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ENETRAP

European Network on Education and Training in Radiological Protection

Coordination Action

EURATOM Research and Training on Nuclear Energy

WD.06 Table of content of the pilot session in RP training

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SCK•CEN / Studiecentrum voor Kernenergie • Centre d'Etude de l'Energie Nucléaire

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Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	x
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Members of work package nr 7

- INSTN - France (WP 7 coordinator)
- SCK•CEN – Belgium (Project leader)
- FZK-FTU - Germany
- BfS -Germany
- ENEA - Italy
- NRG - The Netherlands
- CIEMAT - Spain
- HPA-RPD - UK

1. Regulatory context

Requirements related to radiation protection training for European Union Member States are laid down in the European Directive 96/29/EURATOM of 13 May 1996, and detailed in the Appendix I of Communication from the Commission Nr 98/C133/03.
This Work Package deals with the validation of the results of previous WPs' and the establishment of recommendations for a pilot session.
The objectives of this WP nr 7 are:

- to analyze the possibilities of including a system of credit points for the ERPC,
- to recommend an adaptation of the current ERPC and its validation,
- to prepare a pilot session run of one or two modules of the course.

In this context, a syllabus has been developed. It has been named "ENETRAP Training Scheme" E.T.S. (Appendix 1, table 1 to 8 and Appendix 2). It is based both on the feedback of the European Radiation Protection Course (ERPC) run for four years in the INSTN (France, from 2000 to 2003), the IAEA PGEC syllabus, the French master in Radiation Protection and existing training courses from ENETRAP partners.
In Appendix 3, the figure shows the historic links between these different courses.

2. Experience of the European Radiation Protection Course

The ERPC was launched in 1999 at the INSTN by a group of interested colleagues from European radiation protection organisations and national training centers (Germany-BFS, The Netherlands-NRG, Belgium-SCK/CEN, Spain-CIEMAT, Italy-ENEA, France-INSTN and DGSNR and UK-University of Surrey).The objective of this course was to provide the theoretical knowledge needed for recognition as a Qualified Expert in radiation protection according to EU training requirements. It was open to postgraduate students (initial education) and to professionals (continuous professional development) from all European countries.

Four sessions were organised between 2000 and 2003. The ERPC syllabus was based on the EU requirements laid down in Appendix I of Communication from the Commission Nr 98/C133/03. Despite that, the lack of recognition by a number of national competent authorities has been a strong barrier to the attendance of the course by European participants. Another barrier has been the total cost for participants or their employers including fees, accommodation and the time to attend the course.

One objective of the ENETRAP project is to propose a revised content, the "ENETRAP Training Scheme", more suitable to radiation protection workers and their employers. Therefore the ENETRAP partners, within several ENETRAP work packages, have performed several studies the conclusions of which will allow to adapt this revised ENETRAP Training Scheme to the needs and the contexts of the European countries.

3. Recommendations of the ENETRAP work packages

3.1. WP2: "Assessment of training needs and capabilities" and WP3: "Recognition of competencies and diplomas"

The analyzing of the gathered data in a common questionnaire sent to each European countries, shows pertinent information that are key points for setting up a new European RP Training for Qualified Experts.

To date, a total of 24 of the 31 countries originally contacted have responded to the ENETRAP questionnaire.

The number of radiation protection experts (RPEs) working in European countries are generally in the order of hundreds or thousands. The distribution of the RPEs for specific sectors points out that the medical sector is the area were the greatest number of RPEs are engaged, even for the countries where significant nuclear applications are undertaken. The industry sector is the second sector where a significant number of RPEs is working.

Half of the 24 countries that have responded to the questionnaire consider the number of RPEs available in the country as inadequate to national needs. Among them, the shortage of RPEs seems to be less evident in the EU-15 countries (except for Austria, Greece, Ireland and Portugal) than in the other (Bulgaria, Estonia, Hungary, Latvia, Lithuania, Malta, Norway and Slovenia).

All countries have legislation in place that requires the RPEs (and the other workers) to be suitably trained. There are, however, large differences between the national syllabus for the RPE.

In the ENETRAP questionnaire, countries were also asked whether their training scheme for RPEs fulfils EU requirements. From the responses, it appears that most of the countries consider their schemes as not, or only partly, reflecting the EU and/or the IAEA's basic syllabus.

The majority of these countries require an academic level of basic education for their RPEs, although in some countries a lower background education is allowed, depending on the sector and the complexity of the application. When the completion of a general professional radiation protection course is not a prerequisite for recognition of the RPE, work experience is required.

The situation with respect to radiation protection education and training infrastructure in the European countries is rather good. Most of the responding countries have a self sustainable system and can educate their RPEs. Nevertheless, some countries consider themselves as being partly self sustainable, with the exception of the medical sector, non-destructive testing and the nuclear sectors (Latvia, Malta, Slovenia and Switzerland). Estonia and Portugal consider their systems as not self sustainable. A reason for not achieving self sustainability in small countries may be that for a certain sector of work the number of workers is rather small. In such cases it may be more efficient to send persons to training events organized abroad rather than setting up training courses in their own country. For the moment, in those countries, part of the training is supported by the IAEA.

3.2. WP4: "On-the-job training programmes"

The objectives of this WP4 were first to gather information on the capacities of European countries to welcome trainees (subjects, number of places, training providers...). This has been done using the same questionnaire as WP2 and WP3 sent to every European countries. These data, and the analysis of previous experience related to on-the-job training (OJT) should allow the development of new OJT approaches that could be recommended for the new "European RP Training".

The final report of WP4 has already been sent to the European Commission and we will here only come back on the conclusions and recommendations for a new "European Radiation Protection Course".

Practical experience, both as OJT and work experience (WE), appears to be a key element of Education & Training in radiation protection. Therefore, appropriate qualification for RPEs must include theoretical knowledge as well as the ability to practice RP. Theoretical knowledge is obtained through the successful completion (by examination) of suitable education and RP training courses. These training courses should provide a suitable mixture of theory and practical exercises.
Competency and skills are a second, essential element of RP Education & Training and can only be acquired by appropriate OJT followed by a period of WE.

From the analysis of the questionnaires, it can be concluded that OJT and WE are generally required for RPEs. Generally, according to the questionnaire, the strictest regulations with respect to practices are in medicine and in the nuclear industry. The minimum duration of OJT and WE in medicine, where an RPE is usually a medical physicist, is in the range of 1 to 2 years. The same timeframe is required for RPEs in nuclear power plants.

Based on feedback from student trainees of existing OJT programs at the University of Surrey (UK), University of Cooperative Education (Germany), PAN courses (The Netherlands) and participants of IAEA courses, it can be concluded that OJT has become very well accepted. OJT provides better chances for future job opportunities and increases international mobility among EU partners. Mutual recognition of OJT facilitates the exchange of RPEs.

OJT requires a suitable environment where the necessary facilities and infrastructure are available. In addition, direct supervision by an experienced mentor is compulsory. Therefore, opportunities and time for this kind of training are usually limited, due to financial considerations, as trainees usually require financial support. The responsibilities of host organisations and trainees must be fixed. The duration of OJT activities is typically between several weeks and several months and, in most practical cases, an additional period of time for gaining work experience (WE) is obligatory. In WE training activities, employees actively work within a specific practice and gain in-depth knowledge of the practice and experience in relevant RP issues.

OJT should follow a scheduled programme with respect to topic (syllabus, learning objectives) and time duration. A training plan based on identified practical competencies and including a list of topics to be covered and tasks to be carried out should be prepared.
This structure is also comparable to the IAEA's approach and would help facilitate mutual recognition. However, there should be room for flexibility in each practice.
The participants' progress and achievements should be recorded on a checklist of topics and tasks. On completion of the training, the competence of the trainee should be formally assessed, in order to verify whether the participant has acquired competence in all the areas defined as learning objectives of the training. To fulfill this purpose, the assessment could be done in two parts:

- continuous evaluation by the supervisor during OJT (working report, training files, operational records, OJT checklist); and
- an assessment of practical skills based on performance during daily routine operation.

A format for the certificate should be defined in order to assure the recognition of OJT.
Since OJT is not available in some EU Member States (i.e. Cyprus, Malta, Lithuania) and is often not or not comprehensively available for all practices in one country, a list of institutes that could provide suitable OJT for foreign trainees should be established.
OJT should be part of ENETRAP Training Scheme. It could be split into two parts: a core part according to the common basis part of the E.T.S. and a more specific one according to and in conjunction with the specific modules. Training providers of modules of the E.T.S should also take care of accompanying OJT.

3.3. WP5: "New concepts and new tools for ENETRAP Training Scheme"

Modern education tools, such as distance-learning were evaluated in this work package. Feedback from previous ERPC was examined with regard not only to the content and methodology, but also to feasibility.
In addition, a review was carried out on the evolutions, approaches and methodologies aiming to provide education and training in radiation protection. An overview of the current status of open and distance learning in radiation protection was made.
The final report on WP5 has been presented to the EC in July 2006.

A platform has already been set up allowing free and easy accessible teaching sessions for both professionals and students. Courses can include a theoretical part and exercises offered via texts, slides, audio and video materials. Currently a demo session is being prepared on "basic nuclear physics" and on "interaction of radiations with matter" that could be offered in the ENETRAP Training Scheme.

3.4. WP6: "IAEA Education & Training modules and European requirements"

The objective of this work package was to compare the content of the former ERPC with the requirements published by the EC and the IAEA and to propose improvements for the future revised European RP Training. The WP6 report has been sent to the EC.

According to this report, the scientific/technical content of the former ERPC was in accordance with the *Basic syllabus of the Qualified Expert in RP,* laid down in the Appendix I of Communication from the Commission Nr 98/C133/03. Most of the *Additional Topics* of this communication were covered fully, such as Medical applications and General Industry. Nuclear Installations were covered to a great extent except for issues related to fuel fabrication, processing and storage.

When writing the syllabus of the future European RP Training, these topics should be included as well as issues related to new EC Directives such as the control of radioactive sources (EC Directive 2003/122/EURATOM of 22 December 2003 on the control of high-activity sealed radioactive sources and orphan sources).

In order to bring a new approach to the future European RP Training, learning objectives for each module/lecture should be formulated appropriately. These objectives are the knowledge and skills that participants are expected to have gained on the completion of this training. They can be seen as performance goals for the participants with measurable outcomes. Practical work/exercises should be described in more detail in the syllabus.
The main learning objectives are integrated in the E.T.S in Appendix 1 (pale orange color).

4. Content of the ENETRAP Training Scheme

Taking into account the conclusions and recommendations of the work packages 2 to 6 a structure and tables of content for the new syllabus have been established.

4.1. A modular approach

The ENETRAP Training Scheme is based on a modular structure. It is structured with a "common basis" and optional modules which can be selected by participants in relation with their own field of activities.
The "**COMMON BASIS**" will be constituted of three modules: module 1 to module 3 presented in Appendix 1, table 1 to 3. This common basis will last about 3,5 weeks.

- **Module 1**, first part of the "common basis" deals with physics related to ionizing radiations: radioactivity and nuclear physics, interaction of radiations with matter, dosimetry, biological effects of radiations, detection...
- **Module 2**: fundamental aspects of the operational radiation protection; external and internal exposures, dose monitoring, regulatory context, natural sources, public and environment RP, ethical considerations and communication.
- **Module 3**: all others aspects common to the different domains of the radioprotection as for example, the transportation, accidental and the emergency situations, ALARA and safety culture, design issues and principles of waste management.

OPTIONAL MODULES 4 to 8 concern Radiation Protection in the different wide domains of activity.

- **Module 4**: the Radiation Protection in the domain of nuclear power plants and research reactors

- **Module 5**: Waste Management and decommissioning
- **Module 6**: Research and non-nuclear domains
- **Module 7**: Medical domain
- **Module 8:** Naturally Occurring Radioactive Material – NORM

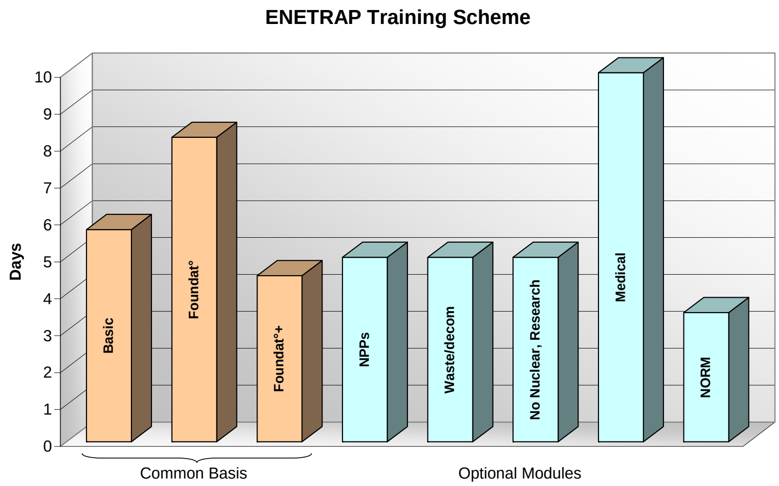


Fig.: Duration of ENETRAP Training Scheme Modules

4.2. Content of the modules and possible collaborations

The suggested content of each module is detailed in the Appendix 1, table 1 to 8. It could of course be refined after further detailed discussion with other groups or networks, like EURADOS, EURANOS, EAN (European ALARA Network), etc...

First contacts have already been taken with the EURADOS Network on the "dosimetric" aspects, which is part of modules 1 to 3 of the "common basis" and are addressed by an expert of EURADOS. The same approach has been used with the EURANOS network about emergency preparedness and response.

Contacts with the European ALARA Network - EAN have been established. EAN is willing to contribute to the ENETRAP Training Scheme by providing lecturers to cover optimisation of radiation protection and ALARA procedures.

Generally speaking, the ENETRAP partners wish to involve every interested European group or network in European courses based on the ENETRAP Training Scheme, to build a consistent and up-to-date training event. This collaboration should avoid duplication of training events organised by the different networks and thus reduce the costs of these events.

Lecturers of modules 1 to 3 could make use of NUCLEONICA web site. Contact has been taken with Dr Magill (EC / JCR) and could be integrated during the e-learning period.

Different visits should be organized during the optional modules (NPP, waste storage facilities, hospitals...) in accordance with the subject of the module.

The Steering Committee of ENETRAP still has to organize the coordination between the different training centers and a way to insure the consistency of each module. A, possibility could be that each training center designates a person for each module delivered. This "local coordinator" should be responsible for the consistency of the module and all other pedagogical issues.

It is also foreseen that the chapters/lectures taught either be e-learning or by "classical" course must have the same content.

4.3. OJT period

According to the WP4 recommendations, an OJT period should be proposed to the participants in relation with each specific module.

The OJT period related to one specific module should have about the same duration as the module itself. It could be organized either just after the module or a few weeks later, in the country where the module took place (as soon as the participant is able to understand the local language) or in the country of the participant.

The steering committee of ENETRAP has still to establish a list of places in Europe where OJT could take place. A contact has already been taken with ITN in Portugal who is willing to participate. In France and in Germany, previous experiences have shown that many places could welcome participants for OJT periods. Contacts in other European countries are being taken.

4.4. Use of e-learning

As pointed out in the WP6 report, the total cost of the former ERPC was a strong barrier for participants (or their employers) to attend the course in Saclay.

To decrease this cost (fees, but also time and accommodation) the WP5 of the ENETRAP project has studied different e-learning systems and developed a module using a Learning Management System.

For the moment, the chapters dealing with "basic nuclear physics" and "interaction of radiations with matter" are developed. Contact has also been taken with the IAEA about the possibility of using its standardized material.

When the ENETRAP Training Scheme is in place, it is foreseen that the whole first module will be available on an e-learning platform. Participants will then have the possibility to follow this first module either by e-learning or in a "real" classroom.

In order to create a module 1 entirely tailored for e-learning purposes, it is necessary to carefully define the pedagogical objectives, the competences/skills foreseen for participants. Then pedagogical *scenari* including the implementation of tutoring will be designed according to what pedagogical resources are available.

4.5. Links with the future European Master in Radiation Protection - E.M.R.P.

The main goal of work Package 8 was to establish a European Master degree in Radiation Protection. An application for funding to assist this development was submitted by four partners, in February 2006 to DG Education (EACEAgency) and was successful. This new program of European Master in Radiation Protection will be based on the feedback of 12 years of the French Radiation Protection Master from Grenoble, of the four ERPC courses held in Saclay, the IAEA syllabus and PGEC courses, the European directive, the EUTERP recommendations and the ENETRAP works.

Therefore the program encompasses all the ENETRAP training scheme proposals and fulfils the requirements of the European directive.
The theoretical part of the course will last six months with approximately half of the time devoted to lectures and the other part to exercises, case studies, practical work and technical visits. The students will then spend a further six months working in nuclear facilities or laboratories, through on the job training period (internship). In respect of the Bologna conference, 60 European Credit Transfer System - ECTS will be sum up for this full year.

Some overlaps could be managed in order to propose to Long Life Learners to follow some specific modules. In this case, LLLs can sum up ECTS after succeed to examination as the ECT System allows.

The 4 partners (UJF-F, UHI-UK, CTU-Cz and INSTN-F) would proposed all modules from the Master syllabus or only a part. The common basis will be teach in local language. The optional modules could be teach in English if necessary.

4.6. The training centers

The different modules will be organized in different training centers in Europe, according to the availability of practical and logistical aspects. One module could be organized at several places, on the condition that the number of participants is big enough. The list of training centers interested in taking part in this project is still under discussion among the ENETRAP partners.

One participant will be allowed to register in one module in a training center and in second module in another center. The modules will have to be scheduled carefully, and in a harmonized way, to allow this mobility.

As mentioned in the WP4 report, training providers of modules of the ENETRAP Training Scheme should as well take care for accompanying OJT. This could also be part of the responsibilities of the "local coordinator".

4.7. Certification

The ENETRAP Training Scheme will be validated by a certificate.
To get this certificate, a participant will have to attend to the "common basis" (modules 1 to 3) plus at least one of the optional modules depending of his field of work or interest.
At that time, the modalities of assessment (theoretical part and OJT) and certification of participants are still under discussion among the ENETRAP partners.

4.8. Pedagogical committee

To assess the consistency and the quality of the ENETRAP Training Scheme, it is anticipated that a committee will be established. Although their attributions have not yet been defined precisely, they could be:

- periodic review of content of the course,
- "schedule" of the different modules in the different countries, to allow mobility of participants,
- establishment of a network of "local coordinators" in the different training centers.
- establishment of a base of potential lecturers / experts,
- periodic assessment and quality insurance,
- organization of the assessment of the participants,
- organization of the communication / advertising.

5. Pilot Sessions

The ENETRAP Partners will implement the ENETRAP Training Scheme during three types of training courses.

- **Course 1**: Pilot Session Module 5 - "Occupational Radiation Protection: Specificities of Waste management and decommissioning"
  The Karlsruhe Research Center will run the Module 5 of E.T.S.
  This course will concern all topics of E.T.S. The duration is 5 days for theoretical part and 5 days for O-J-T.
  In the theoretical part, each day deals with a topic as follow:
  - waste management
  - Decommissioning
  - Ventilation and filtration

- Safe Handling
- Transport

In the ENETRAP Training Scheme, the OJT period is planed to be organized either just after the module or a few weeks later the theoretical part. In this pilot course, the O-J-T period is planed just after the theoretical part. By this way, we will collect feedback in order to evaluate what is the most appropriate planning.

Dates: October-November 2007
Place: Karlsruhe Research Center Germany

- **Course 2**: e-learning module

Students (Long Life Learners and Initial training) from the French Master in Radiation Protection will follow e-learning courses. The latter are part of module 1 of the ENETRAP Training Scheme and concerned the topic of Interaction of Radiation with Matter. This course has been developed and scenarized by ENETRAP Spanish Partner - CIEMAT using Belgian pedagogical resources. The tutoring part will be managed by two tutors from France. As a feasibility experiment, the use of "blended" learning (b-learning), a mix between e-learning and traditional learning methods, will be assessed at the end of the course.
The use of b-learning is seen as particularly valuable as the university partners believe that the use of such synchronous or asynchronous web-based delivery, with tutor support, could become the norm for many Masters' programmes, in order to promote a wider participation and to encourage partnerships across Europe.
Concerning tools, the Moodle Learning Management System, will permit to plan all exercises related to the course, proposed to students. After that, an assessment of this part will be performed both from the point of view of students and from tutors one's.

Date: start 17th September 2007, end 16th November 2007
Places: In 2007 only students from Grenoble-F are concerned. In 2008 students from Grenoble-F, Thurso-UK and Prague-Cz will be concerned. Tutors are from research Atomic Center in Saclay-F. The e-learning team is located in Madrid-Sp.

- **Course 3**:

Based on the Radiation Protection Training Scheme from HPA-UK, three courses using part of E.T.S could be proposed on:

- Selection, Use and Testing of Radiological Protection Instrumentation
  Date: due to run 13-15 November 2007-07-10
  The course will be held at the HPA Training Centre at Chilton.

- Radiation Emergencies: Planning and Response
  Date: due to run 3-6 December 2007
  The course will be held at the HPA Training Centre at Chilton.

- Principles of Protection Against External Radiation
  Date: due to run 23-26 October 2007
  The course will be held at the HPA Training Centre at Chilton.

It will be interesting to assess if existing courses can be easily take into account the ENETRAP Training Scheme. This assessment will outline the advantages and/or disadvantages to promote an E.T.S course based on an existing or a new build curriculum.

6. Perspective and conclusion

From works achieved in the framework of the ENETRAP project (WP2 to 6) and the EUTERP platform, the necessity to clarify the definition of the "Qualified Expert" and also to propose a definition of the "Radiation Protection Officer" was shown.

Once these validated and then proposed definitions for the review of the Basic Safety Standards and Euratom Directive, it will be necessary to define a referential of competencies / skills for the Qualified Expert. After this task, the establishment of an updated training scheme centered on this referential of competencies / skills should be achieved. Thus, the content of the training course will be specified by using pedagogical objectives retailed for each training parts. In the same way, some "problem situations" will permit to put the participant in capacity to act (*e.g.* case of contamination in a work place, source of gamma radiography blocked in the guide tube...). Other pedagogical sequences like "case studies" will permit to confront a participant to all the necessary steps of the implementation of Radiation Protection actions in a wide range of RP topics.

The evaluation of participants is an important part for recognition. This evaluation linked to the referential of expertises / capacities will permit to enable the experience on the basis of knowledge and also on the one of competences / skills.

The definition of precise pedagogical objectives enables European States to consider a harmonization of the contents is therefore a mutualisation of the educational resources. Common resources would contribute to the harmonization of "QE" curriculum, but the issue of copyrights remains.

Finally, the ENETRAP Training Scheme, with its modular approach will allow candidates to achieve the status of a Qualified Expert as defined in the 96/29 European Directive, achieving both professional development and additional qualifications at a pace which best suits their career and employment profile.

APPENDIX 1 - table 1

ENETRAP Training Scheme
Module 1: Basics

MODULE 1 - DETAILED PROGRAM

At the end of the course, the participant will be able:
- 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 ionizing radiations in the different domains and to know the type and range of used radioactive sources.

Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total =	**40,5**	34,5	6	0	0
1. Basics					
1.1 Inaugural conference (optional)					
1.2. Radioactivity and nuclear physics		6			
- Explain the different modes of disintegration and desexcitation *- The different type of radiations emitted and their features* *- Define and explain the notions of activity, intensity of radiation, period* *- Calculate the activity of a source at any time...*					
1.2.1. Alpha decay		3			
- Description - characteristics of the daughter nucleus. Decay scheme, Ground or excited state of the daughter nucleus. . Examples of decay schemes					
1.2.2. Beta minus decay					
- Description, characteristics of the daughter nucleus. Repartition of the available energy between the electron and the neutrino, energy spectrum of the electron, examples of decay schemes					
1.2.3. Beta plus decay and electron capture					
- Beta plus decay: Description, characteristics of the daughter nucleus. Repartition of the available energy between the positron and the neutrino. Energy spectrum of the positron, examples of decay scheme					
- Electron capture: Description, characteristics of the daughter nucleus, examples of decay scheme , competition between beta plus decay and electron capture					
1.2.4. Electronic shell rearrangement			1,5		
- Consequences of a vacancy on a shell.					
- Amount of energy available from the electronic shell rearrangement					
- consequence of the electron capture: X-ray or Auger emission					
1.2.5. Gamma emission and internal conversion					
- Gamma emission: Description, examples of decay schemes					
- internal conversion: description, consequences: X-ray or Auger emission					
1.2.6. Evolution of the activity		1,5	1,5		
- Exponential law: decay constant, half-life					
- Decay chain with two isotopes. Special cases: T1 >> T2 and T1 << T2					
- Decay chain with n isotopes.					
- activity law, relationship between mass and activity of a sample					
1.2.7. Producing radionuclides by nuclear reaction		1,5			
- Cross section. Evaluation of the activity created in a thin target. Activity of the irradiated sample. The case of thick targets					
- Production of artificial radioactive substances: examples (for medical or industrial purposes)					
1.3. Interaction of radiations with matter		4,5	1,5		
- Explain the different phenomena of interaction of the radiations with matter (loaded particles, electromagnetic radiations, neutrons) *- Define the linear transfer of energy* *- Define and calculate the range of a beta radiation* *- Explain the genesis of the electric source radiations*					
1.3.1. Directly ionising radiations					

- Heavy charged particles (a, atomic particles): ionisation, excitation, stopping power, range. - Light charged particles (electrons): ionisation, excitation, stopping power, range, brehmstrahlung effect. - Linear transfer of energy - Case of the positrons: annihilation phenomenon - Application: principle of the X-ray tube 1.3.2. Non directly ionising radiations - Electromagnetic radiation: Compton effect, photoelectric effect, pair creation. Repartition of energy, angular distribution of secondary electron and diffused photon.. Influence of the energy, relative importance of the three effects. - General principle of building: build up factor coefficients. - Neutrons: ranges of energy and types of slowing-down and attenuation.					
1.4 Dosimetry: quantities and units *- Define the operational Quantities and Units, realise related calculations* *- Define the absorbed dose, the doserate of absorbed dose.* 1.4.1 Physical and dosimetric quantities - Radiometric description of a radiation field: fluence and energetic fluence - Dosimetric quantities: exposure, kerma, absorbed dose - Relationships between radiometric and dosimetric quantities - Calculation of absorbed dose in radiation equilibrium conditions. 1.4.2 Radiation protection dosimetry - Need for protection quantities to assess the risk of exposure to ionizing radiations -The new approach in ICRP 60, ICRU 51 and EC Directives: equivalent dose and effective dose, radiation weighting factor w_R and tissue weighting factor w_T, committed effective dose.		4,5			
1.5. Biological effects of radiations *- Explain the effects of the radiations to the cellular, at tissular level and at the body level* *- The features of determinists and stochastic effects* *- Define the effective dose, equivalent dose and the dose rate of equivalent dose* 1.5.1 Basic biology 1.5.2 Cellular and molecular effects, Tissue lesions 1.5.3 Deterministic effects - Global irradiation, partial irradiation. 1.5.4 Stochastic effects - Cancer induction, genetic effects - Notion of detriment linear non-threshold dose response hypothesis - Equivalent dose and effective dose, radiation weighting factor w_R and tissue weighting factor w_T, committed effective dose. 1.5.5 Exposure of the pregnant woman and exposure of the fœtus 1.5.6 Epidemiology		3			
1.6. Physical principles of detection *- Explain the principle of performance of the detectors used in radioprotection* *- Calculate the limit of detection, and others characteristics* 1.6.1 General principles of detection - measurement chain, efficiency, dead-time, detection threshold, background and noise - uncertainty of a measurement 1.6.2. Ionisation of gas - Ionisation chambers - Impulsion detectors (proportional counters, GM counters), 1.6.3. Luminescence phenomenon. - Scintillators (solids and liquids). Thermoluminescence. Photoluminescence. Optically Stimulated Luminescence dosimeter 1.6.4. Ionisation into solids. - Semi-conductors. 1.6.5. Physical and chemical phenomenon. - Photographic dosimeters. Traces detectors 1.6.6 Detector functioning - Pulse functioning: amplificator, discriminator, mono and multi channel selector, ratemeter. - Current functioning: amplificator, signal acquisition system. 1.6.7 Calibration - Relative and absolute measurements - General principle of calibration, calibration factor and uncertainty associated		7,5	1,5		

- Metrological chain					
1.7. Applications of ionising radiation (overview) *- To raise a panorama of the usages of the ionizing radiations in the different domains* *- Know the order of magnitude of the activities related to these radioactive sources*		3			
Total = 1.2 week					

APPENDIX 1 - table 2

ENETRAP Training Scheme
Module 2: Foundation

MODULE 2 - DETAILED PROGRAM					
At the end of the course, the participant will be able: *- 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 national regulatory.*					
Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total =	**79,5**	37,5	12	30	0
2. Foundation: Operational radiation protection and regulatory context					
2.1. Radiation protection external dosimetry		3			
2.1.1 Dose assessment for external exposure					
- Need for operational quantities to estimate the protection quantities: H*, Hp					
- Skin and depth dose assessments, conversion coefficients for external exposure.					
2.1.2 Calibration of a radiation protection device to measure external exposure				6	
- beta radiations,					
- gamma radiations,					
- neutrons					
2.2. Protection against external exposure		3	3		
- Distinguish external exposure and internal *- The 3 main protective means against the external exposure* *- Estimate the doserate due to a point source (characteristics and activity given - beta or photon)* *- Estimate the doserate to different distances from a point source (beta or photon)* *- Calculate the shielding characteristics*					
- Radiation protection principles: time, distance, shielding. Shielding calculations for a beta source, for a gamma source and for a neutron source. 1/d² law for a photon source...					
- Extremity exposure					
- Use of calculation codes: MicroSHIELD or others…				6	
2.3.Protection against internal exposure		3			
- Define the different standard of contamination *- Define the committed dose and the effective period* *- Calculate the committed dose by using the dose unit of intake h(g)* *- Existing methods of decontamination* *- Determine the collective and individual protective means*					
2.3.1 Modes of intake					
2.3.2 Collective protection:					
- Static and dynamic containment. Types of devices used for containment.					
2.3.3 Individual protection:					
-individual behaviour, gloves, devices used for the protection of respiratory tract, protective clothing (ventilated and non ventilated)			3		
2.4. Dose monitoring					
2.4.1 Area monitoring:		3		6	
- Regulatory requirements. Objectives of the area monitoring. Area monitoring management: Technical aspects, quality control, records.					
- operation monitoring, environmental monitoring, surface monitoring					
- design of a monitoring program					
- classification of areas - Examples					
- utilisation of detectors			3		
2.4.2 Individual monitoring (external, internal, decontamination)					
2.4.2.1 External exposure:		1,5		6	
- objectives of the individual monitoring					

- Devices used for individual monitoring: characteristics, limitations, need for calibration. - Management of the dose: recording, action levels, investigation levels - Quality requirements - intercomparison exercises. 2.4.2.2 Internal exposure: - Management of a contaminated person. Role of the medical and toxicology labs. - The means to assess internal contamination (in vivo counting by gamma and X spectrometry; radiobioassays; utilisation of area monitoring data). Routine and special monitoring. - Management of the dose: recording, action levels - Biokinetic models from the ICRP (respiratory tract, digestive, coetaneous). - Biokinetic behaviour of several categories of radionuclides. Dose assessment principles Therapeutic strategies after an internal contamination (I, Cs 3H, actinides) - Quality requirements - intercomparison exercises.		6		6	
2. 5. Regulatory context 2.5.1 The basic principles of radiation protection 2.5.2 ICRP recommendations - Justification, optimisation and dose limitation; dose constraints; inequity and ethical issues 2.5.3 IAEA Safety fundamentals, requirements and guidelines 2.5.4 EC Directives (e.g. 96/29, 97/43, 03/122…), practices and interventions 2.5.5 ALARA principle 2.5.6 Individual work on the national regulation of learner's country		6	3		
2.6 Natural sources of ionizing radiation - Natural radionuclides (U and Th-series; Rn; H-3; C-14; Be-7;...) - Case of Radon - External irradiation (UNSCEAR overview of terrestrial radiation (range of concentrations and exposure levels) and cosmic radiation (public doses and air crew doses)) - Internal irradiation (UNSCEAR overview of range of concentrations, exposure levels and indoor and outdoor Rn; Rn in water) - NORM industries (general overview; inhalation of dust as source of occupational exposure; building materials		6			
2.7 Public and environmental radiation protection 2.7.1 Public radiation protection - Dose limits and dose constraints - UNSCEAR overview of exposure levels from artificial sources - Principles of dispersion models in air and water 2.7.2 Environmental radiation protection - ICRP system of environmental RP 2.7.3 Medical exposure		3			
2.8 Ethical considerations on the applications of radioactivity and radiation protection		3			
TOTAL = 1.7 weeks + 1 week OJT					

APPENDIX 1 - table 3

ENETRAP Training Scheme
Module 3: Foundation+ (Occupational)

MODULE 3 - DETAILED PROGRAM

At the end of the course, the participant will be able:
- to know the regulatory process in order to complete transportation of radioactive material
- at his 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 wastes management and decommissioning

Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total = **3. Foundation +**	**27**	27	0	0	0
3.1. *Transport*		3			
- to quote the applicable texts concerning the regulation of the transportation of hazardous material					
Presentation of the ADR: responsibilities -Types of packages, transport index, signalisation and labelling, measurements					
3.2. *Design Issues* 3.2.1 Choice of materials (type of source / domain of activities) 3.2.2 Maintainability of installation 3.2.3 Work places, hot cells, Gloves boxes		3			
3.3. *Accidents and emergency Issues*		3			
- to be inform of the feedback experience and countermeasures to limit the consequences of an accident.					
3.3.1 Accidents: feedback experience - risks in the event of nuclear accident and radiological accident 3.3.2 Medical management in accidental situation 3.3.3 Management of populations					
3.4. *Safety Culture* - Interface Radiation Protection and Safety		3			
3. 5. *ALARA* - Justification and optimisation; dose constraints; New ICRP recommendations		3			
3.6 *Principles of decommissioning* - Strategies, techniques and implementation		3			
3.7 *Principles of waste management* - Regulatory context, classification and techniques		3			
3.8 Communication public, medias		6			
TOTAL = 0.9 week					

APPENDIX 1 - table 4

ENETRAP Training Scheme
Module 4: NPPs, Research Reactors

MODULE 4 - DETAILED PROGRAM					
At the end of the course, the participant will be able: *- 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)*					
Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total =	**60**	30	0	30	0
4. Occupational radiation protection: specificities of the nuclear installations, Power Plants and Fuel Cycle					
4.1. Main types of nuclear reactors'"		5			
- General principle - Basics on neutron physics, Nuclear fission, criticality					
- Visit of a Nuclear Power Plant if possible					x
4.2. The Fusion		1			
- General principle					
- Visit if possible (For example in France: Tore Supra and ITER Project - Cadarache)					x
4.4. The fuel cycle		3			
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					x
4.4. Dose monitoring and Regulatory controls		3			
Environmental monitoring and controls around a nuclear installation				12	
4.5. Safety culture - Interface Radiation Protection and Safety					
- Basic concepts of safety culture		3			
- Safety of the pressurized water reactors and interface with protection		3			
against radiation - Prevention of the risks of criticality and fire					
- Organisation, task and responsibilities of RPE, daily RP and RP		3			
during annual outage, equipments, dosimetry				18	
4.6. Accidental situations					
- Lessons learnt from nuclear accidents		3			
- Emergency procedures and interventions, report					
- Management of the populations and medical aspects		3			
Principles and countermeasures					
Particular case of iodine					
- Medical management in accidental situation		3			
Dosimetric 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					
Dosimetric evaluation and reconstitution					
TOTAL = 1 week + visits + 2 weeks OJT					

APPENDIX 1 - table 5

ENETRAP Training Scheme
Module 5: Waste Management, Decommissioning

MODULE 5 - DETAILED PROGRAM					
At the end of the course, the participant will be able: *- to implement principles of radioactive waste management and their basic techniques,* *- to implement principles of decommissioning and related strategies,* *- to understand the principles of ventilation and filtration in waste management and decommissioning field,* *- to perform the classification of areas (controlled and supervised)*					
Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total = **5. Occupational radiation protection: specificities of waste management and decommissioning**	**60,0**	18,5	11,5	30	0
5. 1. Waste management				12	
- Legal aspects, Waste preparation and collection		1,5			
- Waste classification and strategies for waste conditioning		1,5			
- Radiation protection during combustion, bituminising and vitrification of radioactive waste		2			
- Radiation protection aspects in a final storage facility		2			
- Environmental monitoring and controls around a waste storage facility		2			
- Visit of a storage facility (if possible)					X
5.2. Decommissioning-				12	
- Strategies, radiation protection planning and organisation		1			
- Techniques for disassembling, dismantling and safe handling		1			
- Decontamination and measuring techniques for release of materials from controlled areas		1,5			
- Planning and implementation of these techniques - case study			2,5		
- Visit of a facility under decommissioning (if possible)					X
5.3. Ventilation and filtration					
- Basics of aerosol physics, granulometry, principles of ventilation and filtration, Mains types of protection		3			
- Air renewal, measurement of air rate, optimisation of the position of air sampling, seek for leakage			3		
- Protective clothing (different types), work in a contaminated area, work and maintenance on a glove-box			6		
5.5. Transport				6	
- European regulations (ADR): responsibilities, types of packages,					
- transport index, signalisation and labelling, RP measurements, documentation		3			
- Practical examples, lessons learn from accidents					
TOTAL = 1 week + visits + 1 week OJT					

APPENDIX 1 - table 6

ENETRAP Training Scheme
Module 6: Non-nuclear, Research, Oil & Gaz

MODULE 6 - DETAILED PROGRAM					
At the end of the course, the participant will be able: *- 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.*					
Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total = **6. Occupational radiation protection: specificities of non nuclear industries and research laboratories**	**60**	18	12	30	0
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 an industrial irradiation facility (if possible)		6	3		x
6.2. Industrial radiography. - Technical principles of these equipments: gammagraphy and X-ray generators - Radiation protection adapted to these equipments + regulatory controls - case study		3	3		
6.3. Unsealed sources - sources management - regulatory controls - ventilation and filtration - waste management - transport - management of a contamination (of a surface or of a person) – Practical Work - case study		6	3 3		
6.4. Potential accidents - emergency procedures and interventions, report - lessons learnt from radiological accidents		3			
Total = 1 week + 1 week OJT					

APPENDIX 1 - table 7

ENETRAP Training Scheme
Module 7: Medical

MODULE 7 - DETAILED PROGRAM					
At the end of the course, the participant will be able: *- 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)*					
Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total =	**60**	25,5	4,5	30	0
7: Occupational radiation protection: specificities of the medical activities					
7.1. Technology of the equipments		6			
7.1.1 For diagnosis purpose					
- Conventional and numeric radiology,					
- Mammography,					
- Computerised tomography,					
- Interventional radiology,					
- Nuclear medicine including positron emission tomography (PET).					
7.1.2 For therapy:					
- External beam therapy,					
- Brachytherapy,					
- Nuclear medicine (iodine 131),					
- Therapy using heavy particles or neutrons.					
7.1.3 VISITS OF HOSPITALS OR MEDICAL INDUSTRIES					X
7.2 Occupational radiation protection: specificities				30	
- Regulatory context (Directive EC 97/43, practices, radiation protection of patient…)		1			
- Conception of the premises (therapy treatment room, nuclear medicine lab), classification of the areas		1,5	1,5		
- Radiation protection of the operators in interventional radiology		1,5			
- Radiation protection of the operators in brachytherapy		1,5			
- Radiation protection of the operators in the hot lab		3			
- Regulatory controls of the sources and their shielding, maintenance		3			
- Management of the sources (brachytherapy and nuclear medicine)		1			
- waste management (nuclear medicine)		1,5			
- transport of radioactive sources		1			
- management of a contamination (of a surface or of a person) – Practical Work			3		
- individual dosimetry		1,5			
7.3. Potential accidents		3			
- emergency procedures and interventions, report					
- lessons learnt from radiological accidents					
Total = 1 week including a visit + 2 weeks OJT					

*Caution: this module does not deal with RP of the patient, that is the job of medical staff (medical physicist included)

APPENDIX 1 - table 8

ENETRAP Training Scheme
Module 8: NORM Naturally Occurring Radioactive Material

MODULE 8 - DETAILED PROGRAM

At the end of the course, the participant will be able:
- to know what are activities where NORM are present,
- to participate at the evaluation of population and workers exposures.

Contents of teaching	Lecturer	Lec	Ec/PW	OJT	Vis.
Total = **8: Radiation Protection for Naturally Occurring Radioactive Material (NORM)**	**21**	21	0	0	0
8.1. Different activities where NORMs 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 the 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 the human consumption - of mineral waters; - The thermal establishments.		6			
8.2. Evaluation of dose for exposed workers		6			
8.3. Evaluation of the exposure of population		3			
8.4. Implementation of the protective measures and the corrective actions in NORM activities Visit to be defined		6			X
Total = <1 week including a visit + 1 week OJT (?)					

APPENDIX 2

COMMON BASIS

Module 1 BASICS	L	E
Radioactivity	6	3
Interactions	4,5	1,5
Quantities and Units	4,5	
Basic biology & Bio. Effects	3	
Physical Principles of Detection	7,5	1,5
Applications of Ioni. Radiation (overview)	3	
Hours	28,5	6
OJT		

Module 2 FOUNDATION	L	E
RP and External Dosimetry	3	
Prot. against external Expos.	3	3
Prot. against internal Expos.	3	3
Dose monitoring (area + individ)	10,5	3
Regulatory Framework	6	3
Natural sources	6	
Public/Environmental	3	
Ethical consideralions	3	
Hours	37,5	12
5 days OJT		

Module 3 FOUNDATION + (occupational)	L	E
Transport	3	
Design Issues	3	
Accidents & Emergency Issues	3	
Safety Culture	3	
ALARA	3	
Decommission. principles	3	
Waste Management principles	3	
Communication public, medias	6	
Hours	27	0

OPTIONAL MODULES

Module 4 NPP, Research Reactors	L	E
Reactor types	5	
Fusion	1	
Fuel Cycle	3	
Dose Monitoring/Regulalory control	3	
Safety Culture	9	
Accidental situations, Criticality	9	
Hours	30	0
10 days OJT + Visits		

Module 5 WASTE MANAGEMENT DECOMMISSIONING	L	E
Waste Management	9	
Decommissioning	3,5	2,5
Ventilation, filtration	3	9
Transport	3	
Hours	18,5	11,5
5 days OJT + Visits		

Module 6 NON-NUCLEAR, RESEARCH, Oil & Gaz	L	E
Irradiators/generators/Accelerators/Gauges	6	3
Industrial Radiography	3	3
Unsealed sources	6	6
Accidental situations	3	
Hours	18	12
5 days OJT + visits		

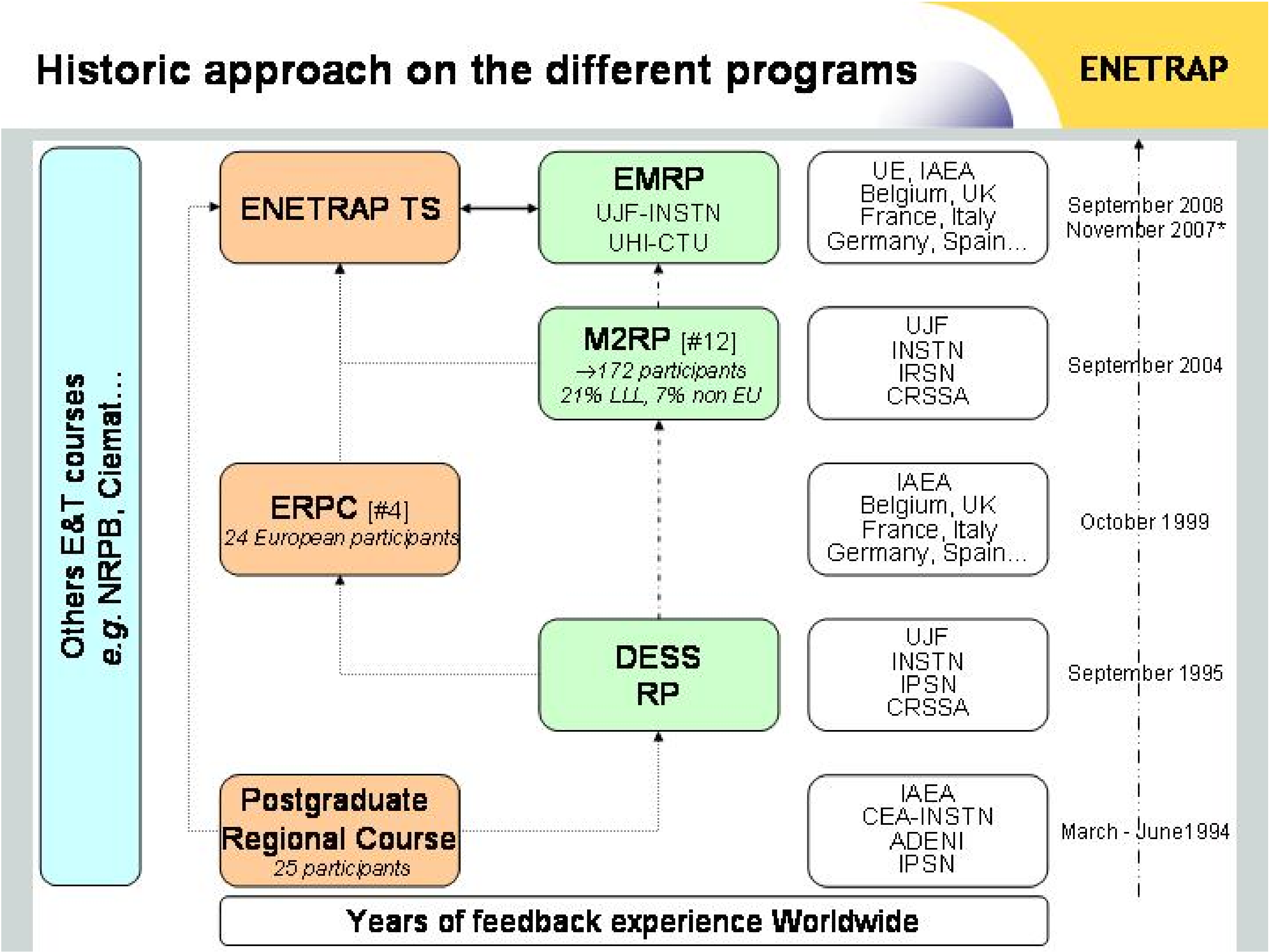
Module 7 MEDICAL	L	E
Equipment	6	
Occupational RP	16,5	4,5
Accidental situations	3	
Hours	25,5	4,5
10 days OJT + Visits		

Module 8 NORM	L	E
NORM activities	6	
Dose of workers	6	
Dose of population	3	
Protective measures, corrective actions	6	
Hours	21	
5 days OJT + visits		

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6	Module 7	Module 8
Hours	34,5	49,5	27	30	30	30	30	21
Days	5,75	8,3	4,5	5	5	5	5	3,5
Weeks	1,2	1,7	0,9	1	1	1	1	0,7

Total hours	252
Total days	42
Total Weeks	8,4

APPENDIX 3


Historic approach on the different programs
ENETRAP
Others E&T courses
e.g. NRPB, Ciemat…
ENETRAP TS
EMRP
UJF-INSTN
UHI-CTU
UE, IAEA
Belgium, UK
France, Italy
Germany, Spain…
September 2008
November 2007*
M2RP [#12]
→172 participants
21% LLL, 7% non EU
UJF
INSTN
IRSN
CRSSA
September 2004
ERPC [#4]
24 European participants
IAEA
Belgium, UK
France, Italy
Germany, Spain…
October 1999
DESS
RP
UJF
INSTN
IPSN
CRSSA
September 1995
Postgraduate
Regional Course
25 participants
IAEA
CEA-INSTN
ADENI
IPSN
March - June1994
Years of feedback experience Worldwide