuclear reactions, cross section	
	Light charged particles	
	- Ionising capacity, LET, stopping power	
	- Range	
	- Bremsstrahlung	
	- LET	
	- Case of the positrons	
	- Application: principle of the X ray tube	
	Non directly ionising radiations	
	Electromagnetic radiation	
	- Energy dependent effect	
	- Attenuation coefficients, half-value layer	
	- General principle of building: build up factor coefficients	
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	- Kind of neutrons	
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	- Particle- and energy fluency and density	
	- Electron equilibrium	
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	- Relationships between radiometric and dosimetric quantities	
	- Calculation of absorbed dose	
	- Inverse-square law	
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	- Need for protection quantities	
	- New approach in ICRP 103, 60, ICRU 51 and EC directives	
	- Collective dose	
	- Neutron dosimetry	
	- Accident dosimetry	
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	- Dose-effect relations	
	- Somatic/genetic - early/late - stochastic/deterministic effects	
	Deterministic effects	
	Stochastic effects	
	Early effects after global or partial irradiation	
	Exposure of pregnant woman and foetus	

module	Subject	Grade
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	- Risk assessment	
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	- Measurement of chain, efficiency, dead-time, detection threshold, background and noise	
	- Uncertainty of a measurement	
	Ionisation of gas	
	Luminescence phenomenon	
	Ionisation into solids	
	Physical and chemical phenomenon	
	Detector functioning	
	Bragg-Gray principle	
	Whole body counters	

module 2	**Foundation: operational radiation protection and regulatory context** Goal of the module: To estimate the doserate to different distances from a radioactive point source (beta or photon) To determine the collective and individual protective means both for external and internal exposure To assess individual dose for both external and internal exposure To determine the features of a dose monitoring program (area and individual) To explain the process from ICRP, IAEA recommendations to a national regulatory	
2.1	Radiation protection external dosimetry	
	Dose assessment for external exposure	
	Calibration of a radiation protection device to measure external exposure	
2.2	Protection against external exposure	
	- Radiation protection principles	
	Shielding from charged particles, neutron and gamma radiation and X rays	
	Shielding gamma radiation / X rays:	
	- Small and broad-beam geometry; point source, build up factor	
	- Material choice in relation to photon energy	
	- Calculation of radiation scattering	
	- Use of graphs regarding attenuation and transmission	
	- Extremity exposure	
	- Use of calculation codes	
	- Personal control devices	
2.3	Protection against internal exposure	
	- Reduction of exposure, general principles	
	- Classification of activities based on radio toxicity and possibility of spreading used nuclides	

module	Subject	Grade
	- Maximal allowed surface contamination	
	Modes of intake	
	- Reference man	
	- General transport-model from the ICRP, transfer coefficients, dosimetry models from the ICRP	
	- Background and use of tables and other data from the ICRP on dose calculations for:	
	· Chronic and acute inhalation and ingestion	
	· Wound contamination	
	· "Submersion"	
	- Use of retention and excretion models from the ICRP	
	- Classification of radionuclides based on radio toxicity	
	Collective protection	
	Individual protection	
	- Working methods / protection measures	
	- Waste treatment, standards for discharging waste	
	- Decontamination methods	
	- Control methods:	
	· Leak test sealed sources	
	- Air filtration	
	Risk evaluation of open sources	
2.4	Dose monitoring	
	Area monitoring	
	- Regulatory requirements	
	- Operation-, environmental-, and surface monitoring	
	- Design of a monitoring program	
	- Classification of areas	
	- Utilisation of detectors	
	Individual monitoring	
	- External exposure	
2.5	Regulatory context	
	Basic principles of radiation protection	
	ICRP recommendations	
	IAEA safety fundamentals, requirements and guidelines	
	EC directives, practices and interventions	
	ALARA principles	
	Individual work on national regulation of learners country	
2.6	Natural sources of ionising radiation	
	- Natural radionuclides	
	- Case of radon	
	- External irradiation and cosmic radiation	
	- Internal irradiation	

module	Subject	Grade
	- NORM industries	
	- Dose due to natural radioactivity	
2.7	Public and environmental radiation protection	
	Public radiation protection	
	- Dose limits and constraints	
	- UNSCEAR overview of exposure levels from artificial sources	
	- Principles of dispersion models in air and water	
	Environmental radiation protection	
	-ICRP system of environmental RP	
	Medical exposure	
2.8	Ethical considerations on the application of radioactivity and radiation protection	

module 3	**Foundation+** Goal of the module: to know the regulatory process in order to complete transportation of radioactive material at this level, to mitigate the consequences of an accident or emergency issues to integrate the alara principles and a safety culture in his practices to know the principles of waste management and decommissioning	
3.1	Transport	
	- Regulation of the transportation of hazardous material in relation to the transport of radioactive materials	
	- Presentation of the ADR	
	- Types of packages, transport index, signalisation and labelling, measurements	
3.2	Design issues	
	Choice of materials	
	Maintainability of installation	
	Work places, hot cells, glove boxes	
	Specific shielding measures for nuclear installations	
3.3	Accidents and emergency issues	
	Accidents: feedback experience	
	Medical management in accidental situation	
	Management of populations	
	Measurements during accidents	
	Personal radiation accidents:	
	- External exposure	
	- Contamination of clothing and skin; decontamination	
	- Internal exposure	
	- Organisation measures, internal and external	

module	Subject	Grade
3.4	Safety culture	
	Interface radiation protection and safety	
	Risk evaluation in relation to nuclear installations	
3.5	ALARA	
	Justification and optimisation: dose constraints: new ICRP recommendations	
3.6	Principles of decommissioning	
	Strategies, techniques and implementation	
3.7	Principles of waste management	
	Regulatory context, classification and techniques	
3.8	Communication public, medias	
further	Organizational aspects	
	- Tasks and responsibilities of the radiation expert	
	- Administration and management	

Module 4	**Occupational radiation protection: specificities of the nuclear installations, power plants and fuel cycle** Goal of the module: To know the specificities of radiation protection in the fields of NPPs, fuel cycle facilities To implement safety and ALARA cultures To perform the classification of areas (controlled and supervised) To be aware of accidental situations (causes and consequences)	
4.1	Main types of nuclear reactors	
	- General principle - basics on neutron physics, nuclear fission, criticality	
	- Visit NPP if possible	
4.2	The fusion	
	- General principle	
	- Visit if possible	
4.3	The fuel cycle	
	- Lectures (radiation protection in front end and in back end)	
	- Visit of an enrichment plant, a fuel processing plant or a reprocessing plant if possible	
4.4	Dose monitoring and regulatory controls	
	Environmental monitoring and controls around a nuclear installation	
	Activation	

module	Subject	Grade
4.5	Safety culture - interface radiation protection and safety	
	- Basic concept of safety culture	
	- Safety of the pressurized water reactors and interface with protection against radiation- prevention of risks	
	- Organisation, task and responsibilities of RPE, daily RP and RP during annual outage, equipments, dosimetry	
4.6	Accidental situations	
	- Lessons learnt from nuclear accidents	
	- Emergency procedures and interventions, report	
	- Management of the populations and medical aspects	
	Principles and countermeasures	
	Particular case of iodine	
	- Medical management in accidental situation	
	Dosimetry evaluation and reconstitution	
	- Lessons learnt from nuclear accidents	
	- Emergency procedures and interventions, report	
	- Management of the populations and medical aspects	
	Principles and countermeasures	
	Particular case of iodine	
	- Medical management in accidental situation	
	Dosimetry evaluation and reconstitution	

Module 5	**Occupational radiation protection: specificities of waste management and decommissioning** Goal of the module: To implement principles of radioactive waste management and their basic techniques To implement principles of decommissioning and related strategies To understand the principle of ventilation and filtration in waste management and decommissioning field To perform the classification of areas (controlled and supervised)	
5.1	Waste management	
	- Legal aspects, waste preparation and collection	
	- Waste classification and strategies for waste conditioning	
	- Radiation protection during combustion, bituminising and vitrification of radioactive waste	
	- Radiation protection aspects in a final storage facility	
	- Risk evaluation in relation to waste management	
	Environmental monitoring and controls around waste storage facility	
	- Visit a waste storage facility (if possible)	
5.2	Decommissioning	
	- Strategies, radiation protection planning and organisation	
	- Techniques for disassembling, dismantling and safe handling	
	- Decontamination and measuring techniques for release of materials from controlled areas	

module	Subject	Grade
	- Planning and implementation of these techniques	
	- Visit a facility under decommissioning (if possible)	
5.3	Ventilation and filtration	
	- Basics of aerosol physics, granulometry, principles of ventilation and filtration, mains types of protection	
	- Air renewal, measurements of air rate, optimisation of the position of air sampling, seek for leakage	
	- Protective clothing (different types), work in a contaminated area and maintenance on a clove box	
5.4	Transport	
	- European regulations (ADR): responsibilities, types of packages	
	- Transport index, signalisation and labelling, RP measurements, documentation	
	- Practical examples, lessons learned from accidents	

Module 6	**Occupational radiation protection: specificities of non-nuclear industries, research laboratories, Oil & Gas** Goal of the module: To apply a radiation protection program in activities where sealed and / or unsealed radioactive sources are used To perform the classification of areas (controlled and supervised) To react in incidental or accidental situations	
6.1	Irradiators, generators, Accelerators, Gauges	
	- Technical principles of these equipments	
	- Radiation protection adapted to these equipments + regulatory controls	
	- Case study	
	- Visit of an accelerator or industrial irradiation facility (if possible)	
	- Risk evaluation	
6.2	Industrial radiography	
	- Technical principles of these equipments: gammagraphy and X-ray generators	
	- Radiation protection adapted to these equipments + regulatory controls	
	- Case study	
	- Risk evaluation	
6.3	Unsealed sources	
	- Sources management	
	- Specific shielding measures	
	- Regulatory controls	

module	Subject	Grade
	- Ventilation and filtration	
	- Waste management	
	- Transport	
	- Management of a contamination (surface or person) - Practical work	
	- Case study	
	- Risk evaluation	
6.4	Potential accidents	
	- Emergency procedures and interventions, report	
	- Lessons learnt from radiological accidents	

Module 7	**Occupational radiation protection: specificities of the medical activities** Goal of the module: To apply a radiation protection program in a medical field (except for radiation protection of patient) To establish the classification of areas (controlled and supervised)	
7.1	Technology of the equipments	
	For diagnosis purpose	
	- Conventional and numeric radiology	
	- Mammography	
	- Computerised tomography	
	- Interventional radiology	
	- Nuclear medicine including positron emission tomography	
	For therapy	
	- External beam therapy	
	- Brachytherapy	
	- Nuclear medicine (Iodine 131)	
	- Therapy using heavy particles or neutrons	
	Visits of hospitals or medical industries	
7.2	Occupational radiation protection: specificities	
	- Regulatory context (Directive EC 97/43….)	
	- Conception of the premises (therapy treatment room, nuclear medicine lab, classification of the areas)	
	- Radiation protection of the operators in the interventional radiology	
	- Radiation protection of the operators in brachytherapy	
	- Radiation protection of the operators in the hot lab	
	- Regulatory controls of the sources and their shielding, maintenance	
	- Management of the sources (brachytherapy and nuclear medicine)	
	- Waste management (nuclear medicine)	
	- Transport of radioactive sources	

module	Subject	Grade
	- Management of a contamination (surface or person) - Practical work	
	- Individual monitoring	
	- Risk evaluation	
7.3	Potential accidents	
	- Emergency procedures and interventions, report	
	- Lessons learnt from radiological accidents	

module 8	**Radiation protection for naturally occurring radioactive material (NORM)** Goal of the module: To know what are activities where NORM are present To participate at the evaluation of population and workers exposures	
8.1	Different activities where NORM are present	
	- The combustion of coal in thermal power stations	
	- The processing of ores of tin, aluminium, copper, titanium, niobium, bismuth, thorium…	
	- The activities of glassware, foundry, steel industry and metallurgy	
	- The production or usage of compounds using thorium	
	- The production of zircon and baddaleyite, and the activities of foundry and metallurgy	
	- The production of fertiliser with phosphates and the production of phosphoric acid	
	- The processing of the titanium dioxide	
	- The processing of the rare earths and the production of pigments	
	- The processing of underground water by filtration intended to the production:	
	* of waters intended to human consumption	
	* of mineral waters	
8.2	Evaluation of dose for exposed workers	
8.3	Evaluation of the exposure of population	
8.4	Implementation of the protective measures and the corrective actions in NORM activities	
	Visits	

Appendix B Lists for the evaluation of training events

Learning Outcomes regarding knowledge	Grade 0 not covered 1 basic awareness 2 basic understanding 3 detailed understanding
Be able to:	
Explain the different modes of disintegration and desexcitation	
Describe the different type of radiations emitted and their features	
Define the notions of activity, intensity of radiation, half-life.	
Explain the different phenomena of interaction of the radiations with matter (loaded particles, electromagnetic radiations, neutrons)	
Define the linear transfer of energy	
Interpret attenuation of gamma radiation as a function of thickness and Z	
Define the operational quantities and UNITS	
Define the absorbed dose, the doserate of absorbed dose	
Explain the principle of performance of the detectors used in radioprotection	

Learning Outcomes regarding skills	Grade YES NO
Be able to:	
Calculate the activity of a source at any time...	
Calculate the range of a beta radiation and the attenuation of a radiation using curves	
Apply relationship between fluence, kerma and absorbed dose	
Calculate the limit of detection, and others characteristics	
Use the appropriate detection device and probe vs type of radiations	

Appendix C List for the evaluation of training providers

General quality criteria

1. Each course or refresher course formulates its learning outcomes on the level of knowledge, skills and competence. The learning outcomes are level or target group focused.
2. The courses should reflect the requirements of national legislation.
3. For each course a program with table of lessons, subjects, teachers and methods is available.
4. The responsibility with regard to the course is in the hands of a person whose competence level on radiation protection is at least equivalent to the level that has to be achieved by the course.
5. The content of the course program is kept under review, so that learning outcomes are always appropriate. This review includes consideration of didactic methods, new scientific insights, adapted legislation.
6. The content of a course should match reference syllabi drawn up for Europe, at least for RPO/RPE courses. Where appropriate the requirements of the memorandum of understanding (MoU), as meant in ECVET, must be considered.
7. Teachers and practical tutors have demonstrable competences with regard to the topic of their lessons.

Organization directed quality criteria

8. The management of the training provider is involved in the quality assurance and provides the necessary interest, support and resources.
9. Each event is subject of a written evaluation by the participants. Items for evaluations are organisation, teachers, content, materials and facilities.
10. The system of evaluation should be stable to achieve continual improvements.
11. Complaint procedures are present.
12. There is a participant registration associated with a document control system (list of participants, score lists, archive of distributed diplomas and certificates).
13. The identity of the participant is determined before the distribution of diplomas or certificates of participation. The course provider is responsible for distribution of the diploma or certificate to the right person.

Examination directed quality criteria

14. There is an examination regulation, describing at least the exam procedure, marking scheme, the marking procedure (e.g. 2 correctors, blind correction).
15. There is procedure to maintain the quality of the examination.
16. The examination methodology should take into account the learning outcomes and the national regulations properly.

Appendix D The European Qualifications Framework for Lifelong Learning

	KNOWLEDGE	SKILLS	COMPETENCE
	In the context of EQF, knowledge is described as theoretical and/or factual.	*In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).*	*In the context of EQF, competence is described in terms of responsibility and autonomy.*
LEVEL 1	• basic general knowledge	• basic skills required to carry out simple tasks	• work or study under direct supervision in a structured context
LEVEL 2	• basic factual knowledge of a field of work or study	• basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	• work or study under supervision with some autonomy
LEVEL 3	• knowledge of facts, principles, processes and general concepts, in a field of work or study	• a range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	• take responsibility for completion of tasks in work or study • adapt own behaviour to circumstances in solving problems
LEVEL 4	• factual and theoretical knowledge in broad contexts within a field of work or study	• a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	• exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change • supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
LEVEL 5[2]	• 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

The Framework for Qualifications of the European Higher Education Area provides descriptors for cycles. Each cycle descriptor offers a generic statement of typical expectations of achievements and abilities associated with qualifications that represent the end of that cycle.

[2] The descriptor for the higher education short cycle (within or linked to the first cycle), developed by the Joint Quality Initiative as part of the Bologna process, corresponds to the learning outcomes for EQF level 5.

LEVEL 6[3]	• advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	• advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	• manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts • take responsibility for managing professional development of individuals and groups
LEVEL 7[4]	• highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • critical awareness of knowledge issues in a field and at the interface between different fields	• specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	• manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches • take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
LEVEL 8[5]	• 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

[3] The descriptor for the first cycle in the Framework for Qualifications of the European Higher Education Area agreed by the ministers responsible for higher education at their meeting in Bergen in May 2005 in the framework of the Bologna process corresponds to the learning outcomes for EQF level 6.
[4] The descriptor for the second cycle in the Framework for Qualifications of the European Higher Education Area agreed by the ministers responsible for higher education at their meeting in Bergen in May 2005 in the framework of the Bologna process corresponds to the learning outcomes for EQF level 7.
[5] The descriptor for the third cycle in the Framework for Qualifications of the European Higher Education Area agreed by the ministers responsible for higher education at their meeting in Bergen in May 2005 in the framework of the Bologna process corresponds to the learning outcomes for EQF level 8.