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## **ANNETTE PROJECT**

**Advanced Networking for Nuclear Education and Training and Transfer of Expertise**

### **DELIVERABLE D 2.4** **Implementation of the pilot courses**

Nature of the deliverable		
R	Report	X
P	Prototype	
D	Demonstration	
O	Other	

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Dissemination Level		
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PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the partners of the ANNETTE project	
CO	Confidential, only for partners of the ANNETTE project	Yes

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### ABSTRACT:

This report summarises the actions performed during the ANNETTE pilot course delivery in the frame of WP2 (and partly of WP5 and WP6), including the Summer School held in July 2019, summarising the obtained result so far. A first edition of this report is being released within month 44 (August 2019), as planned, though the information on running and planned pilot courses is only partial. More complete information will be issued by the end of the project in Deliverable 2.5. The results obtained in terms of learners' participation in the courses and the lesson learned from the real implementation of the prepared course programme, as described in Deliverable 2.2 and further adapted during the course of the actions, are duly commented in view of the phase of final assessment of the work performed.

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## GENERAL LIST OF ABBREVIATIONS

ANNETTE	Advanced Networking for Nuclear Education and Training and Transfer of Expertise
ASME	American Society of Mechanical Engineers
BelV	Subsidiary of the Belgian Federal Agency for Nuclear Control
BSc	Bachelor of Science
CEA	Commissariat à l'Énergie Atomique et aux Énergies Alternatives
CCS	Carbon Capture and Storage
CIRTEN	Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare
CITON	Centre of Technology and Engineering for Nuclear Projects
CLP4NET	Cyber Learning Platform for Network Education and Training
CMET	Competence Maintenance, Education and Training (Working Group in IGD-TP)
CPD	Continuous Professional Development
DoW	Description of Work
EC	European Commission
ECTS	European Credit Transfer System
ECVET	European Credit system for Vocational Education and Training
EdF	Electricité de France
EFTS	European Fission Training Schemes
EHRO-N	European Human Resource Observatory - Nuclear
EMSNE	European Master of Science in Nuclear Engineering
ENEF	European Nuclear Energy Forum
ENEN	European Nuclear Education Network
ENS	European Nuclear Society
ENSTTI	European Nuclear Safety Training and Tutoring Institute
ENSREG	European Nuclear Safety Regulators Group
EQF	European Qualifications Framework
ESARDA	European Safeguards Research & Development Association
ETI	Education and Training and Information (also E&T&I)
EU	European Union
EUTERP	European Training and Education in Radiation Protection Foundation
E&T	Education and Training
FORATOM	European Atomic Forum
FORTUM	Energy company for the Nordic and Baltic countries, Poland, Russia and India
Fusenet	European Fusion Education Network
GENTLE	Graduate and Executive Nuclear Training and Lifelong Education
HERCA	Heads of Radiation Protection Competent Authorities
IAEA	International Atomic Energy Agency
IGD-TP	Implementation of Geological Disposal Technology Platform
INMA	International Nuclear Management Academy
INSTN	Institut national des sciences et techniques nucléaires
ITCE	Information Technology Communication Electronics
I&C	Instrumentation and Control
JRC	Joint Research Centre
KIT	Karlsruhe Institute of Technology
KSA	Knowledge, Skills and Attitude
KSC	Knowledge, Skills and Competences
KSR/A	Knowledge, Skills at appropriate Responsibility Autonomy level
LMS	Learning Management System

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LO	Learning Outcome
LTO	Long Term Operation
MELODI	Multidisciplinary European Low Dose Initiative
MOOC	Massive Open Online Course
MS	Member State
MSc	Master of Science
NCfN	National College for Nuclear
NSC	Nuclear Safety Culture
PhD	Philosophy Doctorate (Research Doctorate in general)
RWM	Radioactive Waste Management
R&D	Research and Development
SAG	Senior Advisory Group
SCK•CEN	Belgian Nuclear Research Centre
SET	Strategic Energy Technology
SMR	Small and Medium sized Reactors
SNE-TP	Sustainable Nuclear Energy Technology Platform
SSS	Safety, Security and Safeguards
STEM	Science Technology Engineering and Mathematics
TSO	Technical Supporting Organisation
UMAN	University of Manchester
UNED	Universidad Nacional de Educación a Distancia
UPM	Universidad Politécnica de Madrid
VET	Vocational Education and Training
WANO	World Association of Nuclear Operators
WNA	World Nuclear Association
WNU	World Nuclear University
WPn	Work Package (n = 1, 2, ...)

## 1. INTRODUCTION

### 1.1 ANNETTE, its commitment and vision

As discussed in previous deliverables issued in the frame of Work Package 2 [1-2], the ANNETTE Project (Advanced Networking for Nuclear Education and Training and Transfer of Expertise) is aiming at a major coordination of nuclear Education and Training (E&T) in Europe. This work package, together with WP5 and WP6, envisages relevant actions in view of establishing a “master” programme for Continuous Professional Development (CPD) and of delivering a Summer School having the role to start the joint education initiatives, planned in the period from June 2018 to July 2019 and now extended to a longer period within this year.

Since the start of the preparation of the ANETTE proposal in spring 2014, it was clear that adhering to the Euratom call asking for “masters” and “Summer Schools” for continuous professional development was a challenging target. At that time, in fact, the post-Fukushima environment, with its adverse attitude towards nuclear energy and its applications, had substantially depressed enthusiasms for a *nuclear renaissance* in western Countries, including many European member states, and the rush for recovering momentum in nuclear education experienced in the last years 2000, up to 2011, was already over. It must be recalled, in fact, that in the short period of reconsideration of energy policies in view of a more relevant role of nuclear energy in the future decarbonised energy mix, several educational initiatives were proposed worldwide in order to quickly recover the time lost in the aftermath of the Chernobyl accident, wasting the long lasting efforts needed to establish a solid background for the workforce needed for new builds and continuing research.

“Masters”, in particular, intended as one-year higher education programmes suited for people mainly having already a STEM MSc, to be converted to nuclear experts, were proposed at several Universities in support to and aside of the existing two-year University MSc programmes in nuclear matters. However, in 2014 that short period of feverish activity was already closed and Europe was back facing the problem of adequately sustaining nuclear expertise in front of a low attractiveness of nuclear careers.

In such an adverse situation, the request for “masters for CPD” in nuclear matters appearing in the Euratom call stimulated the elaboration of new ideas in view of a joint effort by different institutions in Europe, aimed at establishing a programme of courses delivered by different course providers in

different countries, making use of resources already available and of additional ones to be developed. Prior examples of European Fission Training Schemes (EFTS) could suggest about opportunities and difficulties. In particular, the GENTLE project, which was running at that time [3], could provide useful experience of good achievements and challenges to be overcome. In some sense, many previous and parallel EFTS offered lessons learned, recently summarised in a dedicated paper [4], which resulted useful in preparing and delivering the actions of ANNETTE.

Basing on such experience, the main characteristics of the work to be performed in WP2 (and also in WP5 and WP6, specifically related to nuclear safety culture and fusion technology) were devised as follows:

- ANNETTE should set up a long lasting education effort joining the sectors of Nuclear Safety / Technology, Radiation Protection, Geological Disposal and Waste Management;
- this result was part of the targets of “coordination” and “advanced networking”, which inspired the project since the beginning and were specifically addressed in Work Package 1;
- it must be noted that joining in the project contributions from institutions belonging to these three sectors represented a first success, stimulating the idea that ANNETTE could become in the hands of ENEN a powerful tool for its mission of networking; the joining of the ESARDA group and of FuseNet represented further useful developments in this frame.

The relation of WP2 with WP5 and WP6 is illustrated in the DoA of the project in relation to the T2.2: *“As a result of this task, the structure and content of the programme, composed of diverse modules addressing different learning outcomes, and the summer school will be specified by an appropriate programme plan and related module plans. Good coverage of the different nuclear areas will be assured, also including modules to be developed in the frame of the activities addressing nuclear safety culture (WP5) and the transition from non-nuclear to nuclear in the fusion field (WP6).”*

Except for the choice of the delivery of lectures at different institutions, the characteristics of the “master” were left to be discussed with stakeholders. This discussion was made in steps and was described in previous deliverables [1-2]. On the other hand, the Summer School was conceived as having a more traditional structure, except for the fact that it was organised in tracks reflecting the different nuclear fields considered in ANNETTE.

In summary, the “vision” of ANNETTE in relation to courses to be delivered is reported in Figure 1. In practice, the initial core of course providers is envisaged to catalyse efforts from additional external course providers. The initial plans in this regard were a bit more ambitious than it was finally possible, as it will be explained later on. However, the Belgian Nuclear Education Network (BNEN) and the Framatome Professional School (FPS) at KIT enlarged their initial proposals in spirit of cooperation. The pilot courses planned in the period from summer 2018 to 2019 were envisaged to run to provide experience especially on the attractiveness of the different proposed courses and their way to be delivered (in presence, e-learning, MOOCs, etc.). The long term goal is to keep within ENEN a permanent Steering Committee that should continue to propose each year courses for CPD, in similarity with what proposed during the ANNETTE project, in front of certifications released by the different course providers and by ENEN. These details, on which proposals have been already circulated within ANNETTE participants, will be defined during the last stage of the project, in front of the analysis of the success of courses, also based on the information collected in this report.



Figure 1. The “vision” of ANNETTE as presented to the Stakeholders

In the following subsections, the conclusions reached in the two previous deliverables D2.1 and D2.2, leading to structure the master courses and the Summer School, are shortly summarised for the purpose of reminding the rationale followed in this regard.



## 1.2 Conclusions from D2.1: Specific needs for an advanced European programme for CPD

The report was based on a **desk research** about relevant reports on the subject, **an interaction with JRC G10 Group** and **an interaction with Stakeholders** performed by distributing a questionnaire and collecting the related answers. This activity involved a considerable effort, especially in contacting the Stakeholders and getting useful suggestions; in change the number and quality of indications to be taken into account in developing the programme was quite extensive and precious.

The desk research pointed out the urgency of taking care of nuclear education at CPD level, also allowing to infer from different sources (EHRO-N and national reports on nuclear workforce from UK and Finland) a classification of the different target groups, generally divided into different “tiers”, e.g. identified as “nuclear experts”, personnel to be “nuclearized” and personnel to be made “nuclear aware”. The E&T needs are different in this regard:

- people having a basic education in nuclear matters may need to specialise in specific sectors (e.g., decommissioning, waste management, geological disposal, radiation protection, nuclear safety culture, fusion, project or knowledge management, etc.);
- people needing to be nuclearised or made nuclear aware need **«minor» courses** to be included in their curriculum.

It is therefore important that the offered courses be made available to the different target groups, when appropriate, or customised for each one of them. After the collection of the pilot courses within the ANNETTE project, the latter process can be considered a medium-long term target to be accomplished by a continuous interaction with Stakeholders and a close monitoring of needs.

Speaking about professionals needing CPD, it was clarified in the contacts with Stakeholders that **the courses should be short and focused**, to allow professionals for taking part in them in a limited time each year. This led to conceive an **“incremental” process of lifelong learning for CPD**, which can be established in order to let people achieve competences according to their inclinations and professional needs, possibly in agreement with their employers. In other words, there is a clear need to **introduce flexibility also in accreditation**, whenever this step is really considered necessary; as we will see, in fact, some doubt can be raised on this aspect after course implementation and the consequent observation of the attitudes of the learners towards course attendance, on one side, and certification, on the other.

**In setting up the proposal, a number of courses to be delivered was already planned**, though the interaction with Stakeholders was considered a crucial aspect to check for the adequacy of the offer. Reading the answers of Stakeholders in the collected questionnaires in this regard, it could be confirmed that the initial choice of courses was rather good for the intended purpose, receiving a general appreciation: this represented an encouraging aspect, in front of the risk that the Consortium could have been incapable to respond to the needs highlighted by the Stakeholders. By the way, **some Stakeholder proposed to join the offer with own courses**; this exciting aspect of the initial interaction with the Advisory Committee and the End-User Group (leading to expect an “avalanche” effect in courses build-up) resulted much less practicable than expected, remaining an issue to be tackled in the longer term delivery of the offer for CPD.

The contacts had with the G10 group of JRC allowed to **improve the standard format established under WP2 for the specification of the learning outcomes (LOs)**, adhering to the latest developments in the field of ECVET application in the nuclear field, envisaging **Knowledge and Skills at a prescribed Responsibility / Autonomy level**, in difference with the previous paradigm, prescribing Knowledge, Skills and Competences or Attitudes. Most of the proposed courses, though not all, unfortunately, have been equipped with such a detailed description of the learning outcomes, also with reference to professions listed in EHRO-N reports, which unfortunately still stick to the old paradigm and do not contain professions related to research and development.

**In relation to the use of e-learning tools**, something explicitly asked by EC as an aspect to be enhanced in the offer of ANNETTE, the **Stakeholders had mixed feelings**; some considered them as necessary for modern teaching, while some assigned to e-learning only a “preparatory” role, in order to equalise the basis of the learners. The opinion of learners, as it was found in a limited inquiry conducted more recently during course delivery, was similar: some considered e-learning a great opportunity, others did not like it too much. These are opinions that must be taken into due consideration.

In summary, the Deliverable D2.1 collected several useful suggestions coming from different sources in relation to the way to propose courses and the needs to be responded to in their collection and design.

### 1.3 Conclusions from D2.2: Course Plan for the Advanced European Programme

The Course Plan for the Advanced European programme has been specified in D2.2 on the basis of information collected from Course providers at the time. This plan was subjected to minor changes during the preparation of courses and their advertising (from December 2017 to June 2018), owing to further choices by course providers or considerations of better opportunity. In one case, owing to personnel turnover at one of course providers, a new proposal was made, anyway being close to the initial one.

The plan of courses as presented in D2.2 mostly adhered to the suggestions proposed in D2.1 and involved the aspects described in the following.

- 1. Requirements about target attendees.** As described in the previous subsection, the courses were intended to be offered to people with different background and different prospective careers (nuclear experts, nuclearized and nuclear aware personnel). Though a specific systematic diversification was not carried out, the specification of the necessary background and the detailed presentation of learning outcomes made the target attendees to have clear indication on what to select for their own purposes.
- 2. Requirements for CPD and LLL: modular vs full one year courses.** This mainly led to promote *courses having a modular structure*, to be delivered in a short time. In this regard, it must be mentioned that both courses delivered at the level of MSc and specific courses developed for CPD were found to be modular in the available offer. In the former case, a dual purpose use of courses (for MSc students and professionals wishing to have a single course) was found e.g. at Manchester University, at Framatome (ex-AREVA) KIT Professional School and BNEN, inter alia. It must be considered that this educational arrangement should be considered ideal in the nuclear E&T panorama, e.g. for providing professionals wishing to enter the nuclear field a plenty of offers, while assuring the necessary continuity to MSc students. Anyway, it will be shown in this report that, contrary to expectations, a specific course released in semester format and in Spanish language got an exceptional attendance, also owing to its synchronous e-learning delivery. This observation suggested further reflections on this issue with respect to what initially conceived.
- 3. Incremental character and intermediate certifications.** At the time of writing D2.2, an attempt was made to conceive a programme “accredited by ENEN”, as suggested by most Stakeholders in their answers, whose certifications could be achieved “**incrementally**” and “**in steps**”, meaning that each

year professionals could pile-up courses (whose worth had to be measured in terms of ECTS or, better, ECVET credits) and achieve certifications at some intermediate thresholds (e.g., 20, 40, and 60 ECTS/ECVET credits). This suggestion about “milestone certifications” was supported by the idea that a professional would like to achieve some degree of accomplishment in a few years, though the process of education could last several years, in a lifelong learning perspective. Needless to say, this idea needs to be checked on the basis of what really professionals can afford doing each year. As already mentioned in the previous subsection, the experimented attitude of ANNETTE pilot course attendants towards certifications showed that they often prefer informational courses or hands-on courses receiving just a certification of attendance than being subjected to a final examination granting some credits. This is an aspect to be seriously considered for the future of the ANNETTE offer.

- 4. Professional “tracks” vs. coaching.** Some Stakeholders suggested that the offer of ANNETTE should have been arranged in tracks, related to specific clusters of matters (e.g., under the titles of Nuclear Safety / Technology, Radiation Protection, Geological Disposal and Waste Management, etc.). This is an aspect on which it was prudently tried to remain flexible during the pilot courses, meaning that clustering courses in tracks (as it was made profitably for the Summer School) could have discouraged those attendants that would like to pile-up courses as a consequence of their specific and momentary professional interest, or as a consequence of the interest of their “coaches” (supervisors, mentors, employers). While this approach involves the risk of making a “fruit salad” of courses (whenever the choices could be considered too irrational), it must be considered that lifelong learning and the specific market needs may suggest to leave such freedom in choice, letting the learners to construct their own learning path. While at University level this should be strictly avoided to provide a sound and coherent basis to learners, in a CPD perspective the autonomy of the learners and of their “coaches” should be favoured. Nevertheless, specific “suggested” routes or tracks can be elaborated for the future of the ANNETTE offer within ENEN.
- 5. The evolutionary frame of ANNETTE.** While running the kernel of pilot courses of ANNETTE is providing the first “real life” information on the possibility to stimulate attendance by such an E&T offer, beyond any initial assumption, it will be necessary by the end of the project to prepare mechanisms within ENEN capable to propose yearly the offer in an increasingly adapted and broadened fashion. The fate of the different pilot courses per se is very rich of information to be

considered; especially the “motivations” that applicants to courses proposed at the time of their application are very interesting in this regard, as well as we expect of equal interest will be an inquiry about the usefulness of courses to be conducted at a later stage. This will allow to consider the offer and adapt it for the future editions, possibly involving course providers other than ANNETTE Consortium participants.

## **2. THE SUMMER SCHOOL**

### **2.1 The start of preparation**

The ANNETTE Summer School on nuclear technology (including fusion), nuclear waste management and radiation protection took place on 24-30 June 2018 in Turku, Finland, has been the subject of an intensive preparation work started since spring 2017 and continued up to its delivery in summer 2018. The Summer School virtually opened the offer of ANNETTE and worked as a teaser for the pilot courses. A detailed account about the preparation and the success of the event was presented in a conference of the Spanish Nuclear Society [5]. The following illustration of the event is explicitly drawn from that document conceived for dissemination.

In April 2017 the project partners created a Steering Committee to design and develop the Summer School, and to advise the local organizer (Aalto University). Since then, through regular communications and various discussions, the Summer School was designed, i.e. its objectives, target group, content, and schedule were specified. Furthermore, the members of the Steering Committee contacted experts and asked them to contribute in developing and implementing lectures and workshops. Finally, the design and content of a dedicated website<sup>(1)</sup> for advertising the Summer School and receiving applications was agreed, as well as the evaluation criteria for accepting student applications.

### **2.2 Objectives pursued**

The Steering Committee specified that the main objective should be to provide a concise introduction into the diverse activities related to nuclear energy, while also supporting networking across technical disciplines, nationalities, and professional positions. The focus was to be on nuclear technology for energy production, radiation protection, and waste management. To ensure a broad overview and visibility of the interconnections, these topics should be dealt with in plenary sessions, as well as in more detail in parallel running discipline specific tracks. Additionally, the nuclear technology part should also include the status of fusion technology, and its envisaged future development.

### **2.3 Summer School Target Group**

The Summer School was targeted to young professionals, master's students and doctoral students in these fields, in industry, government, regulatory bodies, research centers and universities. A prerequisite was a BSc-level degree related to any of the Summer School topics. In the participant

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<sup>(1)</sup> See <http://annettesummerschool.org/>

selection procedure, the importance of a clear motivation and a recommendation letter from a supervising professor or direct manager was emphasized.

When selecting the students for the Summer School, well-balanced educational background and nationalities of the participants as well as allocation to the three disciplines was observed by the Steering Committee.

## **2.4 Summer School Content and Schedule**

The content was characterized by a multidisciplinary approach, e.g. reflected in the list of plenary lectures:

- History of radiation protection towards current guidelines and legislation,
- Ethical considerations on nuclear and radiological risk governance,
- Nuclear safety culture,
- Nuclear safeguards,
- Nuclear security,
- The impact of nuclear and radiological accidents,
- Perception vs reality of nuclear safety, waste and costs,
- Safety features of Generation III fission reactors,
- Development challenges of Generation IV reactors,
- Management of radioactive and nuclear waste in Finland,
- The seven challenges of fusion,
- Design of DEMO: implications of the nuclear aspects.

In accordance with the objectives of the Summer School, the schedule was designed in a way to allow for an alternation between plenary lectures and specialized technical sessions, dealing with the disciplines of nuclear technology, nuclear waste management, and radiation protection, see Figure 2. As Olkiluoto with its NPP site of the utility TVO and the Low Level and Intermediate Waste Level (LLW / ILW) repository site of the HLW management company Posiva are close to Turku, an excursion to Olkiluoto was included in the schedule. Thereby, the participants could be easily informed about the practical applications of the theory presented in the lectures and discussed in the workshops.

Figure 3, Figure 4 and Figure 5 report the details of the lectures delivered during the lecturing days of the Summer School, together with the name of the lecturers.

## 2.4 Summer School Implementation

A dedicated web site was established to inform about the Summer School, and to advertise the event in the nuclear fission and fusion communities <sup>(2)</sup>. 85 applications were received, but because of practical limitations, and with the aim to guarantee an effective implementation, the Steering Committee selected 64 participants based on its participant selection procedure. Thereby, a well-balanced educational background and nationalities of the participants were also guaranteed.

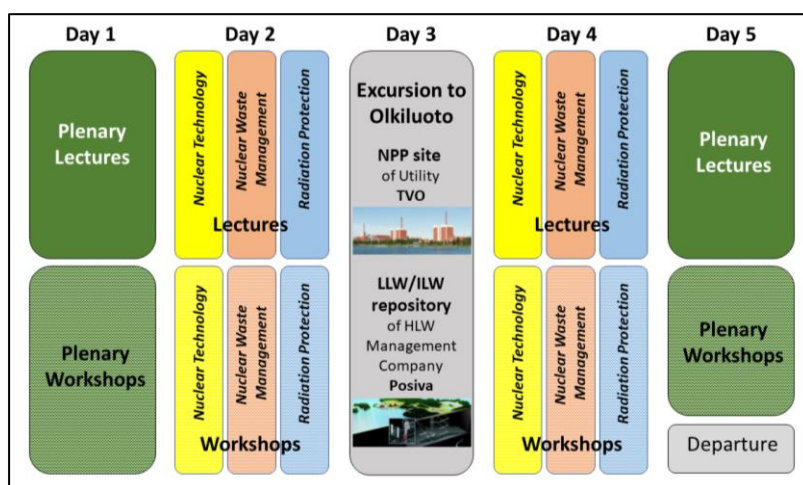



Figure 2. Time Schedule of the Summer School



## ANNETTE Summer School and PETRUS PhD Conference

Turku, Finland, 24-30 June 2018

Version: 20 June 2018

	Sunday 24 June	Monday 25 June	Tuesday 26 June			Wednesday 27 June	Thursday 28 June			Friday 29 June	Saturday 30 June
9:00-9:45	Arrival to Turku	PL01	NL01	WL01	RL01	Bus transport to Olkiluoto (start 8:00)	NL08	WL08	RL08	PL08	Departure from Turku (Alt. B)
10:00-10:45		PL02	NL02	WL02	RL02	Presentations by TVO on BWR plant life extension and EPR commissioning	NL09	WL09	RL09	PL09	
11:00-11:45		PL03	NL03	WL03	RL03		NL10	WL10	RL10	PL10	
12:00-12:45		Lunch	Lunch			Lunch	Lunch			Lunch	
13:00-13:45		PL04	NW04	WW04	RW04	Presentation by Posiva on encapsulation plant	NW11	WW11	RW11	PL11	
14:00-14:45	PL05	NW05	WW05	RW05	Visits to LLW/ILW repository, Onkalo exhibition, EPR site, Onkalo site, visitor centre	NW12	WW12	RW12	PL12		
	Coffee	Coffee				Coffee	Coffee				
15:15-16:00	PL06	NW06	WW06	RW06		NW13	WW13	RW13	Departure from Turku (Alt. A)		
16:15-17:00	PL07	NW07	WW07	RW07		NW14	WW14	RW14			
Evening	Informal welcome reception 18:00-20:00		Photograph 17:15 / Reception at Turku City Hall (walking distance) 18:00-19:30			Bus transport to Turku (return by 20:00)	Sauna evening in Ruissalo (bus transport at 17:15, return bus 21:30)				

PL: Plenary Lecture  
 NL: Nuclear Technology Lecture  
 NW: Nuclear Technology Workshop (Groupwork or Student Seminar or Visit or Lecture)  
 WL: Waste Management Lecture  
 WW: Waste Management Workshop (Groupwork or Student Seminar or Visit or Lecture)  
 RL: Radiation Protection Lecture  
 RW: Radiation Protection Workshop (Groupwork or Student Seminar or Visit or Lecture)

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Figure 3. Detailed planning of the week

<sup>(2)</sup> See <http://annettesummerschool.org/>



	Monday 25 June	Tuesday 26 June		
	Auditorium 1 (2 <sup>nd</sup> floor)	Lecture room 111 (1 <sup>st</sup> floor)	Lecture room 404 (4 <sup>th</sup> floor)	Lecture room 305 (3 <sup>rd</sup> floor)
9:00-9:45	Eduardo Gallego (IRPA): History of radiation protection towards current guidelines and legislation	Roger Jaspers (TU/e): The physics basics of a fusion reactor	Behrooz Bazargan-Sabet (UL): Front end nuclear fuel cycle wastes	Marco Caresana (EURADOS): Refresher of dosimetric quantities
10:00-10:45	Gaston Meskens (SCK•CEN): Ethical considerations on nuclear and radiological risk governance	Antti Rantakaulio (Fortum): Small Modular Reactor concepts and their licensing	Patxi Elorza (UPM): Hydro-mechanical and transport processes	Marco Caresana (EURADOS): External and environmental dosimetry
11:00-11:45	Bogdan Buhai (Framatome): Safety features of Generation 3 fission reactors	Juhani Hyvärinen (LUT): Overall safety conceptual framework	Anne-Magali Seydoux-Guillaume (U St Etienne): Natural analogues	Marco Caresana (EURADOS): Calibration traceability and the role of a secondary standard laboratory
12:00-12:45	Lunch	Lunch	Lunch	Lunch
13:00-13:45	Jaakko Leppänen (Aalto&VTI): Development challenges of Generation 4 reactors	Juhani Hyvärinen (LUT): Overall safety conceptual framework (workshop)	Stella Tournier: Development of a fibre optic probe for the analysis of nuclear waste treatment processes	Gaston Meskens (SCK•CEN): Topical workshop on the ethics, science and technology of radiological protection (Part I)
14:00-14:45	Marjatta Palmu (Posiva): Management of radioactive and nuclear waste in Finland	Bogdan Buhai (Framatome): Basics of nuclear regulation and its impact on licensing and design of NPP	Haiquan Sun: Microstructure characteristics of compacted Czech bentonite B75	Topical workshop on the ethics, science and technology of radiological protection (Part II)
15:15-16:00	Roger Jaspers (TU/e): The seven challenges of fusion	Bogdan Buhai (Framatome): Exercise: how to consider nuclear regulation in design / engineering activities?	Antonio Di Buono: Wireless communications in nuclear decommissioning environments	Sisko Salomaa (STUK): Biological effects of ionizing radiation on humans and biota
16:15-17:00	Gianfranco Federici (EUROfusion): Design of DEMO: implications of the nuclear aspects (discussion)	Jaakko Leppänen (Aalto&VTI): Monte Carlo methods in reactor physics calculations	Ruveyda Ileri: Diffusion analysis of redox sensitive elements in nuclear wastes in polymer based barrier systems	Sisko Salomaa (STUK): Health effects of ionizing radiation

Figure 4. Lectures and lecturers in the different tracks (Monday and Tuesday)

	Thursday 28 June			Friday 29 June
	Lecture room 111 (1 <sup>st</sup> floor)	Lecture room 404 (4 <sup>th</sup> floor)	Lecture room 305 (3 <sup>rd</sup> floor)	Auditorium 1 (2 <sup>nd</sup> floor)
9:00-9:45	Dario Manara (JRC): General introduction to nuclear fuels	John Roberts (UMAN): Radioactive waste immobilisation and geological disposal	Sylvain Andresz (EAN): ALARA fundamentals	Fernando Gonzalez (Tecnatom): Nuclear safety culture
10:00-10:45	Dario Manara (JRC): Nuclear fuel cycles	Pietari Skyttä (UTU): Coupling between the brittle and ductile deformation structures in crystalline bedrock	Sylvain Andresz (EAN): ALARA culture	Riccardo Rossa (ESARDA): Nuclear safeguards
11:00-11:45	Ian Bonnett (ITER): Introduction to Tritium and its processing for Fusion reactors	Karsten Pedersen (Micans): Microbiology in nuclear waste disposal	Jukka Lehto (UHEL): Sources of radionuclides in air, water and soil	Riccardo Rossa (ESARDA): Nuclear security
12:00-12:45	Lunch	Lunch	Lunch	Lunch
13:00-13:45	Michael Loughlin (ITER): Neutron irradiation: what is the impact on the material properties, neutron stopping, safety issues, production of radioactive waste	Kathleen Dungan: The effects of fuel cycle closure on the disposability of resultant wastes	Jukka Lehto (UHEL): Transfer processes of radionuclides in the environment	John Roberts (UMAN): The impact of nuclear and radiological accidents
14:00-14:45	Ian Bonnett (ITER), Michael Loughlin (ITER): Exercises to aspects of tritium / neutron irradiation	Matteo Ferrari: Radiation resistance of O-rings and greases for the management of new generation nuclear targets	Olof Solin (Turku PET Centre, UTU): Visit to Turku PET Centre	John Roberts (UMAN): Perception vs reality of nuclear safety, waste and costs
15:15-16:00	John Roberts (UMAN), Jarmo Ala-Heikkilä (Aalto): Nuclear energy and public acceptance (workshop)	Eveliina Muuri: Upscaling laboratory data towards in situ conditions	Visit to Turku PET Centre (continues)	
16:15-17:00	Workshop continues	Lewis Blackburn: Understanding the effectiveness of surrogates for plutonium waste and stockpile immobilisation	Visit to Turku PET Centre (continues)	

Figure 5. Lectures and lecturers in the different tracks (Thursday and Friday)

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Thereof, 20 persons participated in the Nuclear Technology track, 20 persons participated in the Nuclear Waste Management track, 12 persons participated in the Radiation Protection track; in particular, out of the 20 mentioned attendees for Waste Management, 12 persons attended the Fourth PETRUS-ANNETTE PhD and Early-Stage Researchers Conference 2018 which was organized together with the Summer School. From the Summer School participants, 16 were master's students (BSc degree), 25 were doctoral students (MSc degree), and 11 were young professionals, representing altogether 24 nationalities (see Figure 6).

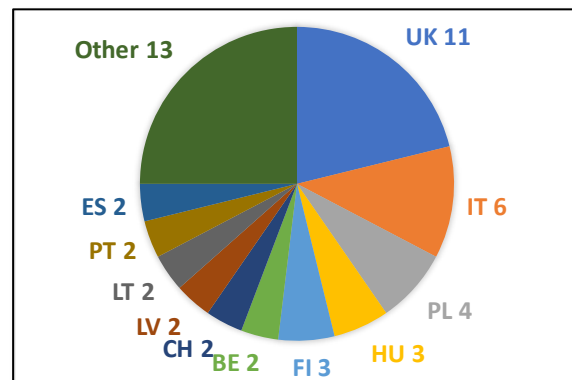


Figure 6. Distribution of nationalities of the attendants at the Summer School

Finally, 29 experts from different technical disciplines contributed to the development and implementation of the Summer School, so altogether 50 lectures and workshops were given. Figure 7 report pictures relating to moments during lecture delivery and discussions.



Figure 7. Lectures and discussions

**All lectures and workshops were video recorded.** After the Summer School the link to a web site (with restricted accessibility) was distributed to the participants and the lecturers to enable them to download the presentations and the video records. No further text books were developed, but with the available material the students will certainly be able to recapitulate the lectures and follow those in the parallel sessions which they could not attend.



Figure 8. Summer School Group Photo

The Summer School was accompanied by two social events: a reception at the Turku Town Hall, and a Sauna evening. Thereby a lot of opportunities were provided to reinforce the internal communication and interactions between the participants, supporting the formation of networks beyond the scope of the Summer School. A group photo of attendants and teachers is reported in Figure 8.

## 2.5 Feedback from participants

After the Summer School, a link to a web form with a feedback questionnaire was distributed to the students, the lecturers, and the organizers. Within a period of one month, about 96% of the participants responded to the questionnaire.

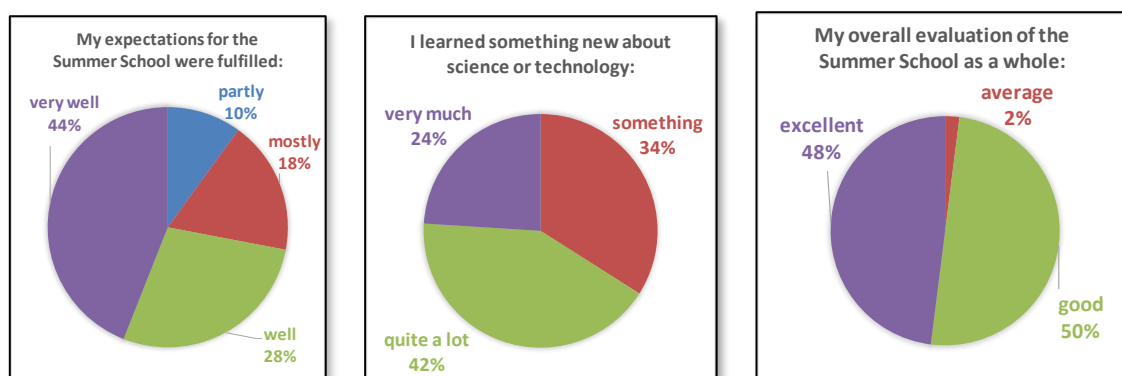


Figure 9. General Feedback on the Summer School

In summary, the participants were mostly satisfied with the Summer School (Figure 9), and expectations were on average fulfilled better than well (no negative responses were given, in the diagrams these are left out for enhanced clarity, also in the following diagrams when applicable).

The evaluation of plenary lectures and lectures on the three tracks do not differ too much from each other: the distributions are very similar (Figure 10). This apparently implies that the program was well balanced regarding the content and quality of implementation.

The participants were also satisfied with the level of interactivity (discussions, possibility for questions). This is a good sign, as the program was quite compact with many different lectures (Figure 11). This feedback and the general evaluation was due to the carefully selected pedagogically good lecturers teaching in the Summer School.

Also, the enhancement of the lectures through the excursion to Olkiluoto was considered excellent by two thirds of the respondents. This feedback is no surprise, as this could be seen directly on the faces during the excursion, and through hearing the comments directly afterwards.

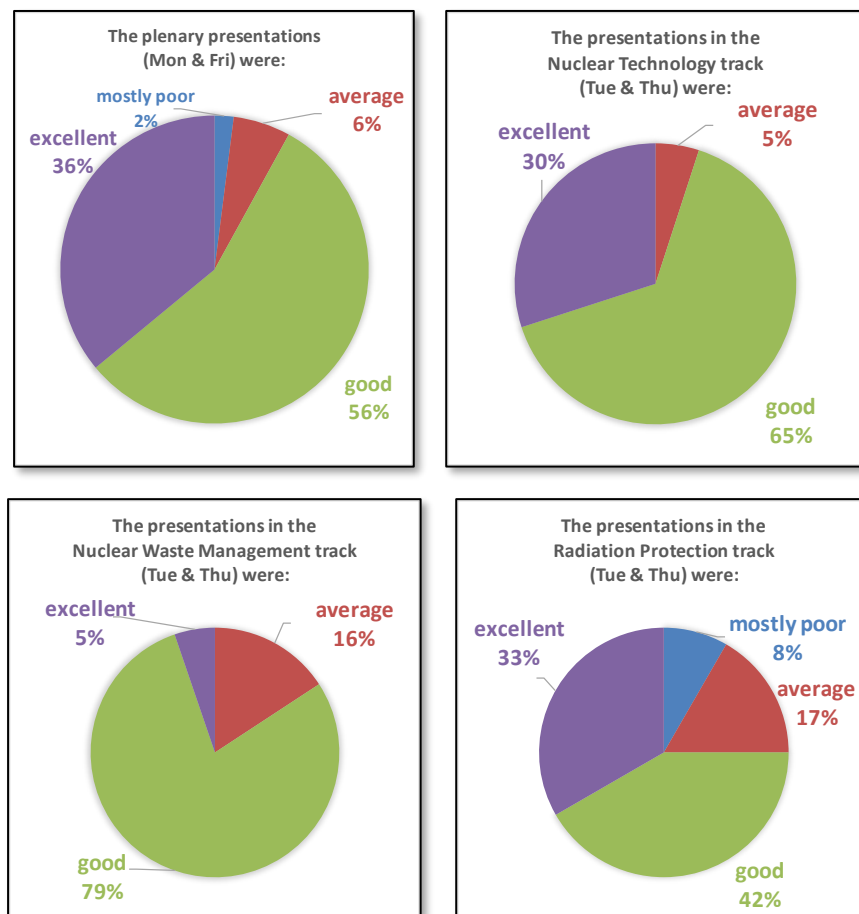


Figure 10. Feedback on presentations

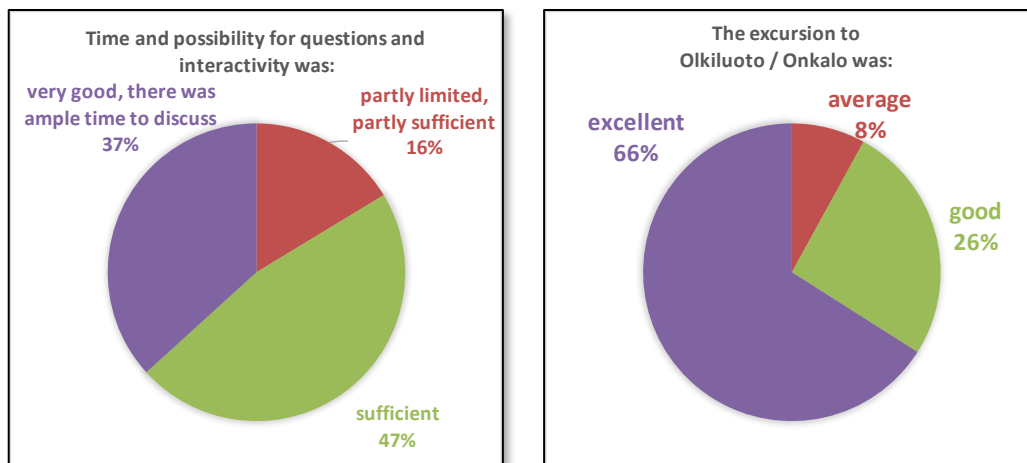


Figure 11. Judgement on interactivity and the excursion

Finally, the practical arrangements (organizational support before and during the school, school venue, accommodation) seem to have been mostly successful.

The participants were also asked to reflect on what was good / negative in the Summer School, and how one could improve the next time. Here the quality of the Summer School was often praised, e.g. "... an excellent occasion to obtain a broad view on different nuclear domains and discuss with people working in these different domains. Lectures gave a good introduction into the domains. The visit to Olkiluoto provided an added value to the school. The organization of the Summer School was excellent, communication and instructions to the participants were to the point and clear. The social activities ... were very well appreciated."

Comments on the lectures were generally praiseworthy, but also indicated areas for improvement: "interesting but slightly too general", "some of them went into far too much detail", "Lecturers had in many cases too little time to go through their slides", "too much information in a short time", "some lectures were less interactive", "The quality of the lecturers was really good, for the plenary sessions as well as for the N-Track. They provided so much insight on the nuclear industry", "Lecturers was high-level and well-trained to convey their knowledge".

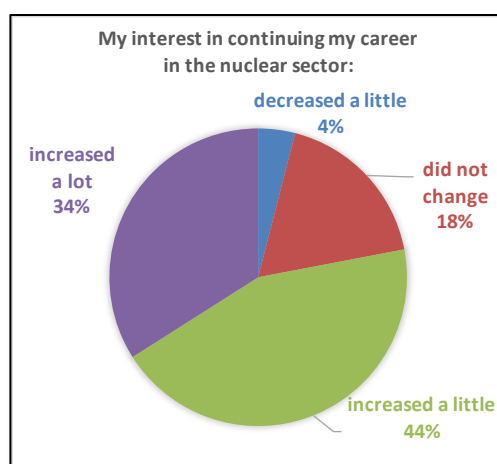


Figure 12. Career perspective in nuclear

One further interesting observation is that the Summer School did not change the interest to continue careers in the nuclear sector very much for the participants (Figure 12). It decreased a little for two respondents but looking at the respondent-level report from the questionnaire system, these respondents did not provide any written comments as a motivation.

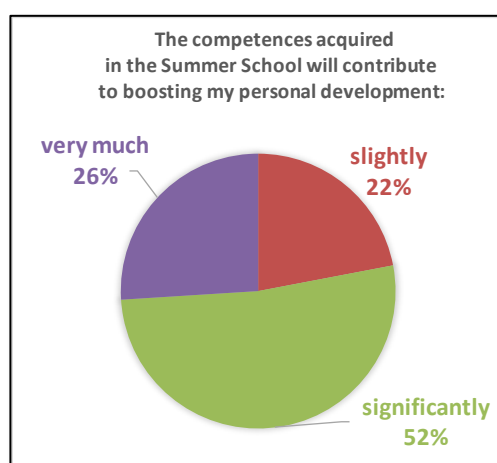


Figure 13. Contribution to personal development

However, there are high expectations that the competences acquired in the Summer School will boost the personal development of the participants (Figure 13).

## 2.6 Conclusions and recommendations

As the Summer School was very well rated by the participants, we recommend implementing this type of course annually. Through targeting young professionals, master students and doctoral students in these fields, both in industry, government, regulatory bodies, research centers and universities, we may thereby contribute substantially to the attractiveness of job positions in the nuclear field.

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Additionally, getting a broad picture and good overview on the various aspects of nuclear applications, with nuclear technology (including fusion), radiation protection, and nuclear waste management, will certainly boost the looking-out-of-the-box attitude of the participants. For today's challenges related to applications of nuclear, this attitude is indispensable for a successful work in nuclear. And it will certainly support the flexibility of participants in a world with ever changing work boundary conditions, providing a stepping stone to lifelong learning, while relying on networks that can be fostered in the Summer School.

Nevertheless, as the success of the Summer School also was caused by the excellent preparation and implementation of the local organizers, this must be taken care of again. Therefore, future summer schools could be easiest performed once more in Turku, thereby also using the vicinity of Olkiluoto as an opportunity for hands-on presentation of nuclear in real life.

Yet for further summer schools it appears to be very important to reconsider in more detail the different lectures, and to arrange for an improved well-balanced level. This refers to scope, level of detail, and adaptation to time that is available for presentation and discussions.

The Summer School also provided the opportunity to present the modular pilot courses being currently delivered in the frame of the ANNETTE project. The participants were highly interested in these modular courses, ideal for Continuous Professional Development. The main outcome of the project, in fact, is to offer yearly short (one week or two weeks) courses that professionals may attend to start, refresh or deepen their knowledge in the nuclear fields.

Finally, one complicated issue to be considered is the timing of a future summer school: the incompatibility with the semester of the home university may deteriorate the interest to participate.

Taking all these issues into account will certainly boost the attractiveness of future summer schools, and their contribution to lifelong learning of the work force in the nuclear field.



### 3. THE PILOT COURSES

#### 3.1 The ENEN website pages about ANNETTE Courses

In December 2017, the deliverable 2.3 was issued, indicating the page of the ENEN website devoted to list and provide information on pilot courses. The page, whose address is

<http://www.enen.eu/en/projects/annette/annette-project-courses1.html>

started to be populated with descriptions and links, according to the information received during programme preparation by course providers and stimulated by asking them the following documentation about courses:

- **the list of learning outcomes** according to the template set up in cooperation with JRC G10 Group, specifying the learning outcomes of courses (Figure 14);
- **a course provider page for course description;**
- however, in the lack of a specific course provider page concerning the specific course and in order to possibly homogenise information, **a HTML page to be linked to the announcement** of the course for advertising was asked, on the basis of a template set up for one of them (Figure 15); this page was stored on a server made available by the University of Pisa, linked to a service page

>>> Content and Minimum Learning Outcomes for the Course of Single- and Two Phase Thermal-hydraulics		
W. Ambrosini		
Course on "Single and Two-Phase Thermal-hydraulics"		
Units and LO Statements	Responsibility / Autonomy	
Unit 1 – Fluids and Balance Equations (5 hours)	Autonomous use of thermal fluid-dynamics principles and balance equations (EQF=7)	
	Skills	Knowledge
<ul style="list-style-type: none"> <li>• Basic Concepts about Fluids</li> <li>• Fluid Models and Flow Regimes (single-phase)</li> <li>• Balance Equations for Single-Phase Fluids               <ul style="list-style-type: none"> <li>○ General Concepts</li> <li>○ Useful Mathematical Relationships</li> <li>○ Level of Detail in Balance Equations</li> <li>○ Integral Lumped Parameter Equations</li> <li>○ Partial Differential Balance Equations</li> <li>○ Need for Closure Laws</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Being able to characterise the state of a fluid on the basis of commonly used thermodynamic diagrams</li> <li>• Critical capability to select an appropriate flow model considering the intended application</li> <li>• Ability to apply the Gibbs rule for determining the number of independent variables for a fluid in conditions of interest for nuclear reactors</li> <li>• Ability to relate the basic laws of physics to the balance equations adopted in thermal fluid-dynamics</li> <li>• Ability to convert surface integrals of advection and diffusion terms in balance equations to volume integrals</li> <li>• Ability to write balance equations in Eulerian and Lagrangian form</li> <li>• Capability to clearly explain the origin of the enthalpy function</li> <li>• Ability to write and apply lumped parameter balance equations to simple systems (filling a volume of water, heat exchanger, forces on a pipe bend)</li> <li>• Ability to retrieve the mass, momentum and energy equations from the general formulation of partial differential balance equations</li> </ul>	<ul style="list-style-type: none"> <li>• Definitions and practical characterisation of fluids</li> <li>• Distinction among the ranges of existence of vapour and gases, liquids and solids</li> <li>• Reminder of p-T and p-v diagrams for a single component substance</li> <li>• Distinction between the different fluid models adopted in thermal-hydraulics</li> <li>• Understanding the characteristics and limitations of different fluid models (e.g., compressible vs., incompressible flows; viscous vs. inviscid fluids, etc.)</li> <li>• Understanding the usefulness of the Boussinesq fluids approximation</li> <li>• Extensive and intensive properties</li> <li>• Concept of equilibrium</li> <li>• Gibbs rule for variance determination</li> <li>• General concept of balance and its applications in fluid-dynamics</li> <li>• Eulerian and Lagrangian points of view for writing integral and differential equations</li> <li>• Divergence theorem and of the Leibniz rule in deriving balance equations</li> <li>• Understanding the relation between Eulerian and Lagrangian forms of balance equations</li> <li>• Integral and differential balance equations: control volumes, control masses, points and particles</li> </ul>

Figure 14. First page of the template for collecting learning outcomes distributed to Course Providers. The example is drawn from one of the courses by CIRTEN / University of Pisa whose complete version can be found at <http://www.dimnp.unipi.it/walter-ambrosini/STPhTh-LOs.pdf>



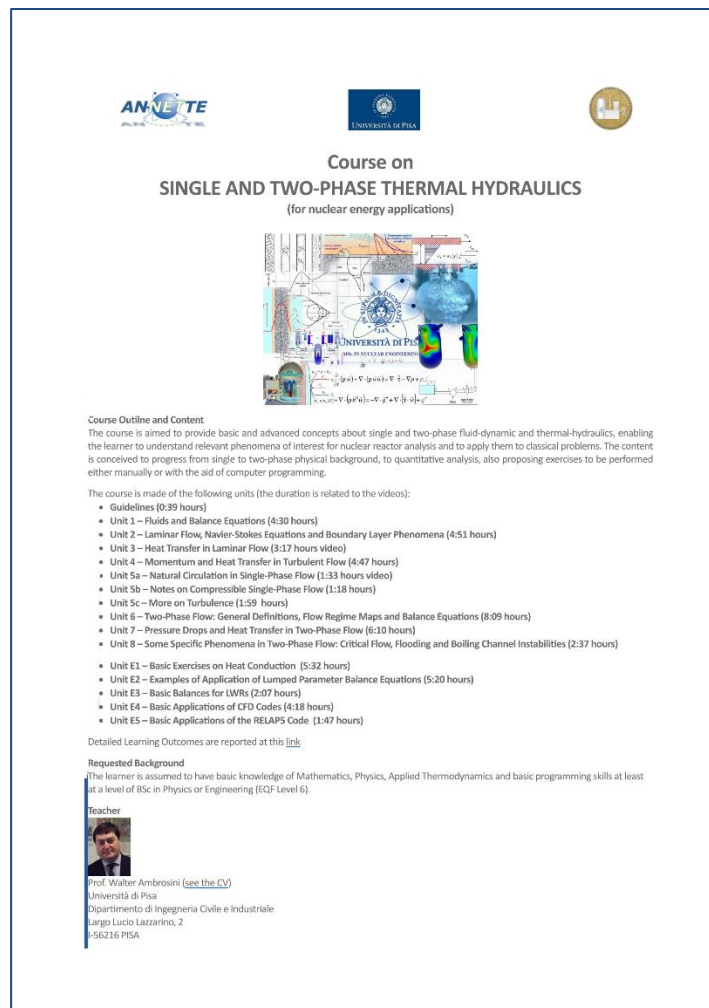


Figure 15. Template of the HTML page be inked to the ENEN page of pilot courses. The example is drawn from one of the courses by CIRTEN / University of Pisa whose complete version can be found at <http://www.dimnp.unipi.it/walter-ambrosini/UniPi-1.html>

The list of courses presently appearing in the page (Figure 16) reflects the latest update in the programme, including courses which have been already run and courses which are going to be delivered in next Autumn, because of delay in preparation or willingness of the Course providers to repeat them. The reader can explore the page to understand the breadth of the proposed program of courses, also making use of the full programme offers by BNEN, the Framatome-KIT Professional School and the University of Manchester. As mentioned above these existing courses were offered in addition to what initially proposed just **because of their modular structure (one or two-week duration)**, which represents the ideal format to serve for Continuous Professional Development and MSc teaching at the same time.



Figure 16. Pages of the ANNETTE Pilot course list

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In addition to the page listing the courses, a mother-page including a general description of the course structure and aim is introduced at <http://www.enen.eu/en/projects/annette/annette-project-courses.html> (Figure 17). This has the aim to shortly describe the general frame and structure of the pilot courses of ANNETTE.

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PROJECTS / ANNETTE Project / Project Course Structure

### ANNETTE COURSE STRUCTURE

ANNETTE Courses have been conceived in order to coordinate and enhance the existing offer for Continuous Professional Development (CPD) in the nuclear fields.

The project is ambitious, since it is aimed to start a long lasting action, to be continued also after the end of the ANNETTE Project (December 2019), in order to plan for courses well suited for end-user needs and to be adapted to the specific trends in Nuclear Education and Training (ENET), under the aegis of the European Nuclear Education Network (ENEN).

The rationale at the basis of the development of courses is depicted in the following figure, highlighting the "vision" of the Project in relation to courses.

**A SKETCH OF THE VISION**

The diagram illustrates the vision of the ANNETTE project. It shows a central box labeled 'ANNETTE Course Providers' connected to 'Selected Previous EFTS' and 'External Course Providers'. Below this, a box labeled 'First core of courses in 2018' is connected to 'Structuring a permanent and evolving offer at the end of the ANNETTE project'. This leads to a box labeled '2019 - i.e. at the Horizon of 2020...' which is connected to 'More External Course Providers (including industry)'. The entire process is framed by 'STAKEHOLDERS' and 'AN-TE'.

As it can be noted, a first kernel of courses has been collected, on the basis of the offer by ANNETTE Participants, made of good new courses and of courses from previous offers by European Fission Training Schemes (EFTS).

The fields of applicability of the courses are:

- Nuclear Fission Technology and Safety / Security / Safeguards
- Radiation Protection
- Waste Management and Geological Disposal
- "Nuclearisation" of Fusion

Specific attention is assigned to Nuclear Safety Culture (NSC) with specific courses and as a cross-cutting issue to be attentively pointed out in all the courses, whatever their specific subject. In fact, an attitude favorable to nuclear safety culture must be promoted at all the levels in organisations working in the nuclear field.

Click here to see the Course Programme

European Nuclear Education Network  
Rue d'Engmont 11,  
1000 Brussels, Belgium

Tel: +32 484 20 15 04  
E-mail: [secretariat@enen.eu](mailto:secretariat@enen.eu)

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Figure 17. Mother page explaining the purpose of ANNETTE Courses.

At the URL <http://www.enen.eu/en/projects/annette/eoi1.html>, the form for submitting applications to pilot courses is available (Figure 18). This page asks the applicant to accept data handling under the applicable European and EU Member State rules and to provide information about his/her background, professional position and also a motivation for application. This information is quite useful for accepting learners on the basis of their background, something done by each course provider in


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compliance with rules applicable at each Institution and with the principles of equal treatment with respect to gender and any other ethically relevant issue.



## APPLY TO ATTEND PILOT COURSES

[BACK TO COURSE LIST](#)

THE PERSONAL DATA COLLECTED WITH THIS FORM WILL BE KEPT CONFIDENTIAL ACCORDING TO THE NEW GDPR. THEY WILL BE HANDLED BY ENEN AND THE INTERESTED COURSE PROVIDERS ONLY FOR THE PURPOSE OF LEARNER SELECTION FOR THE ANNETTE COURSES. THE DATA WILL NOT BE TRANSFERRED FOR ANY OTHER USE WITHOUT FURTHER NOTICE TO THE LEARNER AND HIS / HER EXPLICIT ACCEPTANCE AND CAN BE DESTROYED AT ANY TIME UPON EXPLICIT REQUEST TO BE SENT TO SECRETARIAT@ENEN.EU.

ACCEPTANCE OF DATA HANDLING \* : ☐

NAME \* :

SURNAME \* :

GENDER \* : ☐

INSTITUTION \* :

E-MAIL ADDRESS \* :

ADDRESS \* :

PHONE :

NATIONALITY \* :

BSC IN :

YEAR OF BSC :

INSTITUTION RELEASING BSC :

MSC IN \* :

YEAR \* :

INSTITUTION RELEASING MSC \* :

PHD : ☐

PHD IN (COURSE TITLE AND SUBJECT) :

PHD INSTITUTION :

YEAR :

PRESENT WORKING POSITION \* :

SUPERVISOR / MENTOR (IF ANY, WITH E-MAIL ADDRESS) :

MOTIVATION FOR YOUR APPLICATION \* :

UPLOAD YOUR CV (NOT MANDATORY, PREFERABLY EUROPASS FORM) :  [Sfoglia...](#)

ANNETTE COURSE YOU ARE INTERESTED - 1 \* :

ANNETTE COURSE PROVIDER - 1 \* :

ANNETTE COURSE YOU ARE INTERESTED - 2 :

ANNETTE COURSE PROVIDER - 2 :

ANNETTE COURSE YOU ARE INTERESTED - 3 :

ANNETTE COURSE PROVIDER - 3 :

OTHER COURSES YOU ARE INTERESTED (IF ANY) :

HOW DID YOU KNOW ABOUT ANNETTE COURSES? \* :

ADD A REQUEST OF SPECIFIC INFORMATION IF NECESSARY :

TO VALIDATE YOUR COMMENT, PLEASE ANSWER TO THE FOLLOWING CALCULATION:  
 HOW MUCH IS 5 PLUS 5 ? \* :

\* : MANDATORY FIELD

[Send](#)

Figure 18. Page to apply to pilot courses

The form for collecting applications has at the moment 295 entries, corresponding to an equal number of applications, as shown in Figure 19, in which other entries, except the one of the ENEN+ Mentoring programme Institutions, have been blinded for due discretion in relation to other ENEN activities. The number of applications does not correspond exactly to the number of applicants, because some of them repeated the application for more courses and a few applications were somehow unclear or faulty. However, it must be noted that many of the proposed applications were addressing more than one course, making use of the possibility to indicate up to three choices, with the addition of an available space to indicate interest for other courses. As it will be noted later on, the number of actually occurred attendances is presently in the order of 190 for all the courses proposed under WP2, WP5 and WP6, indicating that some applicants could not finally make to participate in courses they applied to, for reasons that ranged from personal problems, to lack of economic support for the travel, to professional changes.

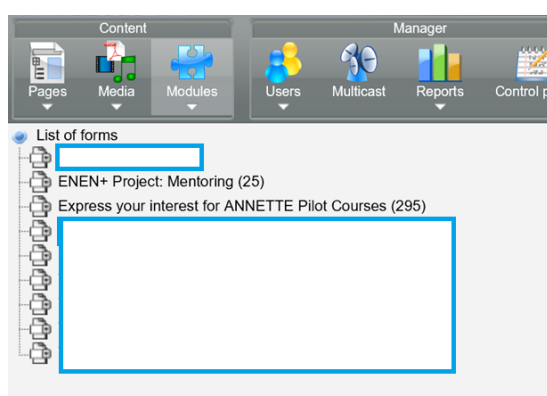


Figure 19. Record of applications to the ANNETTE Pilot Courses from the ENEN website  
(at August 1<sup>st</sup>, 2019)

### 3.2 The ANNETTE Monthly Bulletin and Facebook pages

In the aim to better spread the new about the incoming courses, the leader of WP2 felt the need to prepare a **Monthly Bulletin** (Figure 20) to be distributed to a list of distribution composed of ANNETTE Participants, ANNETTE Stakeholders, Members of ENEN, selected interested groups and to be posted also on the Facebook page of ENEN and on the other pages set up for the purpose of wider and capillary diffusion of notice about the delivery of courses. Stakeholders (i.e., the Advisory Committee and End-User Group members) generally cooperate, as they promised in the first contacts (see deliverable D2.1), by disseminating information in their environments.

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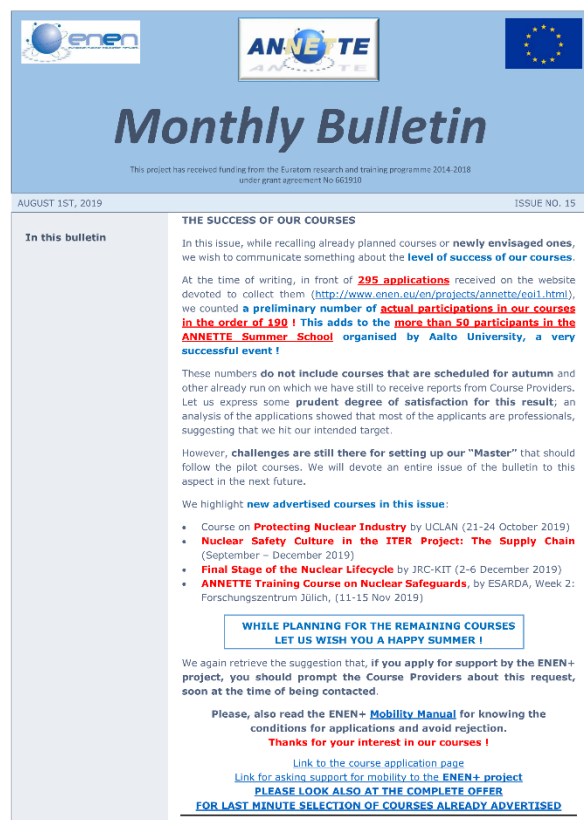


Figure 20. Front page of the latest issue of the ANNETTE Bulletin

A specific Facebook page was open by the WP2 leader for disseminating information about the ANNETTE courses. In developing this page the EC Guidance for the use of social media was attentively made [6]. This **ANNETTE Project Course Forum** (Figure 21) was also intended for exchanges among the ANNETTE applicants, though this did not actually occur notwithstanding invitations to do so. However, the page is a further tool to disseminate information about courses, which is also mirrored on the Facebook page of ENEN (<https://www.facebook.com/European-Nuclear-Education-Network-633261753351848/>) and on other Facebook pages of ENEN projects (e.g., the ENEN+ Mentorship programme). The form in which information is displayed in the Facebook pages is by “slideshows”, which can be set up by Facebook tools as little videoclips with background music; the slideshows are included in posts reporting the link to the ENEN website page where the bulletin issues can be downloaded (<http://www.enen.eu/en/projects/annette/bulletins-and-materials.html>).

At the time of writing, 15 monthly issues of the Bulletin have been issued and a few mid-month issues, motivated by urgency, were also distributed.

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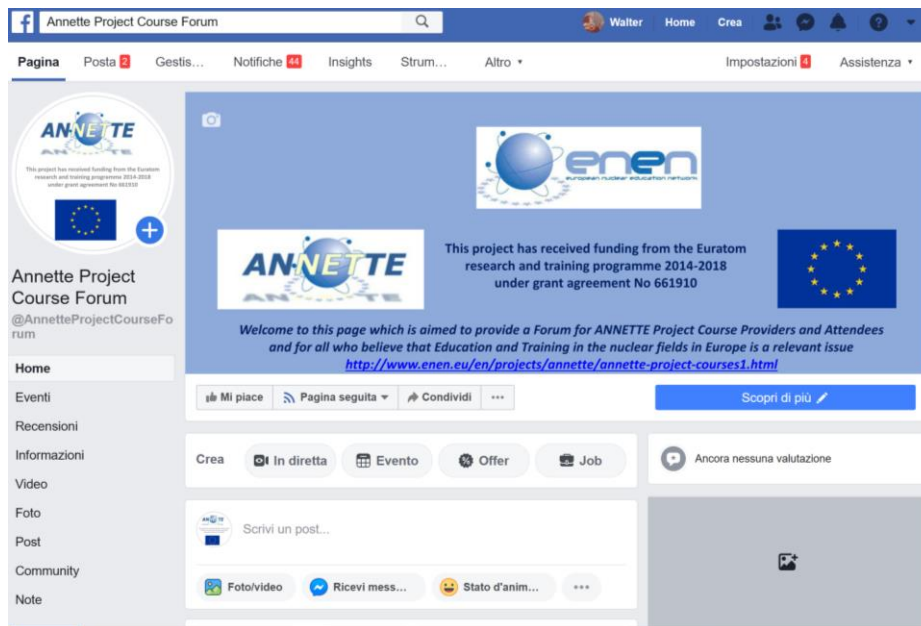


Figure 21. Facebook page of the ANNETTE Project Course Forum

### 3.3 Data on received applications: a picture of attracted persons

The data shown hereafter were elaborated from received application on July 4<sup>th</sup> 2019. So they refer to a slightly smaller number of total applications than received up to now (286 instead of 295); since this difference is rather small and the processing of data is not completely automatic, it was not considered worth to reprocess at this time the data, also considering that this will be made again before the end of the project when courses not yet run will be completed.

First information on received applications is shown in Figure 22, reporting a plot of the number of applications received each month from May 2018 to June 2019. As it can be noted a small number of applications was received in the first two months, generating possible fears of little attractiveness of the courses. Actually, a recovery in the rate of applications was observed in July and August 2018 and then declined before recovering by the end of 2018. Then, the number of applications increased again, reaching a peak in February 2019, when a very successful course by UPM and CIEMAT on waste management started to be announced. Since courses are planned also for autumn 2019 and the related announcement has been just distributed, we can hopefully expect a further recovery of the pace at which applications are received.

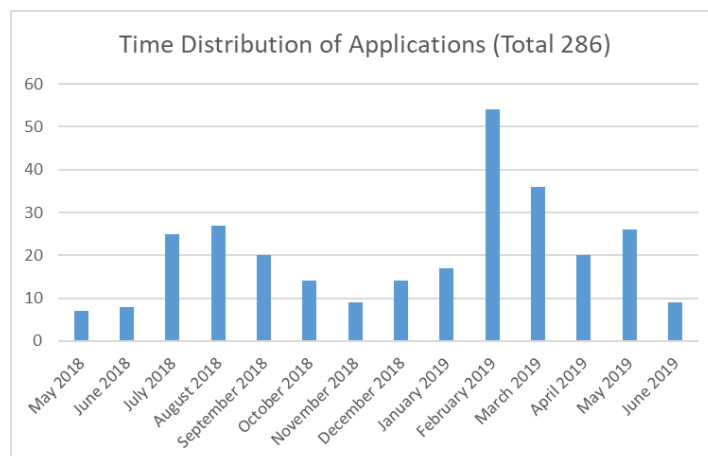


Figure 22. Number of applications received up to June 2019 by month

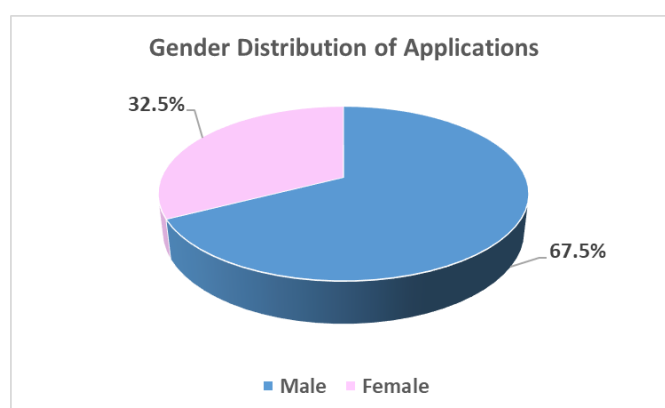


Figure 23. Distribution of applications by gender

A further interesting point is the gender distribution; Figure 23 shows that about two third of applications were received from males and one third from females. On the other hand, Figure 24 shows that the applicants were almost evenly distributed between EU and non-EU nationality, with the former prevailing slightly.

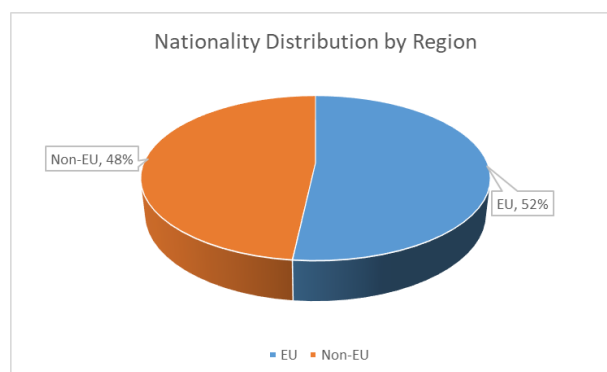


Figure 24. EU and non-EU applications



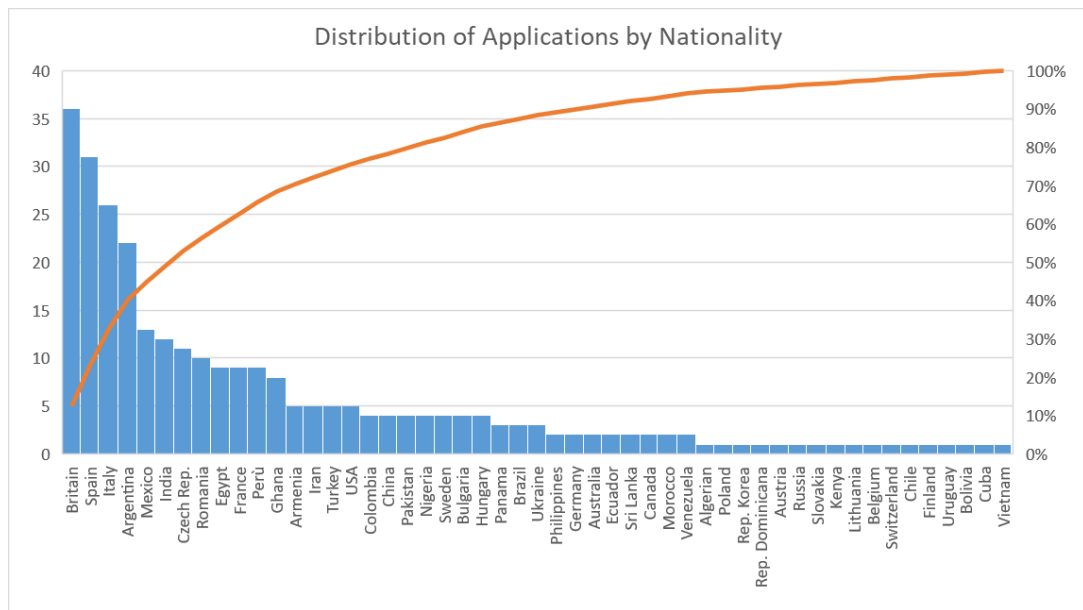


Figure 25. Distribution of applications by nationality

Considering the nationality of applicants, Britain, Spain, Italy Czech-Republic, Romania, France, Sweden, Bulgaria, Hungary, Ukraine appear in sharply decreasing order of applications the forerunners in the European geographical area, followed by Germany, Poland, Austria, Russia, Slovakia, Lithuania, Belgium, Switzerland, Finland. A prevailing part of Spanish language countries in non-EU nationalities is due to the very attractive course on Waste Management of UPM and CIEMAT, delivered in Spanish in presence and e-learning, that attracted really a large number of applicants.

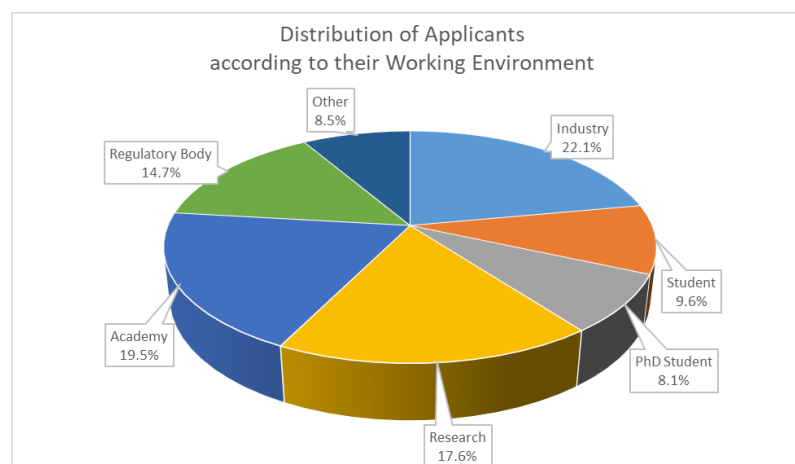


Figure 26. Distribution of applications by working environment

The distribution of applications by working environment of the applicants, shown in Figure 26, shows a prevailing fraction of professionals. In particular, Industry has a prevailing share, comparable anyway

to the two of research and academy, with a slightly lower fraction of people from regulatory bodies. PhD and MSc students represent fractions lower than 10% each one.

By the way, though a bit long to consider, also the detailed list of the professions of those who applied is quite interesting to understand which kind of professionals, academics or students have been attracted. Table 1 reports the related information, which is worth reading because it shows the level of persons who was interested in the ANNETTE Courses. As a general remark, it seems that most of them are persons already close to the nuclear environment or working in it in search of further specialisation or to make more complete their education and training. So, the population of those to be nuclearized seems a minor fraction from these data; this is coherent with the situation of a not too lively nuclear job market, in which new builds or, in general, engaging endeavours have not yet been decided. This may suggest that the flow of people to be nuclearized or made nuclear aware may come at a moment in which the market is more lively, with a possible rush of non-nuclear professionals to acquire competences in the nuclear field. This confirms the “critical” character of the group of professionals to be nuclearized as depicted in the desk research of deliverable D2.1: these professionals will be needed suddenly at the time of request and there could be bottlenecks in their supply caused by their employment in competing sectors.

Similar information can be obtained by Table 2, indicating, again in alphabetic order (to avoid any possibility to connect these data to physical persons), the Institutions which the applicants belong to. This information confirms that most of the applicants come from nuclear organisations, being in search of further competences or to deepen the ones they have already. This also confirms what said before on nuclearized and nuclear aware personnel, being possibly a minority.

Indeed, the described data do represent only the “interested population” of applicants. It is not useless to consider this material because it represents the global population of those attracted by the ANNETTE courses, providing insight into the present “request” of courses.

Table 1. Working position of the persons who applied<sup>3</sup>

Present Working Position
Acting Head of Safeguards
Administrator
Analysis and Code Group Leader
Arms Control Scientist
Assembly /... / Codes and Standards Project Engineer
Assistant Chief Regulatory Officer (Deputy Manager)
Assistant in Radioactive Waste Management
Assistant Professor
Associate Nuclear Engineer
Associate Professor
Business Development Management
C&I Responsible Engineer
Chief Operations Research Scientist
Chief research associate
Chief Scientific Officer
Configuration Manager
consulting, professor
CONSULTOR AMBIENTAL
Co-op Student at ...
Criticality Assessor
Decommissioning and Radwaste Management Engineer
Department Chair
Department Head
Deputy Director General
Deputy Head of Nuclear Non-Proliferation Dept., Safeguards Inspector
Design Authority Project Manager
Design engineer in apprenticeship
Design Knowledge Manager, Design Authority
DIRECTOR DE OPERACIONES
dismantling area
docente
Docente
DOKTORAND
Engineer
Engineer Nuclear Safety, I&C engineering
Engineering Manager
Environment Engineer
Environment Engineer in NPP
FISICO MEDICO

<sup>(3)</sup> The list in alphabetic order and the removal of the indication of companies makes impossible to identify relevant information of the single applicants by any cross check.

Fisico Medico Asistente
Gerente/Académico
Graduate (Master's Degree) Student
Graduate Research Intern at ...
head of Radiation protection unit
Head of Safeguards ...
Head of Security
in charge of international activities and training related to nuclear safeguards and nuclear security
Ingeniería de Procesos - ...
Ingeniero
INGENIERO QUIMICA ASIGNADA AL DEPARTAMENTO DE DESECHOS RADIATIVOS
Inspector
Inspector
Inspector de instalaciones gestadoras de residuos radiactivos
Inspector de residuos radiactivos y desmantelamiento
Inspector for Non-Nuclear Proliferation
Instructora
Intern
International Institutions
Investigador
Jefe de Div. Inspección, Asistencia Técnica y Desmantelamiento - ...
JEFE DE DIVISIÓN CARACTERIZACIÓN DE RESIDUOS RADIATIVOS
Jefe de Protección Radiológica en Planta de Producción de Radioisótopos
Jefe de Seguridad -AGE- CNEA
Jefe Departamento
Laboratory technician at the dosimetry service at JRC-Ispra
Laboratory technician for the dosimetry service of JRC-Ispra
Lead Engineer Balance of Plant
Lead Mechanical Engineer
Leader of Research, innovation and development technology
Learning Expert in the department of radiochemical technologies of spent nuclear fuel reprocessing
Lecturer
Lecturer
Licensing Engineer
Licensing Manager
Managing partner
Master's student
Material Engineer
Materials Engineer
Materials Engineer
Materials Specialist
medica de planta
Medical physicist and member of the Radiological Protection committee of the hospital (opr)
medico staff
N/A

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N/A
N/A
Nuclear Criticality Safety Engineer - Nuclear Fuel Fabrication Plant Supervisor
Nuclear Criticality Safety Engineer - Nuclear Fuel Fabrication Plant Supervisor
nuclear engineering
Nuclear Fuel Researcher
Nuclear PSA Engineer
Nuclear Regulator
NUCLEAR REGULATORY OFFICER, SAFEGUARDS DIVISION
Nuclear Research in ...
Nuclear Safeguards Inspector, Head of Unit, State Office for Nuclear Safety
Nuclear Safety Engineer
Nuclear Safety Engineer
Nuclear Safety Researcher
Nuclear Safety Researcher
NUCLEAR SAFETY RESEARCHER
Nuclear Safety Technical Leader
Nuclear Security and Safeguards Inspector/expert
NUCLEAR TECHNOLOGIST
Oficial de protección radiológica
Oficial de Radioprotección
OFICIAL DE SEGURIDAD RADIOLOGICA
OFICIAL SUBALTERNO
Ph.D Student
Ph.D student
Ph.D. Research Fellow
PhD at ...
Phd Candidate
PhD in ...
PhD Researcher
PhD researcher/student starting October 1,2018
PhD student
PhD Student
PhD Student
PhD student
PhD student
PhD student
PhD student
PhD student
Phd Student / second year
PhD student and Technical Assistant
PhD student at Technical University of Denmark Center for Nuclear Technologies
PhD student at the Fusion Technology Division in CIEMAT
PhD student, researcher
Physicist

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PHYSICIST
Physicist
Physicist
Physics lab engineer -radiation safety officer
Physics lab engineer -radiation safety officer
Posdoctoral researcher
Postdoc
Postdoc
POSTDOC
Postdoc researcher
Postgraduate student in Radiation Protection and Source Management
Practicante
Principal Adviser
Professor
Professor
professor of physics
Project Manager in ...
Project Manager in Decommissioning
Project Trainee at ...
Quality Manager...
Radiation Protection Advisor
Radiation Protection Advisor, Radiological Consultant
Radiation Protection Expert
Radiation protection laboratory technician
RADIATION PROTECTION WORKER
Radiation safety lecturer / RPA
Radiation Safety Specialist
Radioactive Waste Advisor
Radioactive Waste Supervisor
Radiochemistry Division Responsable
Radiofisico
Radiologa
Radiological alert network technician
Radiological Monitoring Specialist
Radiological protection technician
Radiological Services Department Head
Regulatory Officer
Research
Research Analyst
RESEARCH ASSISTANT
Research Assistant
Research Associate
Research consultant
Research Fellow
Research Intern

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Research Intern at ...
Research Scientist
Research Scientist
Research Scientist
Researcher
Researcher
Researcher
Researcher
Researcher
Researcher & CEO
Researcher at the ...
Researcher in the Nuclear Physics Group at ...
Researcher Junior
Researcher on safeguards.
Researcher on safeguards.
Researcher, National Institute of (Non nuclear body)
Researcher-laboratory assistant
Responsable de protección radiológica y transporte de radiaciones- Depto de ingeniería nuclear
Responsible Mechanical Engineer
RESPONSIBLE OF PREVENTION AND PROTECTION SERVICE
Safety Case Manager
Safety Case Manager
Sales and Product Manager
Scientific Advisor
Scientific collaborator
SCIENTIFIC OFFICER
Searching for employment
Senior Adviser - Radioactive Waste Safety
Senior Advisor
Senior Consultant (Radioactive Waste Management)
Senior Expert
Senior Lecturer
Senior Mechanical Engineer
Senior Mechanical Engineer
Senior Mechanical Substantiation Engineer
Senior Nuclear Analyst within the Power Plant and Technology Group
Senior Nuclear Safety Engineer
Senior Program Manager ... R&D Safeguards
Senior safety advisor
Senior safety advisor
Senior scientific researcher, associate professor
Site Remediation Technical, Sellafield Ltd
Site/Operation Manager
Spent Nuclear Fuel Engineer
Staff Scientist

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Student
Student
Student
Student
Student
STUDENT
Student
Student
Student
STUDENT
Student
Student
Student
Student
student
student
Student
Student
Student
student
Student in M1 entering M2
STUDENT, TECHNICAL UNIVERSITY ...
Supervisor
Teaching Assistant
Technical Co-op Student at the ...
Technical Graduate
Technical Graduate Scientist
Technical Specialist Ecology and HRA compliance
Technical Specialist EIA compliance
Technical Support Tecnonuclear
Technician
TECHNOLOGIST - QUALITY CONTROL DEPARTMENT - RADIOPHARMACY CENTER (...)
Técnica en Radiología y en Terapia Radiante.
Técnica Radiologa
Tecnico
Técnico en las áreas de tomografía, Rx, gammagrafía, resonancia
Técnico Superior de Investigación
Técnico, Oficial a cargo de respuesta a emergencias.
Tecnólogo médico en radiología
Theoretical Scientist
Thermal-Hydraulic, Reliability and Safety Engineer
Unemployed
Unemployed
Unit Shift Supervisor
UNIVERSITY OF ...

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Table 2. Institutions which the applicants belong to <sup>(4)</sup>

Institution
"Sapienza" University of Rome
1JSC A.A. Bochvar VNIINM
507 energy solutions, Universidad Especializada de las Américas
ACPRO
AGH University of Science and Technology
Alexandria University
Ansaldo Nucleare SpA
Ansaldo Nucleare SpA
ANSALDO NUCLEARE SPA
ANSTO
Autoridad Regulatoria Nuclear
AWE
AWE Ltd
Brno University of Technology
Brookhaven National Laboratory
Bundesgesellschaft für Endlagerung BGE
CAEN SyS srl
Center for Ecological-Noosphere studies of NAS RA
Center for Ecological-Noosphere studies of NAS RA
CENTRE FOR NUCLEAR ENERGY STUDIES UNIVERSITY OF PORT HARCOURT, PORT HARCOURT.
Centre for Pakistan and Gulf Studies (CPGS)
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT)
Centro de Radioterapia Oncologica del Norte
Centro Fermi - Museo storico della fisica e centro studi e ricerche "Enrico Fermi"
Cerap
Chilean Nuclear Energy Commission
China Institute of Atomic Energy
China Institute of Atomic Energy
China Institute of Atomic Energy
CIEMAT
CIEMAT
CIEMAT
CIEMAT
CIEMAT
CIEMAT
CIEMAT - Universidad Politecnica de Madrid
Clínica San Pablo
Comisión Federal de Electricidad
COMISION NACIONAL DE ENERGIA ATOMICA

<sup>(4)</sup> Again, the list in alphabetic order and the removal sensible details makes impossible to identify relevant information of the single applicants by any cross check.

Comisión nacional de energía atómica
Comisión Nacional de Energía Atómica - P.N.G.R.R
Comisión Nacional de Energía Atómica (Argentina)
Comisión Nacional de Energía Atómica (Argentina)
Comisión Nacional de Energía Atomica- Argentina
Comisión Nacional de Energía Atómica-Programa Nacional de Gestión de Residuos Radiactivos -Argentina
CONSORZIO RFX
Conorzio RFX
Czech Technical University in Prague
Czech Technical University in Prague
Czech Technical University in Prague
Diagnostico medico orño
DNR FNSPE CTU
DOSITRACKER LTD.
Ecole CentraleSupelec
Egyptian Atomic Energy Authority
Egyptian Atomic Energy Authority
EL BAYADH university
EMPRESA NET2NORTH SRL
ENUSA
Enusa Industrias Avanzadas S.A. S.M.E
Enusa Industrias Avanzadas S.A. S.M.E
ENUSA Industrias Avanzadas S.A.S.M.E
Environment Agency
Environment Agency
Escuela Politécnica de Mieres, Universidad de Oviedo
España
European Commission, Joint Research Centre
Federal Agency for Nuclear Control
FENNOVOIMA Oy
Framatome
Framatome
Fusion for energy
Fusion for energy
Fusion for Energy - ITER
GENERALITAT DE CATALUNYA
Ghana Atomic Energy Commission
Graduated from Kyung Hee University
Graduated from Kyung Hee University
Haward tech
Hospital
Hospital
hospital de oncology maria curie
Hospital Eva Perón (ex castex) San Martin
HOSPITAL JOSE CARRASCO ARTEAGA

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Hospital Nacional Edgardo Rebagliati Martins
Hospital Nacional Edgardo Rebagliati Martins
Hospital Nacional Edgardo Rebagliati Martins
Hospital Nacional Edgardo Rebagliati Martins
Hungarian Academy of Sciences Centre for Energy Research
Hungarian Academy of Sciences, Centre for Energy Research
Hungarian Academy of Sciences, Centre for Energy Research
Hungarian Atomic Energy Authority
IAEA
IFIC, CSIC y Universitat de València
IFIN - HH
IMT Atlantique
IMT Atlantique
IMT Atlantique, Nantes Campus, France
INE
Institut Supérieur des Techniques de la Performance (ISTP) / Electricité De France (EDF)
INSTITUTO NACIONAL DE INVESTIGACIONES NUCLEARES
Instituto Peruano de Energía Nuclear
Instituto Tecnológico y de Estudios Superiores de Monterrey
Instituto Tecnológico y de Estudios Superiores de Monterrey
Instituto Tecnológico y de Estudios Superiores de Monterrey
INSTN
International CBRN Risk Mitigation Center
INVAP
INVAP S. E.
INVAP.SE
IRSN
Istanbul Technical University
Istanbul Technical University
Istanbul Technical University
ISTP - Mines Saint Etienne
ISTP Ecole des mines de saint etienne
JRC- Ispra site
JRC-Ispra
K2TIME ENG
Karlsruhe Institute of Technology - Institute for Nuclear Waste Disposal
Karlsruhe Institute of Technology (KIT)
Karlsruher Institut für Technologie - Institut für Neutronenphysik und Reaktortechnik (KIT-INR)
KENYATTA UNIVERSITY
Khmelnitsky NPP
Korea Atomic Energy Research Institute
KYH Royal Institute of Technology
Kyung Hee University (LAST ATTENDED, GRADUATED IN FEBRUARY, 2018)
La Sapienza
Lithuanian Energy Institute

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NuGeneration Ltd
NuGeneration Ltd
Nuvia
OKG AB
OKG AB
Orano
Pacific Northwest National Laboratory
Pacific Northwest National Laboratory
Pandit Deendayal Petroleum University
PANDIT DEENDAYAL PETROLEUM UNIVERSITY
POLICÍA FEDERAL ARGENTINA
POLICÍA FEDERAL ARGENTINA
Policía Federal Argentina
Politecnico di Milano
politecnico di milano
POLITECNICO DI MILANO
POLYTECHNIC UNIVERSITY OF CATALONIA
Radiochemistry and Environmental Radiology Laboratory, University of Granada
Radiólogo tecnólogo
Research Centre Rez
Royal Military College of Canada
Royal Military College of Canada
Science and Research Branch, Islamic Azad University
SCK-CEN
Sellafield Ltd, University of Liverpool Alumnus
SENA
Servicio Nacional de Aprendizaje - SENA
State Nuclear Security Technology Center (SNSTC)
State Office for Nuclear Safety
State Office for Nuclear Safety
State Office for Nuclear Safety
State Office for Nuclear Safety, Czech Republic
Stimson Center
STUK
Swiss Federal Office of Energy
TECHNICAL UNIVERSITY BERLIN
TECHNICAL UNIVERSITY BERLIN
TECHNICAL UNIVERSITY BERLIN
Technical University of Denmark Center for Nuclear Technologies
Tecnatom S.A.
Tecnuclear
The Institution of Engineering and Technology
The University of Manchester
UAEMex
UK Atomic Energy Authority

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UK Atomic Energy Authority
UKAEA
United Kingdom
Universidad Autonoma Juan Misael Saracho
UNIVERSIDAD CENTROCCIDENTAL LISANDRO ALVARADO
Universidad Complutense de Madrid
Universidad Complutense de Madrid
UNIVERSIDAD DE INGENIERIA
Universidad de Oviedo
Universidad Especializadas de las Américas
Universidad Europea de Valencia
Universidad Nacional Autónoma de México
Universidad Nacional Autónoma de México
Universidad Nacional Autónoma de México
Universidad Nacional de Colombia
Universidad Nacional de Educación a Distancia
Universidad Nacional de La Plata
Universidad nacional del nordeste
Universidad Nacional mayor de San Marcos
Universidad Veracruzana
Universidad Veracruzana
Università degli Studi di Genova
Università di Roma La Sapienza - (CIRTEN member)
Università La Sapienza
Universitat Politècnica Catalunya (Barcelona)/ Paris Saclay
universitat politècnica de valència
Universitat Rovira i Virgili
Universite Paris-Sud
Universite Paris-Sud
University of Extremadura
University of Granada
University of Ibn Tofail
University of Ibn Tofail
University of Palermo
University of Paris-Saclay
University of Paris-Saclay ( Ecole CentraleSupelec)
University of Pisa
University of Pisa
University of Pisa
University of Pisa
University of Pisa
University of Pisa
University of Pisa
University of Rome La Sapienza
University of West Bohemia

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University of West Bohemia
University of West Bohemia
University Paris Saclay
University Sains Malaysia
UPC-BarcelonaTech
UPC-BarcelonaTech
UPC-BarcelonaTech
UPPSALA UNIVERSITET
Uppsala University
Uppsala University
Urenco UK
USA DOE NNSA DNN R&D
V.N.Karazin Kharkiv National University
Westinghouse Springfields
Wood Plc
Yalova Üniversitesi
Yalova University
Zewail city of science and technology

In this regard, it is very interesting to consider the “motivations” proposed by the applicants while asking to be enrolled in the courses. A random selection of them is reported hereafter, in an anonymised form and without connection with any order of appearance in the previous tables of the related professions and Institutions.

- *“As I was performing the duties of my role, I was faced with **a scarcity of technical trainings about nuclear security concerns** that might helped me deepen my knowledge about the several aspects of nuclear security and safeguards including prevention, transportation, accountancy and inventory control. Therefore, I am motivated to attend pilot course programme 2018-2019. Graduate Fellows Program in order to gain greater knowledge in nuclear security and create a network of women leaders who would help spread awareness about nuclear security issues.”*
- *“**Extend, upgrade and deepen my education and knowledge in the nuclear field.**”*
- *“I want to **increase my knowledge in the field of nuclear energy and learn about the various advanced techniques in this field.** I live in developing countries and I don't have the ability to attend classes at this level.”*
- *“I would like **to continue my professional development** as a radiation protection professional and learn especially about more European practices.”*
- *“I have over nine years' experience in the environmental measurements of radioactivity levels in lakes, and I believe the knowledge and skills built up during this time make me the right/perfect candidate for School. (...) I have been responsible for environmental measurements of radioactivity levels in aquatic system.(...) In addition; we used naturally-occurring radioisotopes application as geochemical tracers like radium isotopes and radon to estimate the quantification groundwater discharge into lake. **Overall, I think these courses are exactly tailored for my wishes in line of my previous experience.**”*
- *“**It is a good chance to gain new skills and develop knowledge as a future specialist.** (...) Such programmes are a good opportunity both for the students and researchers, who are interested in Radioecology and Radiation protection.”*
- *“The newly launched series of courses under the auspices of the ANNETTE Project is perfectly matching **my strong desire not only to refresh but also to deepen and expand my understanding on topical knowledge areas** in that are of particular interest to me.”*

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- *"I am **very interested in laboratory work**, and I think that it is very important to understand the principles of spent fuel, nuclear waste repository and Nuclear Fuel Cycle at the level of nuclear chemistry it can lead scientists to many findings crucial for the understanding of the nuclear and repository issues."*
- *"**The opportunity to be taught by experts** within their field is both exciting and inspiring."*
- *"**I believe intensive courses and meeting professionals from the field give one a great opportunity to deepen the specific knowledge.**"*
- *"**I like the fact that the courses are in one to two weeks**, so it is very intensive and that we get to meet the professionals from other universities as well as other students. My main goal is, after attending these courses, using the knowledge in research at my home university (...)"*
- *"It is **a very good opportunity to get new interesting knowledge and meet with experts**. And also it is very important for my dissertation."*
- *"The first time, I have seen ANNETTE pilot courses on Facebook page of ANNETTE program. It impressed me due to gaining various nuclear institutions around Europe for this program and offering vital topics of Nuclear Technology with **free of charge**. I assume myself as lucky for bumping into your Facebook page."*
- *"**I still need to enhance this competence and confidence through further career development** which I'm sure your programme can provide."*
- *"**To deepen my understanding of nuclear reactor theory and advanced reactor physics related topics**"*
- *"**Upskilling & motivation of technical employees in this strategic pause.**"*
- *"This training will give me **confidence when managing Stakeholders including regulators**"*
- *"As a mechanical engineer starting a PhD in reactor physics at the (...) University, **I do lack academic knowledge in reactor physics**. (...) doesn't provide any course in reactor physics at the moment. That's why I would like to benefit from one of the two courses (because the timeslots are incompatible) that I listed below."*
- *"**I am always keen to pursue available opportunities to develop my skills and knowledge through Continued Professional Development (CPD)**".*
- *"I have over nine years' experience in the environmental measurements of radioactivity levels in lakes, and I believe the knowledge and skills built up during this time make me the right/perfect candidate for School."*
- *"**I would like to expand and strengthen my current knowledge and understanding** of the various topical aspects related to nuclear safeguards and non-proliferation, (...)"*
- *"**I recently moved jobs from severe accidents to criticality assessor role which naturally involves criticality assessment and safety along with the assistance in production of nuclear safety cases.**"*
- *"During the past six months, I have learned and acquired knowledge about the nuclear fuel, the fuel cycle and the technical aspects of creating nuclear energy. Furthermore, I have gained knowledge and experience in non-proliferation activities. (...) My main motivation is, therefore, **to learn as much as I can during these two weeks, and I hope to broaden my knowledge about non-proliferation and nuclear safeguards.**"*
- *"**To better understand the role of nuclear regulation in research project design**, especially in regard to the standardisation of new techniques for probabilistic safety analysis in materials performance."*
- *"I am interested in the proposed topics, both **to deepen arguments already known for the work I do, and for some topics not very well known to me yet.**"*
- *"My goal from attending these courses is **to gain more knowledge** about the radiation protection aspects and radioactive wastes management requirements. Also, I'd like to improve my radiation protection research skills and interests especially in the radioecology and environmental protection requirements."*
- *"On top of sales and marketing, I took the responsibility of the Decommissioning, Dismantling and Nuclear Waste Management product line of the new division as product manager. Relying on a strong experience in nuclear measurement, **I would like to improve my understanding of the Nuclear Waste Management** to have a magnified view of its processes, challenges and potential needs. I trust attending ANNETTE courses can definitely help me in gaining a more solid knowledge base of this field."*
- *"**Refresh of knowledge in radiation protection domain**"*
- *"I want to **improve and to increase my acknowledgments about nuclear physics fields**. I want to improve my career opportunities."*
- *"I recently graduated as a Medical Physicist, so during my career I learned about the theory and different uses of ionizing radiation. I **now find myself interested in learning about waste management in this type of applications**, as well as in new ones that were not covered during my formation, such as nuclear reactor installations."*
- *"**Improve my work, and my technical skills**"*

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- *"As a Radiation Safety Officer, I want to continue to expand my knowledge and experience within the work area of decommissioning, because I want to be part of the teams that help to reduce and control the nuclear waste in the world."*
- *"I believe that the management of radioactive waste is one of the most important parts of the use of nuclear energy, so I would like to specialize in this topic."*
- *"It is very important to keep up to date in order to be able to adapt to short term nuclear industry future."*
- *"As part of my educational and professional development I would like to increase my knowledge of the science and technology involved in nuclear reactors, advanced reactors and concepts relating to nuclear safety. I also would like to increase my knowledge of radiation protection principles applied to different situations."*
- *"I have been in the radioactivity world for more than 4 years, and I have devoted myself to it professionally for more than 1 year. I think this course can help me to advance professionally and more taking into account that waste management is very important."*
- *"In [my non-EU Country], there is a need for better radiation protection regulatory control, more trained staff in the regulatory issues as well as more women working in the radiation protection field".*
- *"To learn more about the nuclear fuel cycle as it can be applied to our work in researching risks/vulnerabilities associated with safeguards."*
- *"As developer of the measurement methods for nuclear materials, I am interested in these topics. I take part on Safeguards inspections in my country regularly."*
- *"New in this field and want to increase my knowledge to help the authority. Improving in this area will help develop human resource for the progress of the authority."*
- *"Above all this program will enable me to improve myself in the area of radiation protection and also an interesting opportunity for me to be well as equip to come back home and impact same knowledge to my colleagues and subordinates."*
- *"(...) I am confident that I will have the skills, knowledge and contacts that will enable me to acquire knowledge for my project work in my MSc Geophysical Engineering project work which is on borehole disposal of nuclear low level waste."*
- *"At this moment in time, my research activity is mainly focussed on the assessment of the safety DEMO reactor system performances. (...) I am very confident that the proposed training course, aimed at impart specific knowledge on nuclear licensing and the impact of licensing requirements on the design as well as on subsequent down-stream activities will boost my human and scientific capabilities, offering me the possibility to give a fruitful contribution to the DEMO development."*
- *"After years of safe operation of a nuclear facility, I feel the passion to learn more about Human Factor in the nuclear industry."*

As it can be noted, the random collection of sentences from the motivations of applicants mainly suggests the need for persons working in the nuclear field to improve, refresh or deepen their knowledge and skills in this matter. The collection could be expanded to a broader level, though the main traits of the contacted population are believed to be represented in the above random selection.

The way in which this population of applicants was reached is also interesting to comment (Figure 27). It seems, in fact, that a half of the applicants were informed on the working place by supervisors or colleagues. This would (possibly) support the idea of a mechanism of "coaching", in which on the working place people receives suggestions about their lifelong learning paths. If so, this would stimulate to contact relevant Institutions (from Research, Industry, Academy, etc.) to efficiently communicate the issuing of courses, thus stimulating to send employees and young researchers to participate. Lower fractions of applicants knew about the courses through the web or by ENEN members. It is a pity that the possible choices in the form did not include the "Bulletin", since they were conceived before its conception.

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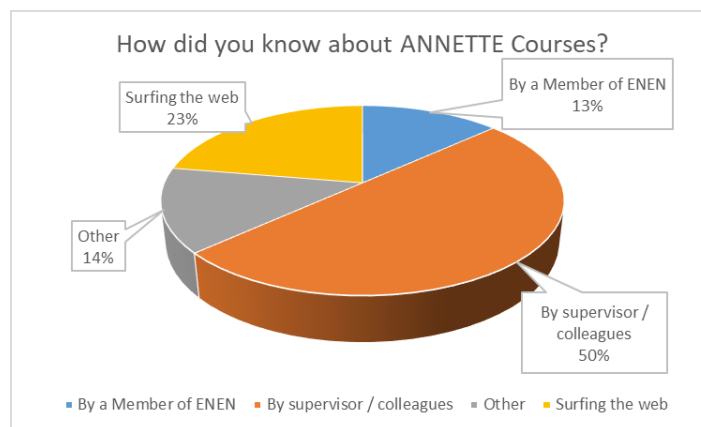


Figure 27. Ways in which the population of applicants knew about ANNETTE courses

### 3.4 Data on the actual attendees in ANNETTE courses

Table 3 and Table 4 summarise the data related to the actual attendance to courses delivered in the frame of the ANNETTE project on which it was possible to get information from course providers at the time of writing (August 2019). As mentioned, the amount of data collected are depending on the number of Course Reports (see below) received to date for courses already run and there is an obvious lack of information on courses planned for Autumn. These data will be updated in further reports (D2.5) and are introduced here in order to draw first conclusions by the month 44 of the project, when this report is due.

As it can be noted, the number of attendances (which does not mean number of attendees because of a few multiple attendances in various courses) is nearly 190. Actually at the time of writing, Course Reports on the attendants at the two last courses listed in the table are still waited, so it was not possible to elaborate the related data. Moreover, courses to be run in Autumn will add additional information. In this version it was possible to consider data only for around 120 attendances, on which course reports have been received. Unfortunately, it was also discovered by a cross check that a few actual participants did not enrol on the ANNETTE website, something on which it was already asked for compensation, so their data cannot be elaborated at this very time and will be in the future.

The above mentioned Course Reports are asked to each course provider in the form reported in Figure 28, in order to summarise the main relevant data about the course and its participants. Such reports allow to judge about the success of the course and draw conclusions in view of a future better customisation of the offer.

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Table 3. Courses actually run up to now in the frame of WP2, WP5 and WP6 (part 1)

Course Title	No. Of ANNETTE Attendants
<b>UL &amp; UPM</b> Geological disposal, PETRUS course, e-learning 18-22 June 2018	2
<b>University of Pisa</b> Single and Two-Phase Thermalhydraulics e-learning, available since September 2018	15
<b>The University of Manchester</b> N03 Radiation & Radiological Protection 10 – 14 September 2018	1
<b>INSTN-CEA/Cadarache, France</b> Basic Operation of Nuclear Reactors September 24th – 28th, 2018	6
<b>The University of Manchester</b> N06 Reactor Materials and Lifetime Behaviour 8 – 12 October 2018	3
<b>Department of Nuclear Reactors, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University of Prague</b> Training Course on Reactor Physics 15th to 19th of October 2018	2
<b>The University of Manchester</b> N09 Policy, Regulation and Licensing 22 – 26 October 2018	2
<b>“Horia Hulubei” National Institute for Physics and Nuclear Engineering (IFIN – HH)</b> Radon and its radiological impact Lecturer: Maria Sahagia, PhD 22 - 24 October 2018	6
<b>Teaching module co-organized by the Karlsruhe Institute of Technology, KIT, and the Karlsruhe site of the Joint Research Centre, JRC</b> “Nuclear Fuel – from Cradle to Grave” October 8th to 12th, 2018	14
<b>University of Central Lancashire</b> N02 Nuclear Fuel Cycle 12 – 16 November 2018	5

Table 4. Courses actually run up to now in the frame of WP2, WP5 and WP6 (part 2)

Course Title	No. Of ANNETTE Attendants
<b>BNEN - Belgian Nuclear higher Education Network (Location SCK•CEN, Belgium)</b> Nuclear thermal hydraulics December 3 – 14, 2018	1
<b>INSTN-CEA/Saclay, France</b> Thermal Hydraulic for Light Water Reactors January 14-18, 2019	3
<b>INSTN-CEA/Saclay, France</b> Materials for Nuclear Reactors, Fuels and Structures January 21-25, 2019	5
<b>INSTN-CEA/Cadarache, France</b> Reactor core physics: deterministic and Monte Carlo codes January 21-25, 2019	5
<b>UPPSALA UNIVERSITY</b> Course on Man-Technology-Organisation/Human Factors for Nuclear Safety including Virtual Reality Resources as part of Safety Culture (6 ECTS) November 5 – December 21, 2018	4
<b>SCK•CEN- ESARDA</b> Course on Nuclear Safeguards February 4-8, 2019	5
<b>FuseNet</b> Nuclear Safety Culture in the ITER Project: the Supply Chain March 19th until April 30th 2019	25
<b>Framatome</b> Nuclear Regulation and its Application in Nuclear Projects February 11th and 12th , 2019	10
<b>ESARDA - SCK-CEN</b> Workshop on “Safeguarding the nuclear fuel cycle” 13th May 2019 - Stresa, Italy	20
<b>“Horia Hulubei” National Institute for Physics and Nuclear Engineering (IFIN – HH)</b> Principles of Radiation Protection. International Framework. Regulatory Control - Elearning Lecturers: Mrs. Gabriela Rosca-Fartat Mr. Gabriel Stanescu, PhD October 2018 – June 2019	8
<b>Framatome - KIT - Dr. Victor Sanchez-Espinoza</b> Design Basis Accidents for Light Water reactors and Numerical Simulation Tools May 20th to 22th, 2019	7
<b>UPM &amp; CIEMAT (semester course in Spanish starting from March 2019)</b> Course on Radioactive Waste Management - both in presence and e-learning	25
<b>UL &amp; UPM</b> Geological Disposal , PETRUS course, e-learning 17-21 June 2019	14
<b>TOTAL</b>	<b>188</b>



SHORT REPORT ON COURSE ATTENDANCE AND RESULTS

(COURSE PROVIDER)

(COURSE NAME)

(Date of course delivery)

COURSE ATTENDANTS ON BEHALF OF ANNETTE

No	Name and surname	Nationality	Affiliation	E-mail address	Notes (if needed, e.g. partial attendance)
1					
2					
3					
4					
5					

(add as many rows as necessary)

Certification or attestation released to attendants at the end of the course

(describe)

FREE NOTES ON COURSE SUCCESS

(Participation in activities by the attendees, level of interest, overall results of the final examinations, any further specific issue considered of interest for the evaluation of the courses)

Place and Date

Filled for the course provider by: (Name Surname)

Figure 28. Template for short course reporting

Because of the mentioned incompleteness of data at the moment, only a few data about the presently known attendance will be shown hereafter, deferring to a later version of the report further refinements.

Concerning gender distribution of actual attendants, Figure 29 suggests that it closely replicates the 1/3 females to 2/3 males proportion found in the applications. The regional distribution (EU or non-EU), instead, is substantially different than for applications, because the fraction of non-EU has decreases from almost 50% in applications to 23% in attendances; this information must be considered in view of two aspects:

- it is probable that non-EU applicants found more difficult to finance their travel to Europe, even if it was suggested to make use of the opportunities offered by the ENEN+ project;

- the elaborated records do not yet contain the fraction of Latin American attendants to the Course on Waste Management by UPM and CIEMAT; so the non-EU percentage can slightly increase.

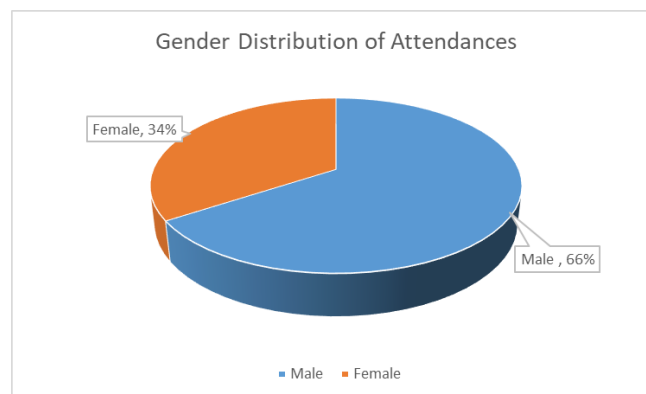


Figure 29. Gender distribution of attendances (known data at August 2019)

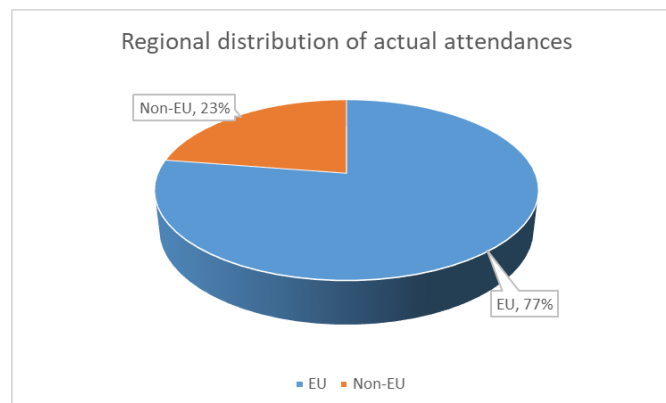


Figure 30. Regional distribution of attendances (known data at August 2019)

On the other hand, it can be noted (Figure 31) that the working environment of the attendants identifies mostly professionals, coming from research, industry, academy and regulatory bodies (for a total share of 65%, while adding PhD students and other we reach 80%: the target audience seems to be the addressed one.

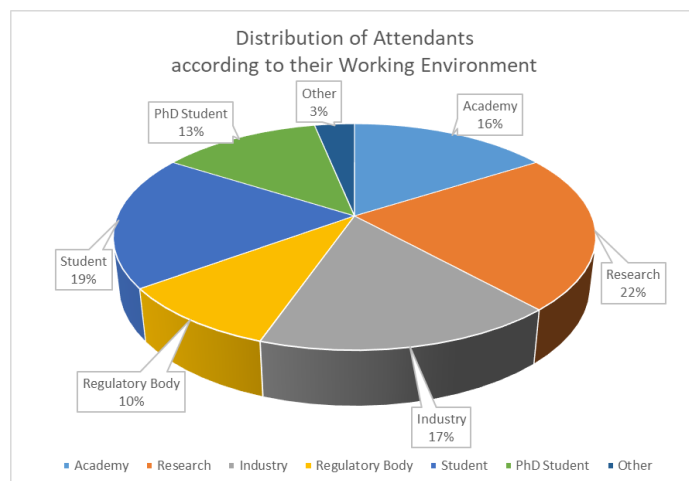


Figure 31. Working environment of attendants (known data at August 2019)

### 3.5 Preliminary Conclusions on Pilot Courses

While waiting for more data to be processed, some preliminary considerations can be already drawn from the presented material:

- The number of received applications (up to now) already exceeds by far what expected when the ANNETTE proposal was conceived. As mentioned in the introduction, in this particular historical period it is easy to get a very little attendance and interest for nuclear courses, making useless the efforts spent in setting up qualified and resource consuming courses.
- The number of attendances is again relatively large, again with respect to initial fears. This, of course, does not suggest that there are no problems in recruiting people for the future nuclear workforce, but at least reveals that there is still interest for nuclear matters and specifically for the courses offered by ANNETTE.
- Indeed, the fact that pilot courses were delivered for free by Course Providers had a role in this result. Courses requiring to pay fees would have possibly been less attractive in this period and this poses a challenge for future sustainability.
- The attendees, as already noted in considering the applications, are mostly coming from a population of people already involved in nuclear matters, who are in search of deepening or broadening their competences in the field. As said, for personnel to be nuclearized or made nuclear aware it will be necessary to wait for a clear offer of jobs from industry to record a corresponding request for courses: this underlines more and more the critical nature of this share of the workforce in case of new builds, since it will be needed to quickly collect and train “on demand” huge populations of professionals, something risky and difficult to achieve in competition with other sectors.
- Some courses, e.g., the ones delivered by Manchester University, UCLAN and, in general, NTEC, had a few attendants just because of limitations in the number of places reserved to the ANNETTE project; however they were highly appreciated and frequently requested.
- Other courses were also selected by attendees in reasonably large numbers but, in the end, people was unable to participate for different reasons. In one case, a company that systematically enrolled people in courses, suddenly withdrew their participation because of changes in the interest towards nuclear and personnel dismissal. All these events testify for a job market that is still difficult



and not stable enough to constitute a real attraction. This effect must be compensated at the level of long term strategies in Europe, provided we wish to keep expertise in the field.

- The interest by professionals for courses, which was the main target of the project, is confirmed. The large fraction of “professional” people (from industry, regulatory bodies, academy, research) who applied to Pilot Courses and attended them is large enough with respect to “students” and even PhD “students”, the latter being anyway within the main target of ANNETTE. These “professionals” total a present share of 65% of the attendants; adding to them the PhD students and other (mostly professionals in other categories than listed) the percentage exceeds 80%. It can be concluded that there is an interest in courses such the ones proposed as ANNETTE Pilot Courses for professionals. This aspect will be better discussed later on in envisaging the further actions to be done.
- In absolute terms, 190 attendances does not represent a little impact of the action, neither a too large one. This number, which will possibly increase with the courses to be run in Autumn, is anyway comparable if not much larger to that achieved in previous EFTS; however, the very intention of the ANNETTE project was not to set up a new EFTS only but to propose a long term effort in collecting courses for CPD and running them in the future. This is the target that must be achieved in the remaining part of the project, within December 2019 and later.
- It must be finally considered that of the proposed courses by providers external to the consortium, just the ones of CONCERT could be advertised in the frame of ANNETTE. Others, like the GENTLE Courses and courses proposed by Stakeholders during a first phase of interaction, resulted finally unavailable, notwithstanding efforts spent in repeatedly trying to achieve involvement. After some insistence, it was necessary to recognise that such an operation would be probably much easier after the end of the project, when the Steering Committee of the ANNETTE Action under ENEN will be in place and will be in the position to invite external providers for a common action.

#### 4. FURTHER MANAGEMENT OF THE ANNETTE INITIATIVE

In chapter 7 of D2.2, preliminary proposals were advanced in order to manage the ANNETTE initiative. These proposals were related to the establishment of a **Steering Board**, in charge of organising the courses each year and of their Quality Assurance. The Steering Board is composed as suggested in **the by-laws for the Master, as reported in a draft proposal in Annex I of this report**. According to what already proposed in D2.2, the Committee should be in charge of the following actions:

- to monitor the delivery of the courses in each yearly edition;
- to establish the quality assurance procedures and evaluate their results, including course providers' reports on the attendance and the results of questionnaires filled by learners;
- to decide about the need of new courses for covering gaps or upcoming topics;
- to accept new course providers within the ANNETTE umbrella, after a quality assurance procedure;
- to interact with platforms and relevant stakeholders.

It must be recognised that after the time of issue of that report, new opportunities grew inside ENEN, also in view of parallel actions to be developed in the frame of the **ENEN+ project for voluntary accreditation**. These actions have an interface with the establishment of **by-laws** for the ANNETTE Master for Continuous Professional Development, already prepared under ANNETTE and reported as a proposal for the Board of Governors of ENEN in Annex I. In these by-laws, further proposals about the name of the master programme and of its regulations are advanced. As a consequence of the above, it seems at the moment necessary to consider **the possibility of a Joint ANNETTE – ENEN+ Meeting on the subject of accreditation**.

A challenge to be considered in this frame is a consequence of an attitude observed in attendants to pilot courses to avoid final examinations in courses that are requesting it for issuing a certification, i.e. courses which are not releasing a simple certification of attendance but are granting some credits. Such a behaviour, which is understandable for professionals having little time to really study and is in line with the success of several short courses providing seeds of knowledge or skills to be deepened later, is actually making difficult to establish a programme for professionals releasing credits of whatever kind (ECTS or ECVET).

Again, a creative reflection on this aspect is necessary in view of releasing certifications in general and of encountering a clear need for courses as the ones delivered in pilot courses of ANNETTE. It is possible, in fact, that in a phase of a better lively job market the number of persons seeking for a real certification of their study will increase, while at the moment the present experience indicates something different. This motivates to find compromise solutions that may reveal useful for both phases of low and high requests of jobs in the nuclear market.

A final phase of assessment of the Pilot Courses, necessary for drawing conclusions on the performed work, is envisaged in view of the release of deliverable D2.5 “Evaluation of the pilot European Programme for CPD and the summer courses”, to be issued by December 2019.

## **5. CONCLUSIONS**

At the time of writing, the ANNETTE summer school was successfully run and evaluated and the pilot course programmes for WP2 (and also WP5 and WP6) were mostly run with a reasonably large number of attendants.

A few pilot courses must still be run and they will be during next Autumn. This report was therefore able to present only a part of the data on these courses, which was anyway sufficient to draw first conclusions. Report D2.5 will contain updated information, including the one on running residual courses that will be made available by course providers.

## REFERENCES

- [1] W. Ambrosini and P. Dieguez Porras, ANNETTE Project Deliverable 2.1, Specific needs for an advanced European Programme for CPD in the nuclear areas, June 2017
- [2] Walter Ambrosini, Rosa Lo Frano and Jarmo Ala-Heikkilä, ANNETTE Project Deliverable 2.2, Course Plan for the Advanced European Programme for CPD and the Summer School, November 2017.
- [3] GENTLE Project Website, <http://gentleproject.eu/>
- [4] W. Ambrosini, R. Lo Frano, L. Cizelj, P. Dieguez, E. Urbonavicius, I. Cvetkov, D. Diaconu, J.L. Kloosterman and R.J.M. Konings, Education, Training and Mobility: Towards a Common Effort to Assure a Future Workforce in Europe and Abroad, FISA 2019, 9th European Commission Conference on EURATOM Research and Training in Safety of Reactor Systems, 4-7 June 2019 Pitesti, Romania
- [5] Jarmo Ala-Heikkilä, Walter Ambrosini, Behrooz Bazargan-Sabet, Michèle Coeck, Pedro Dieguez Porras, Francisco Elorza, Concetta Fazio, Dario Manara, Emilio Mínguez, John Roberts, Mark Scheffer, Christian Schoenfelder, The ANNETTE Summer School: A Significant Contribution to Professional Development, Sociedad Nuclear Espanola, 44° Reunion Anual, 26-28 Septiembre 2018
- [6] H2020 Programme, Guidance, Social media guide for EU funded R&I projects, Version 1.0, 6 April 2018

**ANNEX I**  
**DRAFT By-Laws**  
**regarding the**  
**European Master Programme (EMP)**  
**in support to**  
**Continuous Professional Development (CPD)**  
**in Nuclear Science and Technology (NST)**  
**and the Certifications released in its frame by ENEN**

Upon advice of the Teaching and Academic Affairs Committee, the Board of Governors of the European Nuclear Education Network Association in its meeting in ... on ... has approved the following by-laws for the Certifications to be released in the frame of European Master Programme for Continuous Professional Development in Nuclear Science and Technology organised by the European Nuclear Education Network Association.

#### **FOREWORD AND SCOPE**

The present by-laws are set up as a product of the EU ANNETTE Project (Grant Agreement No: 661910) financed under the Euratom Call of 2014, NFRP 10 – 2014 “Education and Training (Bologna and Copenhagen Process)”. The call was addressed to “*Education and Training organisations (notably at University or equivalent level)*” called to “*submit proposals in close collaboration with end-users*” devoting a special effort in setting up “*European Masters and Summer Schools for the continuous professional development of researchers and other private/public actors*”.

Accepting this challenge, ENEN set up the ANNETTE Consortium, collecting a number of course providers from Universities and Research Centres, in order to start elaborating a flexible Course Programme addressing individuals willing to enrol into the continuous professional development process envisaged in the call. Among the groups who joined the action, FuseNet proposed to cooperate with ENEN, developing courses in support to the ongoing process of “nuclearisation” of fusion.

A desk research and the interaction with Stakeholders, occurred repeatedly during the first and the second year of the project, showed the opportunity to contribute to the process of convergence between “*the world of learning (nuclear E&T) and the world of work (nuclear labour market)*”<sup>5</sup>. This was attempted trying to customise as far as possible the initially proposed course programme to the present needs in terms of nuclear workforce, e.g. as proposed by EHRO-N and the JRC G10 Group in their reports. A deliverable of the project (D2.1)<sup>6</sup> expanded on these needs basing on a desk research and on an interaction with and Advisory Board and an End-User Group set up for the project. This work was made in parallel with developments occurring in the field of the application of European Credit system for Vocational Education and Training (ECVET) to the nuclear job market,

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<sup>5</sup> Mihail Ceclan, “Synthesis Report on the ECVET implementation in the nuclear energy sector Towards the experimental testing of ECVET” JRC Science for Policy Report,  
[http://publications.jrc.ec.europa.eu/repository/bitstream/JRC107184/jrc107184\\_synthesisecvet\\_online\(final\).pdf](http://publications.jrc.ec.europa.eu/repository/bitstream/JRC107184/jrc107184_synthesisecvet_online(final).pdf)

<sup>6</sup> Walter Ambrosini and Pedro Dieguez Porras, ANNETTE PROJECT, DELIVERABLE D 2.1, Specific needs for an advanced European Programme for CPD in the nuclear areas, 20/06/2017

as e.g. described in JRC reports <sup>7</sup> and considering the analyses of the needs in terms of workforce appeared in EHRO-N studies <sup>8</sup>.

The motivation for undertaking the development of a European Master Programme (EMP) can be summarised in the following sentences, taken from one of the mentioned reports.

*“Regarding sector's major HR challenges: to fill-in the **30% gap** between HR demand and supply and to adapt nuclear E&T system to comply more with labour market demands.*

*Regarding sector's major HR solution: the solution to the sector's HR problems has two components: 1) “**Nuclearisation**” is the solution for filling up the 30% HR gap by engaging individuals from non-nuclear sector and training them to get a nuclear qualification; 2) The **ECVET infrastructure development**, is the tool for the paradigm shift from E&T based on inputs towards E&T based on exit-outcomes (market needs).”<sup>5</sup>*

*“When qualifications are under the responsibility of and awarded by the nuclear sector, ENEN could be defined as the independent body, trusted by the nuclear stakeholders, for recognition of units and/or qualification and training programmes.”<sup>5</sup>*

In this regard, the process of establishing a Nuclear Job Taxonomy by JRC is acknowledged and is carefully considered while working in parallel with the mentioned work of establishing an ECVET infrastructure. In a published report, the reached job taxonomy is described as follows:

*“The job taxonomy covers the typical job positions in a nuclear power plant during its three life cycle phases: design and construction; operation; and decommissioning. It does not include related areas not carried out in NPP premises such as research, regulatory activities and fuel and waste treatment or nuclear occupations not related with electricity production.”<sup>9</sup>*

In this regard, it must be clarified that at the moment the certifications being the subject of the present document do not fit completely with any of the 140 job profiles listed in the Job Taxonomy, though the courses collected within the ANNETTE project, to be offered in the years to come, contribute to the Learning Outcomes (LOs) required by many of them and by many other job profiles applicable in fields not yet addressed by JRC. In this regard, the certifications here proposed are aimed at testifying for the course path of an individual, which may need further integrations (at the formal or informal training levels) to fit exhaustively into a specifically coded job profile.

The effort made within ANNETTE was mainly focused on the proposal of courses which can be offered to professionals, researchers and PhD students having already a MSc, who can allocate just

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<sup>7</sup> César CHENEL RAMOS, 2012, The Preparation of an ECVET-oriented Nuclear Job Taxonomy: Concept and Progress Report, JRC Scientific and Policy Reports, Report EUR 25644 EN  
<https://publications.europa.eu/en/publication-detail/-/publication/50685f41-f8b3-4e90-bf87-c1474b657137/language-en>

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<sup>8</sup> Veronika Simonovska, Ulrik von Estorff, 2012, Putting into Perspective the Supply of and Demand for Nuclear Experts by 2020 Within the EU-27 Nuclear Energy Sector, JRC Scientific and Policy Reports, Report EUR 25291 EN, <http://ehron.jrc.ec.europa.eu/sites/ehron/files/documents/public/ldna26443enn.pdf>  
Ferry Roelofs, Ulrik von Estorff, 2014, Top down workforce demand from energy scenarios: Influence of Long Term Operation, JRC Science and Policy Reports, EHRO-N, Report EUR 26962 EN.  
[http://ehron.jrc.ec.europa.eu/sites/ehron/files/documents/public/regno\\_jrc92340\\_lbna26962enn.pdf.pdf](http://ehron.jrc.ec.europa.eu/sites/ehron/files/documents/public/regno_jrc92340_lbna26962enn.pdf.pdf)

<sup>9</sup> Chenel Ramos, C., Nuclear Job Taxonomy, Final Report, A competence-oriented classification of jobs in nuclear power plants, JRC Scientific and Policy Reports, Report EUR 29126 EN, 2018,  
[http://publications.jrc.ec.europa.eu/repository/bitstream/JRC110868/jrc110868\\_njt\\_final\\_\(2\)\\_1\\_\(2\).pdf](http://publications.jrc.ec.europa.eu/repository/bitstream/JRC110868/jrc110868_njt_final_(2)_1_(2).pdf)

a fraction of their time each year to acquire, refresh or deepen their competences in the nuclear fields covered by the offer starting with the ANNETTE Project.

It is recognised that full year or even longer study paths are presently available and could be proposed in the future by higher education institutions in Europe to achieve competences in the nuclear fields in specific sectors and for well defined job profiles. This route was not selected in the present case to avoid duplication of existing initiatives and to provide a flexible study path allowing for making full profit of the richness of the educational offer available in Europe in the nuclear fields.

In summary, though the process of convergence between “*the world of learning (nuclear E&T) and the world of work (nuclear labour market)*”<sup>10</sup> cannot be considered completed in the frame of the ANNETTE project, it is believed that it is favoured and possibly accelerated by the developed coordination of courses and by the stimulus provided by issuing the present certifications, generically defined for “Nuclear Science and Technology”, in support to continuous professional development.

## **PART I - Nature of the Study Programme**

Art. 1 **Purpose of these by-laws.** These by-laws, regarding the European Master Programme (EMP) in support to Continuous Professional Development (CPD) in Nuclear Science and Technology (NST), establish the rules and requirements that must ensure that the awarding of the related ENEN Certifications, to be defined below, reflects the high quality and the objectives set out by the European Nuclear Education Network Association in Article 2 of its Statutes. Moreover, these by-laws define the general principles and the guidelines for the management of the EMP.

Art. 2 **Adopted abbreviations:**

CPD	Continuous Professional Development
ECTS	European Credit Transfer and accumulation System
ECVET	European Credit system for Vocational Education and Training
EMP	European Master Programme
EMSNE	European Master of Science in Nuclear Engineering certification
ENEN-A	European Nuclear Education Network Association
EQF	European Qualification Framework
E&T	Education and Training
LLL	Life-Long Learning
NST	Nuclear Science and Technology
QAC	Quality Assurance Committee of the ENEN-A
TAAC	Teaching and Academic Affairs Committee of the ENEN-A

Art. 3 **Aim of the Study Programme.** The European Master Programme in support to Continuous Professional Development in Nuclear Science and Technology, hereafter referred to as EMP, is a study programme established under the ENEN Association to promote the life-long learning in nuclear matters, embracing several disciplines. These include, inter alia, the following areas: Nuclear Technology and Safety (both in the fission and in the fusion

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<sup>10</sup> Mihail Ceclan, “Synthesis Report on the ECVET implementation in the nuclear energy sector Towards the experimental testing of ECVET” JRC Science for Policy Report,  
[http://publications.jrc.ec.europa.eu/repository/bitstream/JRC107184/jrc107184\\_synthesisecvet\\_online\(final\).pdf](http://publications.jrc.ec.europa.eu/repository/bitstream/JRC107184/jrc107184_synthesisecvet_online(final).pdf)



sectors), Radiation Protection, Waste Management and Geological Disposal, as well as the applications of nuclear radiation in Medicine.

- Art. 4 **Meaning of the word “master” and addressed learners.** In this context, the word “master” is not referring to a MSc conceived as a second level of higher education in the European Higher Education Area (approximately corresponding to the EQF level 7), but to a study programme requesting for its access that an individual be in possession of a MSc in scientific matters, to be clearly specified for each course in the programme. In this regard, the word “master” is herein conceived as a “second level master”, similar to the ones delivered by Universities in some European Countries (e.g., Italy, France, etc.).
- Art. 5 **Life-long learning character.** The EMP is conceived to contribute to life-long learning (LLL), addressing professionals needing to start, restart, improve or requalify their higher education in the nuclear sectors. As such, the master programme, once fully completed by a learner, can be restarted as many times as necessary in order to achieve further learning outcomes, according to the learning needs and to cultural plans of the individual.
- Art. 6 **Cross-border mobility and learning.** The EMP is organised aiming to favour the cross-border mobility of learners and teachers around Europe. The adoption of technologies allowing for the widest possible access to learning, even in the distance, is therefore favoured, as far as they allow for teachers of different countries to teach to learners of their own country or from other countries in an effective way.
- Art. 7 **Adoption of up-to-date teaching technologies.** In view of the previous article, the courses selected for the programme should make use of up-to-date teaching and learning technologies, including the use of tools presently offered by Information and Communication Technologies (ICT).
- Art. 8 **Incremental nature of the EMP.** The EMP can be attended “incrementally”, meaning that courses can be attended year by year in a life-long learning perspective, in order to acquire different competences needed for individual professional development. The collection of certifications testifying in various ways the successful completion of the different courses and recognised under the EMP may lead to the intermediate or the final certifications being one of the subjects of these by-laws.
- Art. 9 **European dimension of the EMP.** The EMP is collecting learning opportunities from several Member States of the European Union and also from International Organisations operating in the European Union. This provides the EMP with a clear European dimension, while not excluding contributions from other regions in the world.

## **PART II - Organisation and features of the EMP**

- Art. 10 **The Steering Board of the EMP.** The Steering Board of the EMP is in charge of proposing and evaluating the course programme offer each year, on behalf of the Board of Governors of ENEN. In this aim, it makes use of courses from previous European Fission Training Scheme (EFTS) projects, whose sustainability has to be maintained, and of new courses developed in the frame of ENEN or by external entities. The selection of the courses is inspired by the principle of the best use of existing courses, while monitoring the momentary trends and needs in terms of present and future workforce in the nuclear fields. In this aim, the Steering Board also acts as a stimulus to the offer of new courses, as needed for a good coverage of thematic areas and for an appropriate knowledge management in the nuclear fields, in cooperation with relevant bodies and human resources observatories in the field (e.g., IAEA, NEA, EHRO-N).

### **ANNETTE**

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Dissemination level: PU

Date of issue of this report: **28/08/2019**

Art. 11 **Composition of the Steering Board of the EMP.** The Steering Board of the EMP is composed by a variable number of persons, approximately around 10-15, appointed by the Board of Governors of ENEN, whose identification is approved by the General Assembly each year. The composition of the Steering Board could follow the general distribution reported below, though the Board of Governors of ENEN may decide in a different way:

- the President of ENEN;
- the Secretary General of ENEN;
- one representative for each one of the nuclear fields (Nuclear Technology - Fission, Nuclear Technology – Fusion, Radiation Protection, Waste Management & Geological Disposal, Medical Applications of Radiations) selected among ENEN members;
- one representative for each one of the Technology Platforms (SNE-TP, IGD-TP, MELODI);
- a representative of ENS/FORATOM;
- a representative of IAEA;
- a representative of NEA;
- one or more representatives of the European nuclear industry.

The Board of Governors of ENEN proposes the specific composition of the Steering Board of the EMP, in terms of number and representation of components, on the basis of the needs for E&T in the nuclear fields. The President of ENEN is also President of the Steering Board of the EMP and the Secretary General has the function of its Secretary. It is appropriate that the member included in the Steering Board of the EMP for the sector of fusion is mandated to this purpose by the FuseNet Association.

Art. 12 **The programme offer.** Each year, after its appointment by the General Assembly and preferably before the end of March, the Steering Board of the Course Programme, composed as specified above, meets (in person or in teleconference) to define the courses to be offered under the umbrella of the EMP during the 12 months period specified below. The list of courses is subjected to approval by the Board of Governors of ENEN and then is made public and advertised by all suitable means. The programme is then run from June of the current year up to the end of May of the next one.

Art. 13 **Education and Training.** In order to preserve and enhance competences in nuclear matters, the European Master Programme includes both Education and Training courses, striving for providing a good mix of learning opportunities to achieve Knowledge and Skills at different levels of Responsibility/Autonomy (KSR/A) in the nuclear fields.

Art. 14 **Quality of the offer.** The quality of the education and training offer is assessed by the Steering Board of the EMP, with the aid of the Teaching and Academic Affair Committee (TAAC) and the Quality assurance Committee (QAC) of ENEN. This assessment is made both a priori, on the basis of the information on the learning outcomes of the courses and of the qualification of teachers, and posterior, making use of adequate means for assessing the effectiveness of the courses in improving the competences of learners. This matter is dealt with in a specific article below.

Art. 15 **Modularity of the face-to-face courses and e-learning.** In order to favour the attendance of professionals, the courses, when delivered face-to-face, should be modular, i.e., typically delivered in few days, one week or two weeks. However, exceptions to this practice can be allowed whenever the courses, e.g., delivered in the frame of academic semesters, may have anyway a sufficient attendance for professional development. This may be the case

of ordinary courses released by academic institutions in semesters, which are traditionally offered also to professionals or for which an attendance by professionals is forecasted. E-learning opportunities must be exploited at the highest possible level, to widen the basin of attraction of learners and maximise the impact of the EMP.

Art. 16 **EQF level of courses.** The fact that the EMP is a study programme mainly conceived for individuals having already a MSc or an equivalent level degree or certification at EQF Level 7 does not imply that its courses should be necessarily delivered at the EQF Level 7 or 8. In fact, it may be the case that individuals having a degree at EQF level 7 need learning matters at an EQF level lower than 7, having had no prior education in that specific field. Courses must clearly be assigned the corresponding EQF Level, basing on the proposal of Course Providers and on the subsequent approval by the Steering Board, which may make use of the advices of the TAAC and of the QAC of ENEN to ascertain the appropriate EQF Level.

Art. 17 **Labelling courses according to nuclear sectors.** In order to facilitate the identification of the life-long learning path taken by an individual learner, it is useful that each course is also labelled according to the specific nuclear sector it is applicable to. The following table applies, though it may be further integrated:

Nuclear Sector	Label
Nuclear Technology / Safety - Fission	NT-FIS
Nuclear Technology / Safety - Fusion	NT-FUS
Radiation Protection	RP
Geological Disposal	GD
Waste Management	WM
Nuclear Technologies applied to Medicine	NT-MED

Art. 18 **Course Providers.** Course Providers may be Universities, Research Centres, Training Providers, Industrial Companies and any other institution credited by the Steering Board of the EMP Courses to have the capability to deliver courses at the required quality and EQF levels. They should be preferably Members of ENEN, but the status of ENEN members should be considered neither a necessary nor a sufficient condition for being selected among the Course Providers for the EMP. The fact that a course delivered by a specific provider is accepted once in the offer of the EMP does not imply that this or any other course by the same Course Provider should be selected in the future unless specifically accepted by the Steering Board of the EMP. A course selected one year in the offer of the EMP may be excluded in future years at discretion of the Steering Board of the EMP.

Art. 19 **Course credits.** By virtue of the fact that the courses embrace both education and training, the appropriate metrics to measure their worth should be ECVET credits<sup>11</sup>. However, different cases can be envisaged:

- a. whenever courses are released by an officially accredited academic institutions legally enabled to certify ECTS credits, ECTS may be used in place of ECVET credits;
- b. whenever courses are not released by an officially accredited academic institution enabled to certify ECTS credits and the use ECVET credits is considered premature or uncertain in its application to the nuclear sectors, it is possible to proceed as follows:
  - the TAAC of ENEN can attribute to these courses a number of "ENEN TAAC Estimated ECTS" credits, corresponding to the number of ECTS credits that could be probably assigned to that course in case it was released by an officially

<sup>11</sup> See, e.g., <http://www.ecvet-toolkit.eu/>

accredited academic institution; since these ECTS credits can by no means be considered legally valid in any Country, their indication must be always accompanied by the identification “ENEN TAAC estimated ECTS” credits; the assignment of credits by the TAAC will follow standard practices in the field<sup>12</sup>;

- as an alternative to the above solution, the number of hours of teaching and personal work can be considered for all the courses and an appropriate metrics specified a priori by the Steering Board of the EMP will be adopted.

### PART III - ENEN Certifications

Art. 20 **Full master programme.** The full EMP includes a total of 60 ECTS credits or 60 “ENEN TAAC Estimated ECTS” or 600 hours of direct teaching and 1200 hours of personal study or application or apprenticeship, including formal or informal training, whenever appropriately quantified. In case of applicability of ECVET credits, the presently defined units should be converted to ECVET credits throughout this document.

Art. 21 **Records of course completion.** The learners and the Course Providers will keep track of the courses attended by the learners involved in the EMP, in order to have multiple records of course completion. A repository of data related to the learning path of individual learners could be identified by ENEN and managed by an adequate software in case this will be considered possible by the Board of Governors of ENEN on the basis of the available resources.

Art. 22 **Certifications to be released by ENEN.** ENEN will release certifications for partial and full completion of the EMP at the following stages:

- a. at the completion of a minimum of 24 ECTS or “ENEN TAAC Estimated ECTS”, including a short project and its public dissertation, or, alternatively, On-the-Job-Training whose preparation or implementation is worth 3 ECTS (i.e., approximately 3x30 hours of full time personal work) and must be performed under the tutoring of senior teachers or personnel;
- b. at the completion of a minimum of 48 ECTS or “ENEN TAAC Estimated ECTS”, including an additional short project and its public dissertation, or, alternatively, On-the-Job-Training whose preparation or implementation is worth 3 ECTS (see above) and must be performed under the tutoring of senior teachers or personnel;
- c. at the completion of the previous step, plus a final project and its public dissertation or, alternatively, On-the-Job-Training having the worth of at least 12 ECTS (i.e., 12 x 30 hours of full time personal work), to be performed under the tutoring of senior teachers or personnel.

Learners may request to ENEN a certification of their EMP accomplishment at any stage, in a partial transcript of records, by presenting the appropriate certifications.

Art. 23 **Valid courses for the certification and recognition.** The courses whose number credits are valid for reaching a given number of ECTS or “ENEN TAAC Estimated ECTS” or ECVET credits are those constituting the offer of the EMP in the year in which the learner attended them. These courses should end with a test or any possible sort of evaluation of the achieved level of competencies, defined according to the practices of the Course Provider. The grading systems and the modalities of finally testing the achieved competences operating at the Course Providers will be considered acceptable for the EMP at the time of acceptance of the Course in the offer of the EMP. The Steering Programme of the EMP and

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<sup>12</sup> See e.g., [http://ec.europa.eu/dgs/education\\_culture/repository/education/tools/docs/ects-guide\\_en.pdf](http://ec.europa.eu/dgs/education_culture/repository/education/tools/docs/ects-guide_en.pdf)

the TAAC may recognise courses attended also from other Course Providers, whenever properly documented and if considered of a sufficiently high level for the recognition; this matter is ruled uniquely at the discretion of the Steering Board of the EMP, with the support of the QAC and the TAAC.

- Art. 24 **Thematic tracks.** Following the principle of life-long learning, the learner is deemed free to select the courses in the EMP offer that are more appropriate for his/her intended professional development or target Job Profile, in consideration of his/her background and of the entrance requirements of each course. Thematic tracks may be also identified, if considered necessary by the Steering Board of the EMP, defining suggested learning paths that aim to provide competencies in a specific nuclear field. However, these tracks, whenever proposed, are not mandatory; the ENEN certifications and the detailed transcript of records will specify the selected education and training path of each learner, together with the detailed Learning Outcomes specified by Course Providers.
- Art. 25 **Tutoring.** Though private individuals may be accepted in the EMP, it is here envisaged that learners may or should have one or more tutors. These may be employers, senior researchers or teachers or any other individual qualified to support and/or direct the learner in his/her choices and, in case, in the project works. It is remarked that tutoring represents an important role in learning to be assigned to qualified persons.
- Art. 26 **Project works.** The project work consists of original applications showing a level of autonomy / responsibility of the learners to be analysed and evaluated posterior by the TAAC of ENEN, also based on the suggestions of the tutors who mentored them. The project work can be performed at an academic institution or at a research centre or at a company being a Course Provider in the EMP or at the institution or company where the learner is employed or is enrolled for study reasons (e.g., in case of PhD students).
- Art. 27 **Dissertations.** The modalities and the timing of public dissertations of the project works are selected by the Steering Board of the EMP and approved by the Board of Governors of ENEN, also according to the number of learners having completed each level of dissertation. As a general rule, the dissertation should be performed face-to-face or in teleconference in front of a Jury of five persons selected for the purpose by the Steering Board of the EMP. In the case of a face-to-face dissertation, the place, date and time of the dissertation will be made public in advance (at least two weeks) and the place should be reachable by the general public. Similarly, in case of dissertation by teleconferencing, the means of teleconferencing, date and time of the dissertation will be made public in advance (at least two weeks) and the connection should be reachable by widespread software to the general public.
- Art. 28 **Grading of the dissertations.** At the end of the dissertation, the Jury will provide an evaluation basing on the grading system applicable at the Institution hosting it. In the lack of such grading, the following categories are used: a) excellent; b) very good; c) good; d) sufficient; e) insufficient. In the latter case, the Jury has to substantiate in a written judgement this decision, identifying the flaws in the performed work and providing suggestions for its reformulation. A dissertation receiving a grade of "insufficient" is not valid for the recording of related credits.
- Art. 29 **Exceptions to the publicity of the dissertation.** In the cases in which the dissertation may contain proprietary information or, in any case, information that cannot or is inappropriate (for sufficiently valid reasons, at the discretion of the Steering Board of the EMP) to be disclosed to the general public, closed-door face-to-face dissertations or limited attendance teleconferences are allowed. In that case, the members of the Jury will normally subscribe a confidentiality agreement whose format will be decided on a case by case basis in agreement with the owner of the property rights or the institution or physical person having the legal right to oppose to public dissemination of the content of the dissertation.

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- Art. 30 **On-the-Job Training (OJT).** As alternative to project works, On-the-Job Training may also be conducted to conclude a learning path. OJT may be performed at an academic institution or at a research centre or at a company being a Course Provider in the EMP or at the institution or company where the learner is employed or is enrolled for study reasons (e.g., in case of PhD students). In this case, the respective institution or company must announce OJT at the Steering Board of the EMP and provide further details on the planned OJT: the task on which OJT will be conducted, the OJT-Guide to be applied, a confirmation that the OJT task will conclude suitably the learning path followed so far by the student, and contact information of the OJT mentor. The OJT guide shall describe the OJT training objectives, the instructional process (task demonstration, practice under supervision), how OJT will be documented, and a guide for the evaluation of the trainee's performance. For a successful OJT completion, the respective institution or company must submit to the Steering Board of the EMP a report on how OJT was conducted, and how the trainee's performance was successfully evaluated.
- Art. 31 **Certification Diplomas.** Examples of certification diplomas are reported in ANNEX I, being an integral part of these by-laws. They concern 40%, 80% and 100% of EMP completion.

#### **PART IV – Management of the EMP**

- Art. 32 **Website for enrolment.** Enrolment in the EMP is made online on a specific website set up by ENEN. The enrolment procedure will involve the assignment to ENEN of the right to manage the personal data of the learner in the purposes and only in the purposes of the EMP along its whole cycle.
- Art. 33 **Data to be provided for enrolment.** The data to be typically provided for the enrolment are:
- general personal data;
  - information on previous education, supported by a CV, copies of the related diplomas or certifications;
  - a statement of purpose, also indicating the initially selected learning path and its motivations; this learning path may also change during the course of the EMP;
  - the indication of the courses selected for possible attendance.
- Art. 34 **Criteria for acceptance in the EMP.** The Steering Board of the EMP and the specific selected course providers will decide about the acceptance of enrolment applications, considering the offer proposed each year and the entrance requirements to courses. In principle, since the EMP is addressing people having already a MSc in some scientific matter providing sufficient background, candidates not possessing this qualification should be excluded. In practice, the criteria should be established at the beginning of the implementation of the EMP and revised periodically on the basis of the experience gained in due course.
- Art. 35 **Enrolment acceptance.** Periodically (e.g., every six months) ENEN will collect the list of enrolment applications and will send it to an Enrolment Evaluating Commission (EEC) composed by four members of the Steering Board of the EMP, identified during one of its meetings. Within two weeks from receipt, the Commission, operating in face-to-face meetings or by electronic communications, will decide about the acceptance. In case of refusal, the decision by the EEC must be motivated to the applicant in written form. Hence, intakes in the EMP are established every (six) months in a year.
- Art. 36 **Enrolment at each Course Provider.** While the enrolment in the EMP grants to the learner the management by ENEN of his/her study career, the learner must also enrol at each

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Course Provider, at the conditions established for the attendance in the specific courses, the final tests and their formal or informal certification <sup>13</sup>.

- Art. 37 **Management of the learner careers.** In order to communicate to ENEN the successful completion of each course, the learners have the obligation to upload on the website established by ENEN the related information and certifications. ENEN will not be deemed responsible for lacking or faulty submissions. In order to get confirmation of the submission of the documentation, the learner will receive an electronic receipt of each submitted document. Documents not submitted or incorrectly submitted will not be considered valid for the career of the learner. Sample checks of validity of the provided documentation will be made by ENEN in order to ascertain the correctness of the submitted documentation. <sup>14</sup>
- Art. 38 **Completion of the EMP.** The EMP is formally completed when the 100% completion certification is released by ENEN. From that time on, the career of the learner under ENEN is considered closed, until a possible next enrolment.
- Art. 39 **Resignation from the EMP.** The learner can ask to resign from the EMP at any time. In that case, his/her career will be considered completed and a final certification of partial completion will be released to the learner. From that time on, the career of the learner will be considered closed; to be possibly continued, a further application for enrolment must be submitted.
- Art. 40 **Successive enrolments.** In the spirit of life-long learning, a learner who has completed a first EMP cycle of 60 ECTS or "ENEN TAAC Equivalent ECTS" credits can enrol again for a new EMP. The new enrolment will have to address courses different from the ones previously attended, except in the case in which a given course has been renewed enough to justify that it should be attended again.
- Art. 41 **General practices of QA in the EMP.** The Steering Board of the EMP is in charge of the Quality Assurance of the study programme, also supported by the TAAC and by the QAC of ENEN. The QA procedure includes the following phases:
- assessment of the quality of courses proposed for inclusion in the offer each year; this will involve the analysis of the learning outcomes of the courses as well as of the qualification of the teachers;
  - assessing the quality of each course by mandatory questionnaires proposed to learners and (if possible) to their tutors/employers providing feed-back on the effectiveness of the courses;
  - discussing the results of their QA assessments with relevant stakeholders and end-users not represented in the Steering Board of the EMP.

## **PART V – Transient provisions**

- Art. 42 The composition of the Steering Board of ANNETTE Courses is considered the same as that of the Steering Board of the EMP for the whole duration of the EU ANNETTE project (i.e., up to the end of December 2019). After the closure of the Project, the Board of Governors of ENEN will decide a new composition (or confirm the existing one).

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<sup>13</sup> Informal certifications may be released in the pilot phase of the establishment EMP during the EU ANNETTE project, whenever it is not possible by legal constraints to release a formal certification for free and the Course Provider has anyway decided to release the course for free.

<sup>14</sup> It will probably better if the learner will be asked to indicate the reference e-mail address of the Course Provider who will be asked to confirm the details provided by the learners and the electronic copies of the documentation about the passed courses.

Art. 43 The learners involved in the Pilot Courses set up under ANNETTE and who will successfully complete them, will receive a certification of 100% completion of the Pilot Courses. This certification may allow to these learners to enrol after the project completion in the EMP asking for recognition of the courses already passed during the pilot period in view of their study career.