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ANNETTE PROJECT

Advanced Networking for Nuclear Education and Training and Transfer of Expertise

DELIVERABLE D 6.4

Report on a pilot run of training courses on nuclear awareness for the fusion field

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ABSTRACT:

This report deals with the pilot run of nuclear fusion training courses developed within WP6 of the ANNETTE project. Based on the material developed for these specific courses as presented in report D6.3, the training courses were implemented. This report describes the feedback provided by the participants, and the conclusions and recommendations based on it.

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List of abbreviations

ANNETTE	Advanced Networking for Nuclear Education, Training and Transfer of Expertise
ASME	American Society of Mechanical Engineers
CCFE	Culham Centre for Fusion Energy
CPD	Continuous professional development
C&S	Codes and Standards
ECVET	European Credit System for Vocational Education and Training
ENEN	European Nuclear Education Network Association
ENSREG	European Nuclear Safety Regulators Group
F4E	Fusion for Energy
FUSENET	European Fusion Education Network Association
IAEA	International Atomic Energy Agency
IO	ITER Organization
ITER	International Thermal Experimental Reactor
LMS	Learning Management System
LO	Learning outcome
MOOC	Massive Open Online Course
NUSHARE	Project for Sharing and Growing Nuclear Safety Culture Competence[1]
RCC-M	Règles de conception et de construction des matériels mécaniques des ilôts nucléaires
RCC-MRx	Règles de conception et de construction des matériels mécaniques des installations nucléaires hautes températures, expérimentales et de fusion
SAT	Systematic Approach to Training
USA	United States of America
VET	Vocational education and training
WANO	World Association of Nuclear Operators

[1] See http://www.enen.eu/en/projects/nushare.html

1. INTRODUCTION

The ANNETTE Project (Advanced Networking for Nuclear Education and Training and Transfer of Expertise) is addressing the present situation of nuclear energy in Europe by a continuing effort in the field of education and training. The aim is to assure a qualified work force in the next decades, by consolidating and better exploiting the achievements already reached in the past and by tackling the present challenges in preparing the European workforce in the different nuclear areas. Special attention is paid to continuous professional development, life-long learning and cross border mobility.

Considering the attractiveness of fusion as a potential sustainable, low carbon source of electricity contributing effectively to a secure mix of different energy sources, the EU created a coherent, ambitious but pragmatic fusion program aiming, via a comprehensive, integrated science, technology and engineering program, to provide electricity to the grid by the middle of the 21st century[2].

As noted in the roadmap to the realization of fusion energy (the Fusion Roadmap), the evolution of the fusion program requires a shift from "from pure research to designing, building and operating future facilities like ITER and DEMO. This transition requires strengthening the available engineering resources, with a marked change from non-nuclear to nuclear technologies and has to be facilitated during Horizon 2020 by specific measures in support of training and education."

Through its Work Package 6 (WP6) the ANNETTE project addresses this challenge, dealing with the transition from non-nuclear to nuclear technologies in fusion, as this will have an important impact on the work force active in fusion: the human resources involved in development, design and construction of fusion facilities must possess suitable nuclear related competences.

Relying on the existing initiatives and institutions in Europe that are providing education and training to build up nuclear (fission) related competences, and that have decided to cooperate within the ANNETTE project, the inclusion of WP6 within the ANNETTE project is an effective contribution to meeting one important objective of the Fusion Roadmap.

Consequently, the objectives of WP6 include

- To facilitate adaptation of existing education and training curricula to or the development of new curricula for the specific nuclear related competence needs of the work force in design and construction of fusion facilities (e.g. ITER, DEMO),
- To provide suitable training courses or other forms of informal or non-formal learning, thereby contributing to the Advanced European Program for CPD and the Summer School with specific courses on Fusion,
- To implement adapted or newly developed courses or other forms of learning,
- To assess the quality and effectiveness of the implemented courses or other forms of learning and discuss the possible means to ensure sustainability of these initiatives beyond the end of the project.

[2] See https://www.euro-fusion.org/eurofusion/the-road-to-fusion-electricity/

To achieve these objectives, WP6 is structured into four different sub-tasks:

- T6.1 Investigate and specify the specific competence needs for the transition of fusion to a nuclear technology
- T6.2 Design and development of fusion specific training addressing the competence needs as specified in T6.1
- T6.3 Implement and evaluate courses or other forms of learning as designed and developed in T6.2
- T6.4 Support the participation in nuclear training activities

This approach reflects a practical implementation of the Systematic Approach to Training (SAT), which was developed in the nuclear (fission) community under the guidance of the IAEA (see [1]).

Considering the current time frame for design, construction and operation of fusion facilities like ITER and DEMO[3], one will have to put the activities of WP6 and its outcomes into this context. What are the current and near term main activities of the involved human resources in the ITER and DEMO projects?

Although basic design already has been completed for ITER, detailed design activities are still ongoing, either within the ITER Organization, or within the various sub-contractors involved with their supplies and services. Furthermore, manufacturing as well as assembly and construction activities are conducted, either on the sub-contractors' or on the ITER construction site. As for DEMO, the conceptual design phase most probably will be performed in the 2020s, basic design activities in the 2030s, and detailed design as well as manufacturing, assembly and construction activities most probably in the 2040s. In parallel, research and development are ongoing (primarily through the EUROfusion consortium) to prepare the operational phase of ITER, and to contribute to resolving diverse technical challenges connected to DEMO.

Consequently, it may be expected that the size of the workforce involved will grow in the 2020s mostly relating to construction, assembly, commissioning and operation of ITER, to be possibly reduced subsequently during the DEMO basic design activities, while mostly kept constant for research and development activities. This certainly will have an impact on the required competences in the work force, with implications on the long-term importance of the courses that are adapted or newly developed within WP6.

Obviously, under this perspective one may conclude that these courses should have a sustainable impact not only on the nuclear awareness of the manufacturing, assembly and construction work force (short-term time frame), but also on the nuclear expertise of engineers and scientists (middle to long-term perspective), and thus on the involved industry and research and development institutions. Furthermore, it may be expected that on the long-run this may lead to a related adaptation of fusion education curricula, e.g. on Bachelor or Master level.

The current report documents how the result of sub-task T6.2, namely the training material for three training courses that have been selected for training development as documented in reports D6.2 and D6.3 (see [2] and [3]), has been deployed for implementing pilot courses.

[3] See, e.g. http://fusionforenergy.europa.eu/mediacorner/newsview.aspx?content=1140

These are:

1. A-NF-01 *Fundamental Knowledge on Fusion and Nuclear Aspects*
   (implemented during the ANNETTE Summer School in Turku, Finland, June 25th – 29th, 2018)
2. A-NF-02 *Regulation and its Application in Nuclear Projects*
   (implemented by ANNETTE project partner Framatome in Karlstein, Germany,
   February 11th – 12th 2019)
3. A-NF-03 *Nuclear Safety Culture in the ITER Project – The Supply Chain*
   (implemented by ANNETTE project partner UNED, Madrid, Spain, March 11th – April 30th, 2019)

The feedback and evaluation from the pilot training will be used for course improvements and further offering of fusion specific training courses, i.e. for sub-task 6.4 within the work package WP6.

2. PROCEDURE FOR IMPLEMENTING THE PILOT TRAINING COURSES

The sub-task T6.3 not only provided the training material for the three courses, but also a training description to specify the courses. These training descriptions were published through the FuseNet Internet site[4]. Additionally, the course offer was made public in the regular ANNETTE Monthly Bulletin which was distributed to a large network of persons that were interested in nuclear education and training. Finally, registrations had to be made through the ENEN Internet site related to ANNETTE[5], thereby allowing a follow-up of course registrations, implementations, and evaluations.

For registration, the applicants were asked to provide some personal information (like their expectations on the course, stored in accordance with the GDPR[6]), which should assist the trainers in course preparation targeting the enrolled students. This should also support an enhanced evaluation of course implementation.

This was the regular approach, but finally conducted somewhat differently for A-NF-01 and A-NF-03, see explained below in the respective chapters.

During the course, training material was handed out to the participants, allowing them to follow the presentation of the trainer.

After the course, the students were asked to complete an evaluation questionnaire, with the aim to identify areas of improvement for the respective course. The results of these course evaluations are shown in chapters 3 – 5, and the conclusions as well recommendations drawn from these are presented in chapter 6.

The following chapters describe the details of training implementation.

Thereby, also some examples from the material will be presented to explain its format, style, and the training method it was used for.

[4] See https://www.fusenet.eu/node/1296, https://www.fusenet.eu/node/1297 and https://www.fusenet.eu/node/1298
[5] See http://www.enen.eu/en/projects/annette/eoi1.html
[6] See, e.g., https://eugdpr.org

3. A-NF-01 *FUNDAMENTAL KNOWLEDGE ON FUSION AND NUCLEAR ASPECTS*

3.1 Course date, location and program

During the execution of the ANNETTE project, namely after start of the second reporting period, it was agreed within WP2 to organize and implement an ANNETTE Summer School at the end of June 2018 (June 25th -June 29th). This Summer School should deal with Nuclear Technology, Nuclear Waste Management and Radiation Protection. Participants should be introduced to the multi-disciplinary present and future challenges in three core topics in present-day nuclear power production, Gen-IV nuclear power production, fusion and medical applications. The aim should be to compare the similarities and differences in the challenges.

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

Consequently, within WP6 this opportunity was taken to implement the planned training course on *Fundamental Knowledge on Fusion and Nuclear Aspects* (A-NF-01). The related lectures should then be implemented through plenary lectures as well as topic specific lectures and allocated exercises / workshops, as foreseen in the Summer School schedule, see Figure 1 *ANNETTE Summer School Schedule June 2018*.

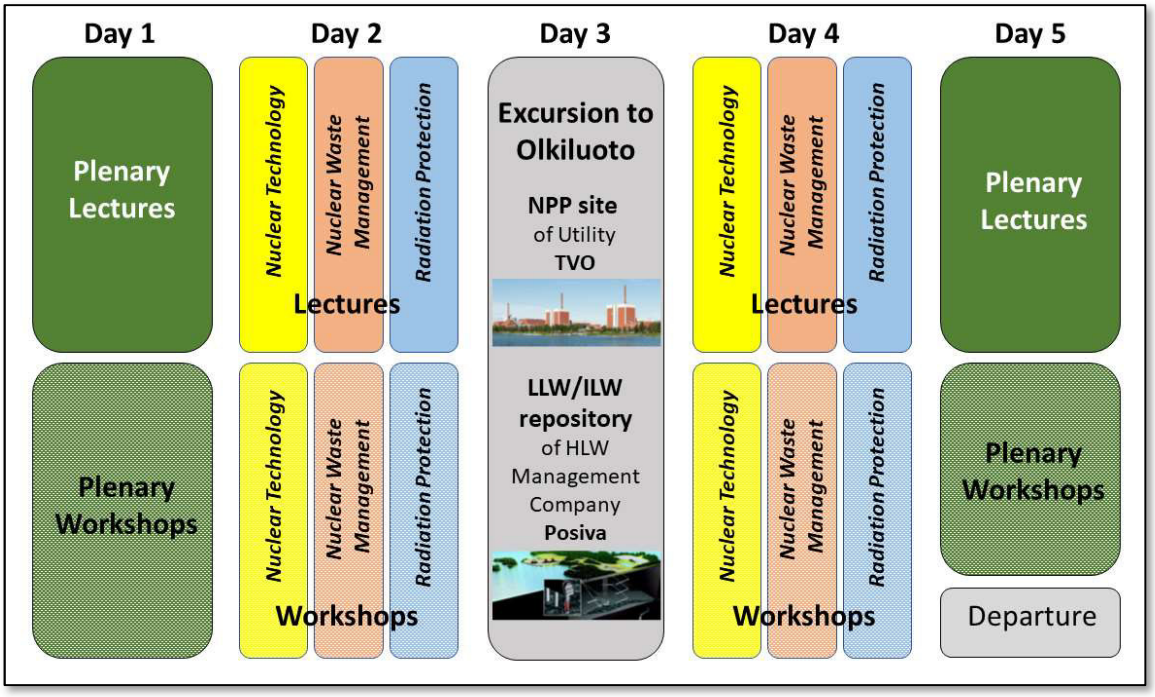


Figure 1 ***ANNETTE Summer School Schedule June 2018***

In accordance with the objectives of the Summer School, the schedule was designed in a way to allow for an alternation between plenary lectures (cross-cutting, introductory-level lectures) on Monday and Friday and specialized in-depth lectures and workshops, dealing with the disciplines nuclear technology, nuclear waste management, and radiation protection, see Figure 1.

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.

When applying for the Summer School the students had to select their core topic, thereby allowing the related Steering Committee to care for an equal distribution of students to the three parallel tracks. The track Nuclear Technology then was further subdivided into the area of GEN IV (fission) plants, and fusion, thereby permitting to present and discuss the commonalities as well as differences in these different technical approaches.

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

The training description is documented in Annex 1, which was also used for presenting this course in the Internet[7]. The detailed fusion specific schedule of the Summer School is harmonized with this training description, see Table 1 *Fusion Track in ANNETTE Summer School*.

No.	Slot	Day and Time	Content
1	PW06	Mon 15:15 – 16:00	The 7 challenges of Fusion and its implications on nuclear safety
2	PW07	Mon 16:15 – 17:00	Design of DEMO: implications of the nuclear aspects *Discuss interactively with the student how the design of a fusion reactor will change due to the nuclear aspects.*
3	NL01	Tue 09:00 – 09:45	The physics basics of a fusion reactor
4	NW05	Tue 14:00 – 14:45	Basics of nuclear regulation and licensing and its impact on licensing and design of nuclear power plants
5	NW06	Tue 15:15 – 16:00	Exercise: how to consider nuclear regulation in design / engineering activities
6	NL10	Thu 11:00 – 11:45	Aspects of tritium: the safety issues, the breeding, the recirculation, the extraction etc.
7	NW11	Thu 13:00 – 13:45	Neutron irradiation: what is the impact on the material properties, neutron stopping, safety issues, production of radioactive waste
8	NW12	Thu 14:00 – 14:45	Exercises to aspects of tritium / neutron irradiation

Table 1 ***Fusion Track in ANNETTE Summer School***

[7] See e.g. http://www.fusenet.eu/node/1296

3.2 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[8].

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.

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, and additionally 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.

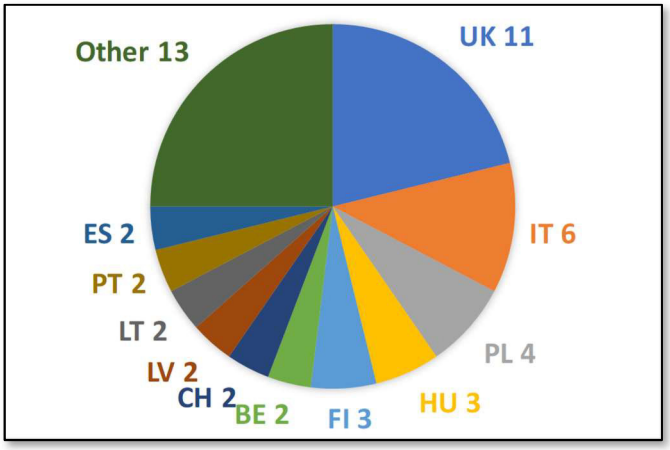


Figure 2. Distribution of nationalities

Finally, 29 experts from different technical disciplines contributed to development and implementation of the Summer School, so altogether 50 lectures and workshops were given.

Figure 3. 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

[8] See https://annettesummerschool.org/

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 4. 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.

3.3 Feedback of 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.

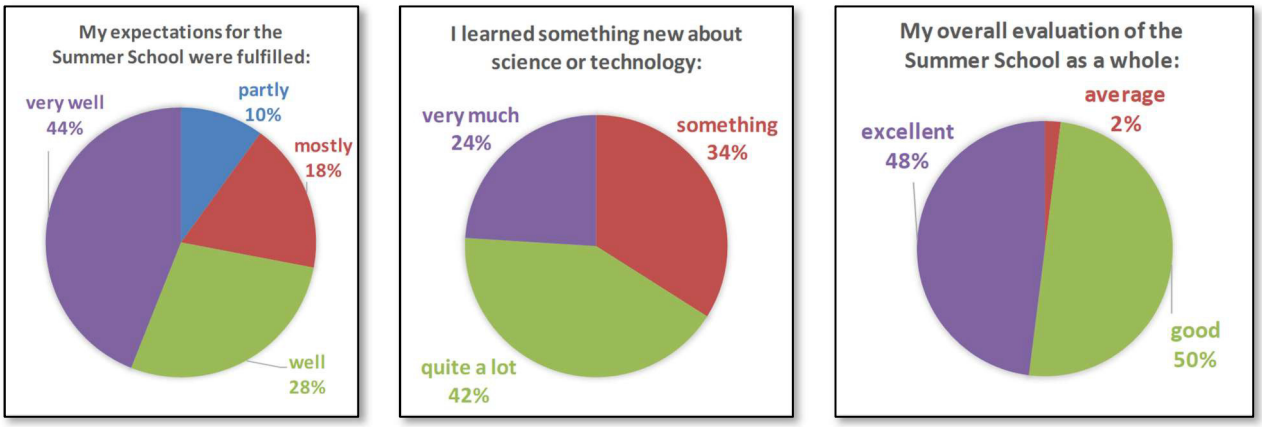


Figure 5. General feedback on Summer School

In summary, the participants were mostly satisfied with the Summer School, 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).

Figure 6. Feedback on presentations

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

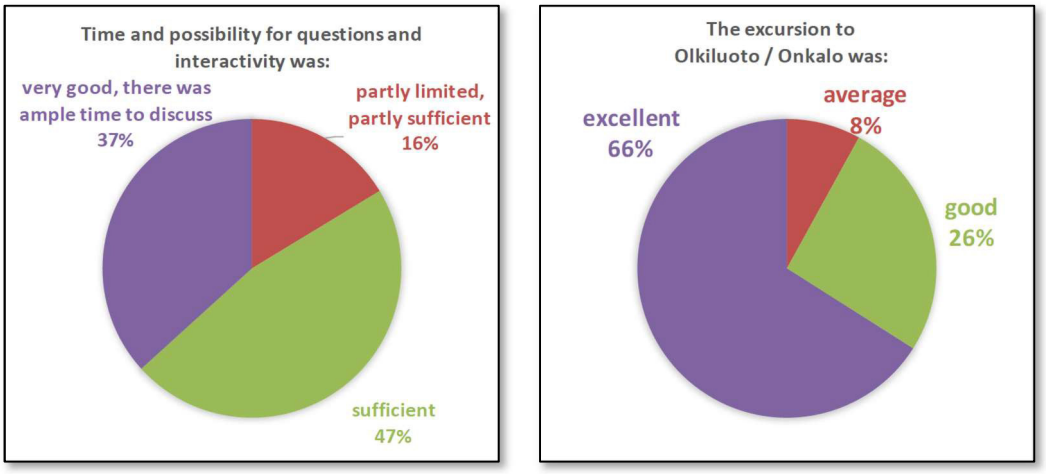


Figure 7. Interactivity, excursion

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. This

feedback and the general positive 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.

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".

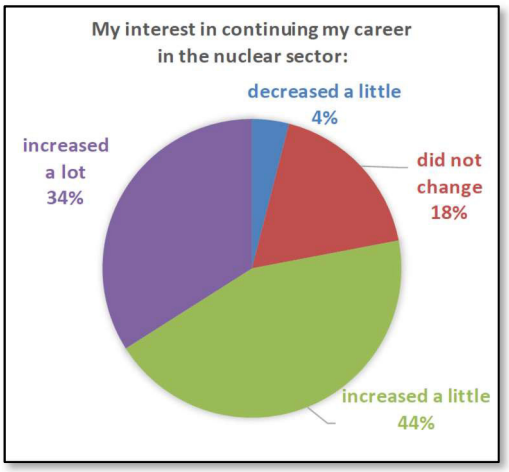


Figure 8. Career perspective in nuclear

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. 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.

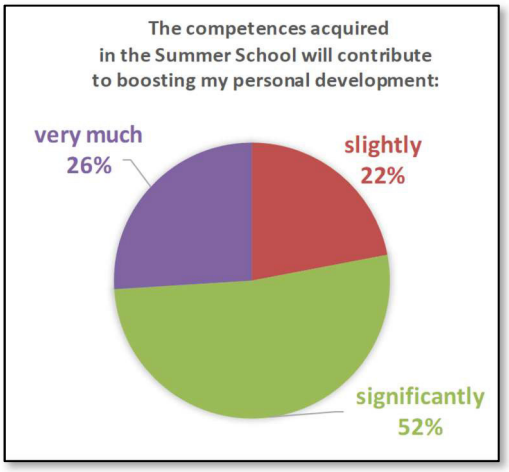


Figure 9. Contribution to personal development

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

3.4 Specific conclusions and recommendations

As the Summer School was very well rated by the participants, it is recommended 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, this may thereby contribute substantially to the attractiveness of job positions in the nuclear field.

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[9].

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.

[9] For a list of these courses, delivered for free in pilot sessions, see http://www.enen.eu/en/projects/annette/annette-project-courses1.html

4. A-NF-02 *REGULATION AND ITS APPLICATION IN NUCLEAR PROJECTS*

4.1 Course implementation

The specification published in report D6.2 was used to develop a detailed training specification or training description. The result is documented in Annex 2, which was used for offering this course in the Internet[10].

Based on the specification, the training material was developed as already described in report D6.3. In accordance with the specification and the training material, a training program (syllabus) was issued. Finally, the pilot course was implemented by Framatome GmbH in their training center in Karlstein (Germany, close to Frankfurt) on February 11th and 12th, see Figure 10.

framatome

Regulation and its Application in Nuclear Projects
11.2. - 12.02.2019
Location: Framatome Karlstein

Framatome Learning Solutions Training Center

Course day	Weekday	Start	Duration	Training Topic	Trainer	Comment
1	Monday	09:00	00:30	Welcome and Instruction to Tablet-PC	Baltin	
		09:30	00:45	Introduction and Overview of national / international nuclear law(s), related regulation	Baltin	
		10:15	00:45	Main licensing activities / deliverables / responsibilities	Baltin	
		11:00	01:00	Basic safety principles and Assessment of safety (1)	Baltin	
		12:00	01:00	Lunch		
		13:00	01:00	Basic safety principles and Assessment of safety (2)	Baltin	
		14:00	01:00	Developing Safety Culture	Baltin	
		15:00	01:00	How to integrate nuclear regulation requirements into fusion projects	Baltin	
		16:00		End of 1st course day		
2	Tuesday	09:00	01:00	Recapitulation of 1st Training Day	Baltin	
		10:00	01:30	1. Case Study: Safety Culture	all	
		11:30	01:00	Lunch		
		12:30	02:30	2. Case Study Implementation of Codes and Standards	all	
		15:00	01:00	Summary and Feedback	Baltin/all	
		16:00		End of course		

Figure 10. Syllabus of pilot course

Altogether, 10 persons attended the pilot course, namely from CCFE, F4E and from some European companies active in the ITER supply chain, thereby well representing the expected target group for this course, also with respect to their professional positions and interests in nuclear regulation.

4.2 Feedback of participants

At the end of the course the participants were given an opportunity to evaluate the training in various aspects. In the Framatome Course Feedback Questionnaire (see Annex 4), feedback was asked for topics like training support, content of the course and its implementation, course material, using the training measures, and overall impression.

The results can be summarized as follows:

First, the organizational / logistics support before and during the training was well appreciated, see figure 11.

[10] See e.g. http://www.fusenet.eu/node/1297

Figure 11. Support before and during the training

Similarly, the quality of the course material was well appreciated, see figure 12.

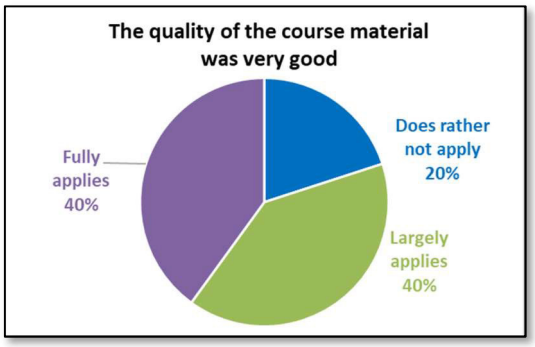


Figure 12. Quality of course material

However, when regarding the duration of the course and its content structure, opinions were rather split, see figure 13. For about half of the participants the course duration was not ok, and the content structure was not logical of the central theme was not clear.

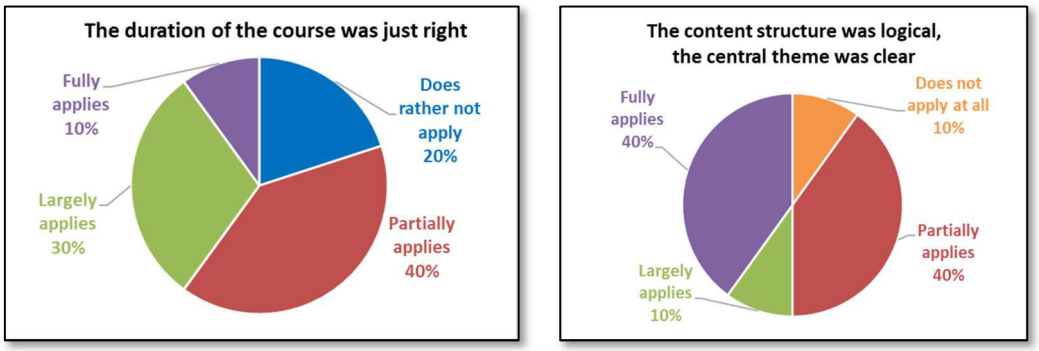


Figure 13. Duration of course and content structure

Similarly, about half of the participants stated that they did not really (or only partially) acquire new knowledge and gain experiences. Consequently, they were rather pessimistic whether they could put what they learnt into practice, see figure 14.

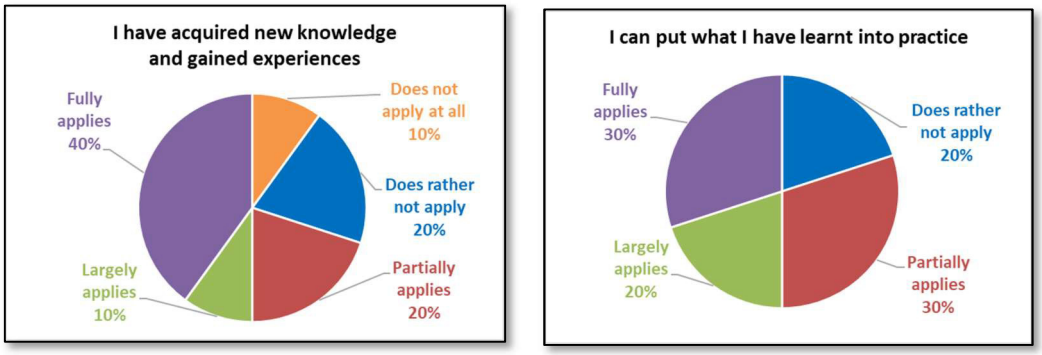


Figure 14. Duration of course and content structure

Consequently, less than half of the participants were very satisfied with the course, as their personal expectations apparently were not met, see figure 15.

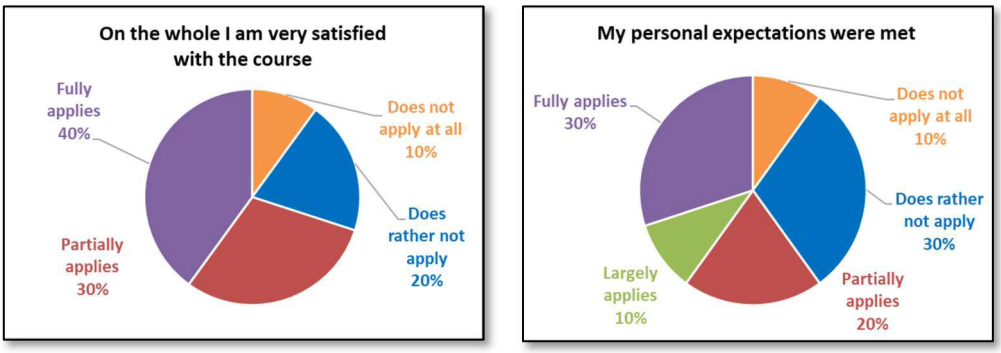


Figure 15. General evaluation

Nevertheless, the participants were highly interested in the topic of the course and took an active part in the discussion during the lectures and while working with the case studies.

In summary, the average results in the different aspects asked for in the questionnaire were:

Training support	1,4
Content of the course and its implementation	2,6
Course material	1,9
Using the training measures	2,5
Overall impression	2,6

(range from 1: best to 5: worst)

However, this rather schematic feedback of the participants is incomplete when not considering the free comments they were asked to provide in addition to the simplified numerical response. As this was comprehensively used by the participants, some important comments are listed in the following.

Questionnaire box Benefits of training course:
It was useful to have an overview of international framework, codes and standard specially with reference to fission NPP and the experience relevant of the trainer.

Questionnaire box What I especially enjoyed:

- *The case studies examples and the open discussions to this* (4x)
- *… Exchange of impressions/visions among participants and trainer*
- *I have enjoyed the way in which fission lessons can be transferred to the fusion environment and the limitations that this implies. The safety classification and analyses were useful to be aware of, as was the understanding of responsible organizations. A very good overview of the whole field.*
- *... Having several nuclear regulation experts in the room was excellent - particularly to hear about past experiences. Fusion regulation aspects were of particular interest. / Overall, excellent course, thanks!*
- *Tips about Finnish experience of the trainer. Very useful as a living experience for fission licensing.*
- *Clear presentation, good place, overall view*

Questionnaire box Suggestions and tips:

- *More detailed approach on fusion regulatory aspects …*
- *More correspondence between course plan & course content (brochure) … possible comparison between different country regulations / bodies / authorities*
- *It is difficult to aim detail at an audience interested in different aspects. I suggest two course levels: an introductory course of a level similar to this with a good overview, and a separate, detailed course on fusion-relevant safety aspects and how lessons from fission can be applied.*
- *Additional details about qualification of new materials / components would be useful. Possibly more depth on regulatory aspects but this would likely result in an increased course length.*
- *The course was not focused on fusion as indicated in the brochure, which was the main reason for me to attend the course. I suggest providing more details/examples of licensing process (analyses, deliverables) about fission. ... This will help us to understand how to apply fission licensing to fusion (where applicable). To do this, safety issues related to fusion should be better discussed.*
- *The expectations were other: to have specific knowledge on French laws - regulation - licensing documents with reference to ITER.*
- *Stressing on fusion regulations and licensing. / Stressing on ASN (French) guidance, approach, etc. / More detailed info on application of codes and standards.*
- *More in depth analysis, more examples of real cases (e.g. various licensing steps) / More integration view among codes and standards*

4.3 Specific conclusions and recommendations

Based on the written feedback of the course participants, but also on the lively discussions that were held during the course, one can draw the following conclusions and recommendations:

- Overall, the importance of the course topic (nuclear regulation and how to apply it in nuclear projects) was rated high by the participants.
- Likewise, it was very beneficial to start with an overview of nuclear regulation and codes and standards.
- Next, the expertise of Framatome in nuclear (fission) safety was well received and acknowledged, as this provided the opportunity to illustrate many nuclear safety related issues.
- Furthermore, the use of case studies drawn from Framatome' s expertise greatly helped to recapitulate and apply the theoretical knowledge provided through the lectures.

- However, several comments pointed out that the course should be more focused on fusion related nuclear safety issues.
- And finally, the specifics of French laws, regulations and nuclear codes and how to apply these in the ITER project ought to be presented more extensively, and illustrated with appropriate, practice oriented examples.

These most important recommendations by the participants, namely, to focus stronger on the French law/regulations and on fusion aspects, will be considered in an update of this training course.

5. A-NF-03 *NUCLEAR SAFETY CULTURE IN THE ITER PROJECT – THE SUPPLY CHAIN*

5.1 From course development to implementation

After having conducted the stakeholders' workshop in November 2016 it emerged that in the ITER project there was a need for fostering a nuclear safety culture within the ITER supply chain. The supply chain consists of different sub-contractors that are active in manufacturing, construction, and assembly of ITER. This issue of nuclear safety culture is specifically important for artisans, technicians, or related supervisors and management staff. Thereby, the target group may extend to several hundred or more persons, when all responsible staff in the complete supply chain on all levels must be addressed. Because of this high number, and the necessity to train people concurrently, best at various locations easily accessible for the target group, it was decided to offer the training as an online training course, designed for flexible and autonomous learning. Participants reach learning outcomes by working through contents explained in videos by a native English speaker, and self-evaluation tests that let participants test their knowledge acquisition.

The challenge in designing and developing this type of training consists in the possible inhomogeneity of the target group (with respect to their competences on fusion and nuclear safety, and their motivation and attitudes towards fostering a safety culture), and the limited capabilities of an online training course. Without a direct face-to-face live training and a possible interaction between trainees and trainer, it will be difficult to strengthen the training part that shall influence the motivation and attitudes towards fostering a safety culture.

Finally, based on the specification made in report D6.2 and the considerations above, a detailed training specification, or training description was developed. The result is documented in Annex 3, which is also used for publishing the course in the Internet[11].

After having concluded the development of training material according to this training specification (documented in report D6.3), the course was reviewed by the Nuclear Safety Division of the ITER Organization and approved for implementation.

5.2 Course methodological design and implementation in UNED Abierta Virtual Learning Platform

Subsequently, the ANNETTE partner UNED (the Spanish national distance education university) assisted in the methodological design of the online course, according to distance education principles, and in testing it in a pilot run, implemented as a SPOC (Small Private Online Course) on its Virtual Learning Platform for MOOCs *UNED Abierta*[12].

This platform, welcome page as shown in figure 17 and developed by UNED based on the open source edX MOOC platform, has a very suitable and elegant design for short courses, supported by a comfortable navigation. As a MOOC platform hosting many MOOCs produced by UNED, a permanent 24h technical assistance is provided.

UNED recommendations, considering the expertise of the course content designers, were to have the following methodological design:

- A brief course guide consisting of an initial page to gather the main information about the course.

[11] See, e.g., http://www.fusenet.eu/node/1298
[12] See https://iedra.uned.es/

- An initial anonymous survey to gather relevant information about participants' expectations, objectives, sociodemographic characteristics and so on.
- For each module/unit:
  - A written synopsis to be shown before each video lesson.
  - One recorded video lesson.
  - A self-evaluation questionnaire. 10 multiple-choice questions, with 3 options and feedback for each of them, were recommended, so the course participant may test what has been learnt, and in case of failure, study again the content, and try once more with the questionnaire.
- Discussion forums, they encourage participation and interaction, and a collaborative environment, and may be guided by the teaching team to solve common doubts or encourage conversations on topics of interest. In this pilot case these were not included, but they may be considered for future editions of the course.
- A final exam, with randomly selected multiple-choice questions out of a questions database. The trainees' responses may be automatically evaluated by the system based on the information about the correct options.
- A final anonymous survey.

When accessing the course as a trainee, you may have available the sections (see figure 16):

- Home: to welcome the trainee and resume the main information about the course, including main objectives and learning outcomes
- Course: to have access to all the course contents, and course surveys
- Discussion: to have different forums for interaction between participants and/or with the teaching team
- Progress: to show the evolution of the trainee

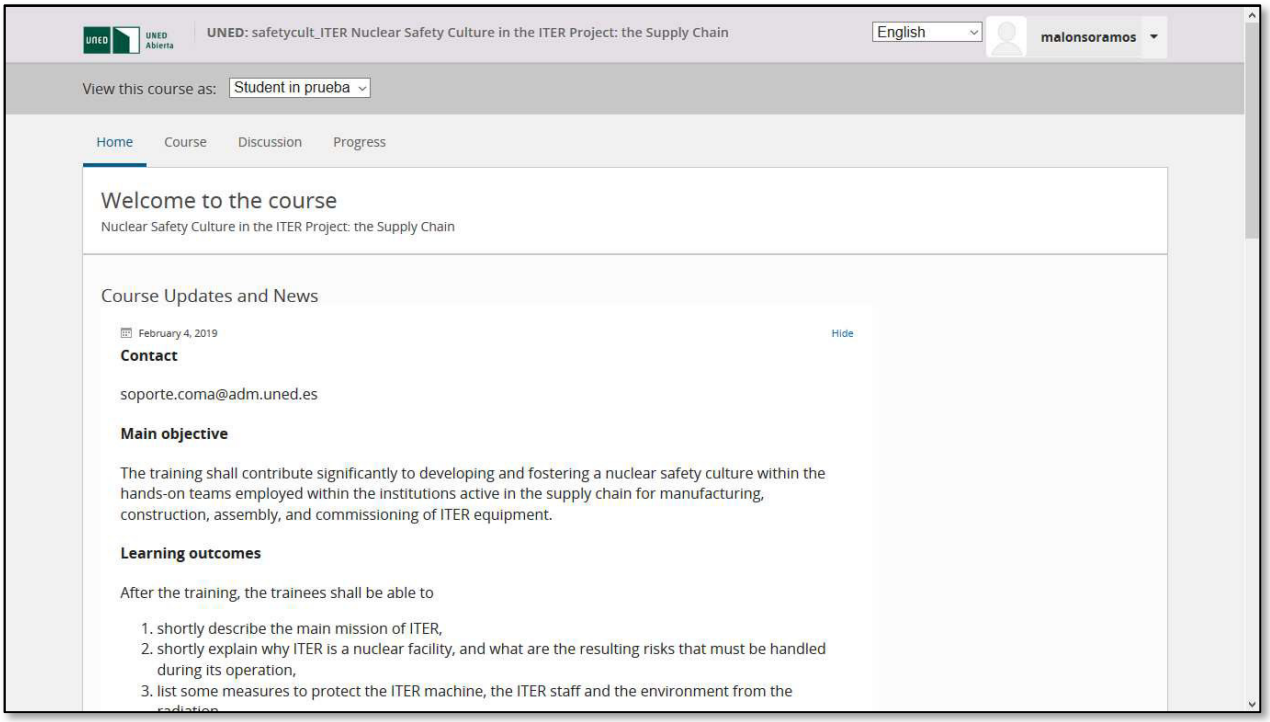


Figure 16. The general view for a student in *UNED Abierta* platform

The teaching team and the administrators of the course have another section called *Instructor*, see figure 17, where it is possible to view information on the trainee's enrolment.

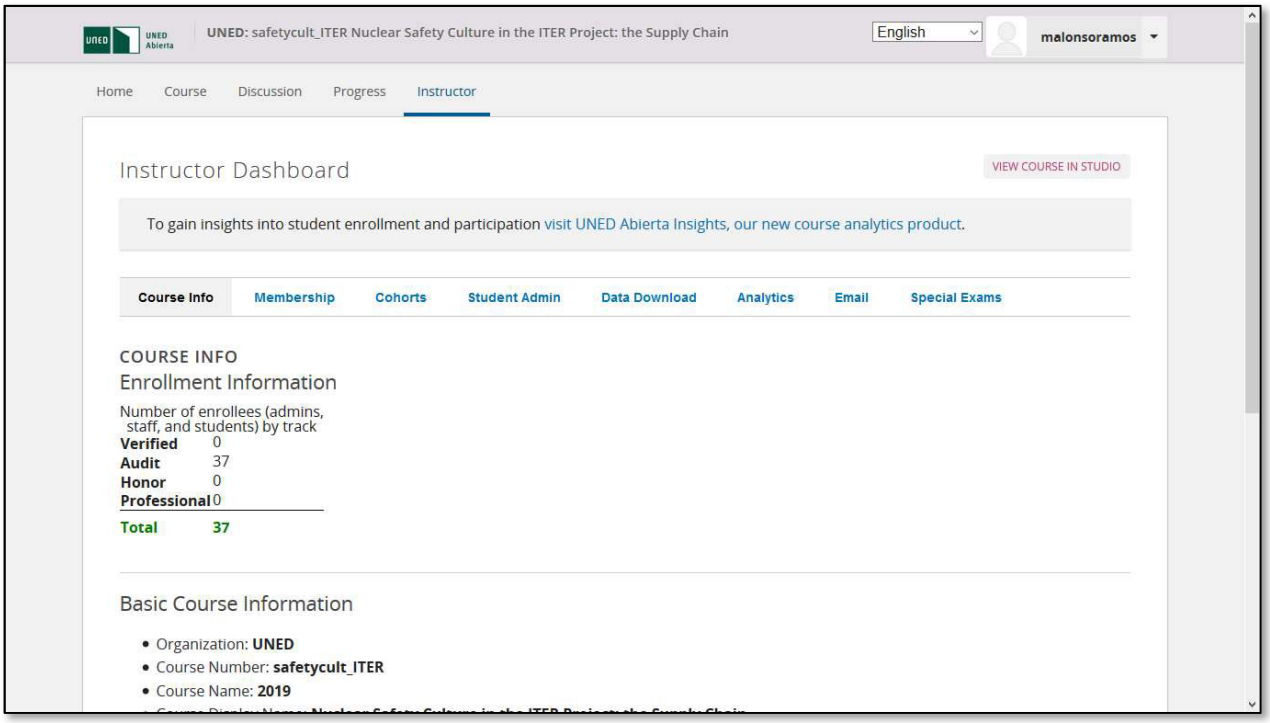


Figure 17. Instructor dashboard, *UNED Abierta* platform

An online course of this kind is recommended to be divided in small chapters or units, delivering content through short videos, so that they are not too long to be followed online. Although regular recommendation is videos from 5 to 10 minutes, the technical contents of this course guided a longer story thread, and the total number of videos, based on PowerPoint presentations, was divided into 6 chapters. See Annex 5, providing an overview of the course, with the most essential information that is also presented to the trainees in *UNED Abierta*.

After the decision on the division of the PowerPoint presentation, the recording of the video lessons was conducted and programmed in UNED CEMAV polymedia studio. The presenter (an English native speaker from CCFE) was placed next to the slides, see figure 18, to promote a more motivating learning experience (with the option to also display the text talked by the presenter). The trainees may view slide by slide through watching the video lectures, allowing them to focus on the content while not being distracted. Viewing all videos by a trainee will require a duration of about one hour.

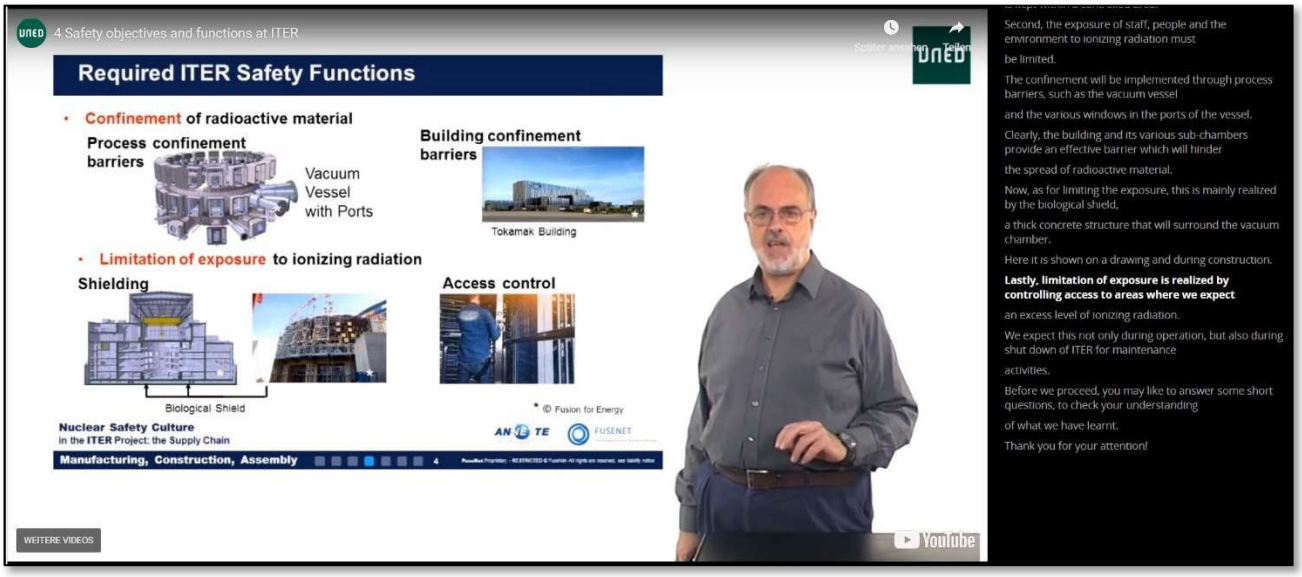


Figure 18. Example: how the course is presented to the trainee in the Internet

Considering the importance of having feedback from the trainees following the course, and the opportunity to have a pilot run, where more specific questions may be asked, two surveys for the course were designed. UNED implemented them in Google forms. This was chosen for allowing anonymous participation, designing a user-friendly interface and the automatic generation of comparative results. See Annexes 6 and 8 to view the complete content of the surveys, and Annexes 7 and 9 to see (part of the) the trainees view and the administrator view in Google Forms.

The information to be gathered in the questionnaires can be grouped as follows:
Before the course

- The person´s profile
  - General data
  - Level of education
  - Work profile:
    - within the ITER project
    - regarding nuclear projects
    - regarding safety cultures issues
  - Experience with eLearning
- The expectations about the course
- Check of pre-knowledge and attitudes related to the course content

After the course

- Overall rating of the course and its importance for the trainee
- Evaluation of the training material and the trainer
- Suggestions and recommendations
- Final check on knowledge and attitudes related to the course content

In the pilot run of the course, the surveys encouraged the participants to give as much feedback as possible in order to provide useful information from their experience to course developers and designers, so further space for comments was allocated. They also were encouraged to enter their real name or email in the “nick” field, if they agreed to share their identity, allowing a further possible quality check of the surveys and the course itself.

To correlate the data before and after the course, the trainees were also asked to use the same "nick" when asked for it in the evaluation questionnaire at the end of the course. As was explained to the trainees, this would allow studying the evolution of the course participants, as at the end of the course the same (seven) test statements are presented. So, in principle, if the trainees had carefully worked through the course and all test questions, they should be able to respond whether a test statement was correct or not.

5.3 Course implementation

After Fusion for Energy had selected persons from sub-contractors that should participate in a pilot run of this course, these persons subsequently were invited by UNED to access the course in *UNED Abierta* (see above). The work of these persons with the course was tracked, in particular the grades of the examination at the end of the course.

For that purpose, a set of examination questions were developed that referred to the content presented in the videos. These examination questions are set up as multiple-choice questions: one question and three responses, but only one is correct. The questions shall be solved by the trainees for documenting that they have achieved the training objectives. Altogether, 40 possible examination questions were developed. By random, out of this set, ten questions are selected for each course student. When they have answered 70% (seven questions) correctly, they will be awarded a training certificate, stating that they have successfully participated in this training course.

The number of possible test questions allocated to the 5 different course chapters depends on the significance of the chapters for the overall training objectives, and the scope of the training content in these chapters. The numbers were specified as follows:

Chapter no.	Chapter title	No. of slides	No. of test questions
2	Basics of Fusion	14	15
3	Why Nuclear is different!	4	6
4	Safety objectives and functions at ITER	3	6
5	Contribution of a safety culture to achieving safety objectives	4	6
6	Nuclear Safety Culture: management /individual commitment	9	17

Table 2 ***Number of examination questions allocated to course chapter***

Chapter 1 deals with a course introduction only, so no test questions are required. By random, for each course student one question will be drawn from chapters 2 to 5, and six for chapter 6. In addition to these examination questions, test questions were developed that are to be presented during the course at the end of each chapter, and to be solved by the participants for recapitulation of the course content in a chapter. These test questions also are set up as multiple-choice questions: one question and three responses, but only one option is correct. However, here the trainees may skip the test, and consider the correct solution directly. If they perform the test, for each response a feedback is given to present once again the related course content, see example below in figure 19:

Nuclear safety in the ITER project is a collective responsibility. Managers must commit to			
No.	**Options**	**Correct**	**Feedback when option is selected**
1	*exhibit behavior that set the standard for safety.*	X	Exactly! Managers must be an example for their subordinates.
2	*not disturb the work activities of their subordinates in the work environment.*		No, on the contrary, they should be commonly seen in working areas of the site observing, coaching, and reinforcing standards and expectations.
3	*blame their subordinates timely when they have committed errors in their work tasks.*		This will not help at all! Everyone must be treated with dignity and respect, and encouraged to voice concerns, provide suggestions, and raise questions.

Figure 19. Example of test question after end of chapter 6

The result of the examination to be performed at the end of the course finally allowed UNED to issue a certificate for successful attendance of the course when 70% of correct responses had been given.

5.4 Course preparation questionnaire – feedback from participants

When accessing the course in the Internet through the contact data distributed by UNED to the participants of the pilot run, the trainees were asked to enter data in a course preparation questionnaire before starting the course, see Annexes 6 and 7. As was explained to the trainees, the aim was to contribute to improve the course through considering their responses. The questionnaire also contained seven test statements to become informed about the existing knowledge and attitudes of the trainees. These test statements were taken from the test questions that were asked at the end of each chapter during working with the course, they were composed of the question itself and one correct or wrong response option. In summary, three statements were correct (nos. a, c, g), and four three statements were not correct (nos. b, d, e, f). They covered all five chapters of the course, two of them specifically related to chapter 6 (*Nuclear Safety Culture: management /individual commitment*), see also chapter 5.5.

In summary, 14 trainees filled out the course preparation questionnaire; however, only ten persons provided a nick name, and out of these only six were used again in the course evaluation questionnaire. As for the general information from the participants, the following responses were given:

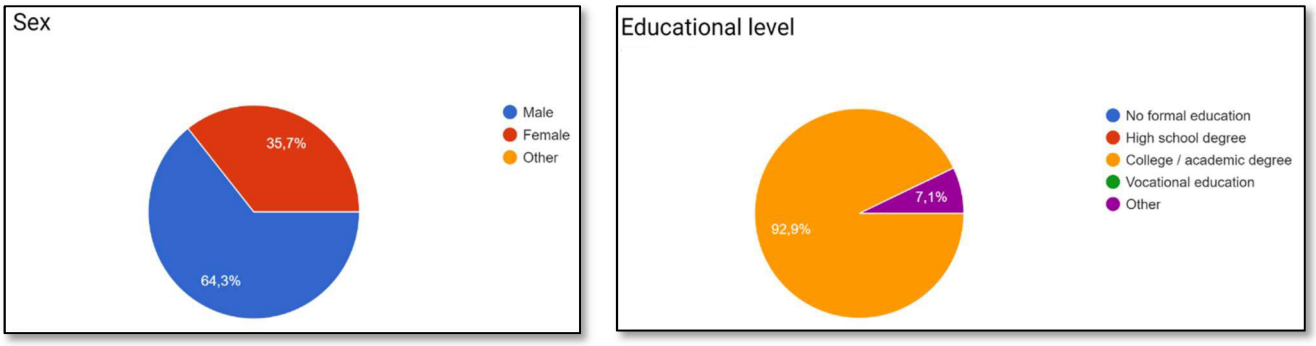


Figure 20. Distribution of responses: sex and educational level

Two thirds of the participants were male, and more than 90% had a college / academic degree.

Next, what about their involvement in the ITER project?

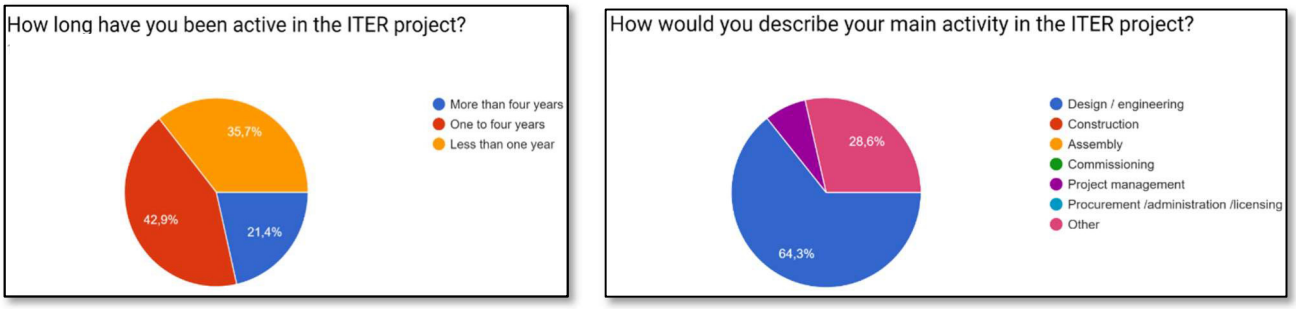


Figure 21. Involvement in the ITER project

About one third of the participants was involved in the ITER project less than one year, somewhat more than 40% have been active one to four years. And the majority (nearly two thirds) is dealing with design / engineering, somewhat less than 30% are active in construction.

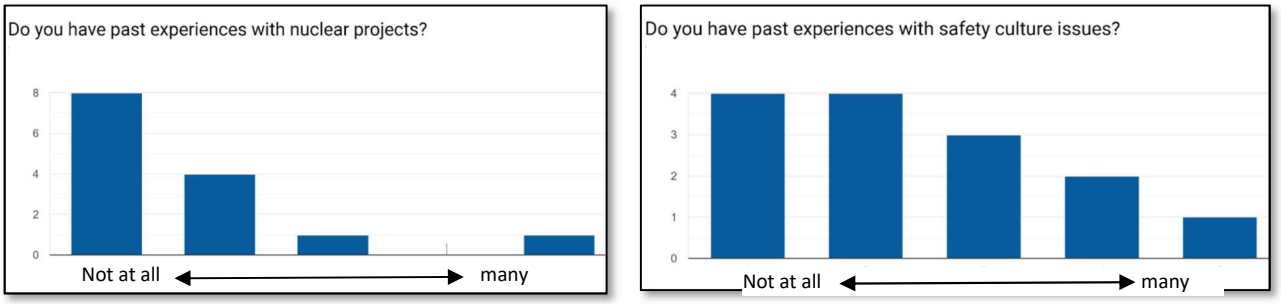


Figure 22. Past experiences with nuclear projects / safety culture issues

Consequently, most of the trainees had no past experiences with nuclear projects, and many had no past experiences with safety culture issues, see figure 22.

However, apparently many were already familiar with e-learning:

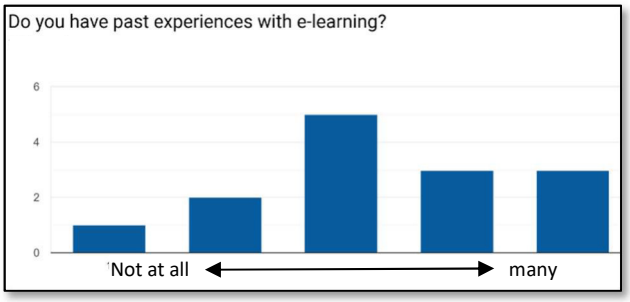


Figure 23. Past experiences with e-learning

And as for the expectations about the course, the majority expected to extend their knowledge about safety culture, whereas 14% and 14% wanted to improve their skills in the ITER project or adapt their behavior in this project, see figure 24.

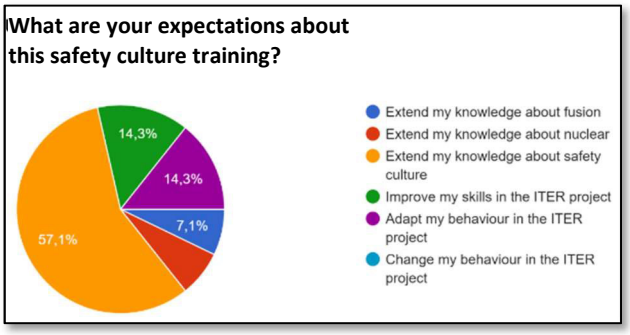
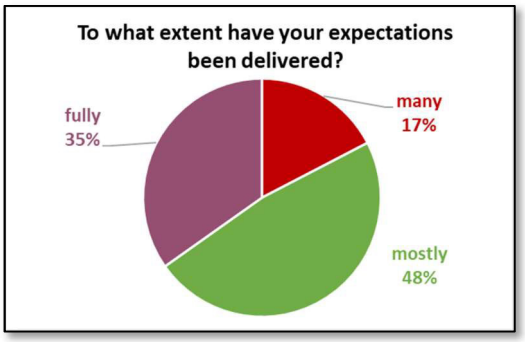


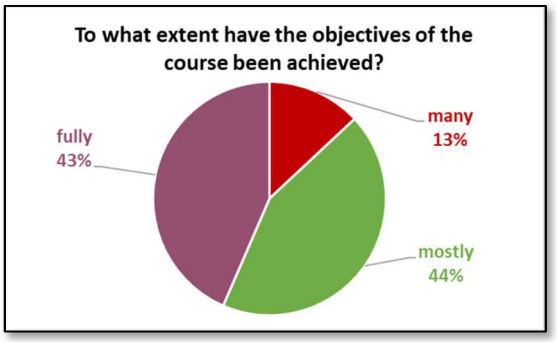
Figure 24. Expectations about the course

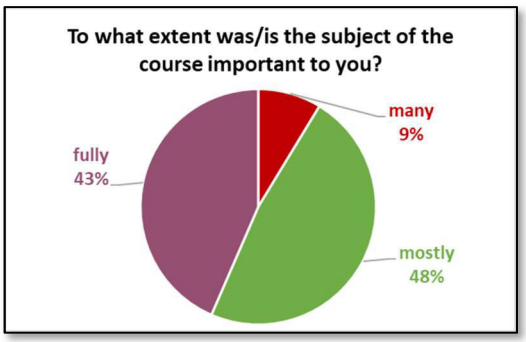
5.5 Course evaluation questionnaire – feedback from participants

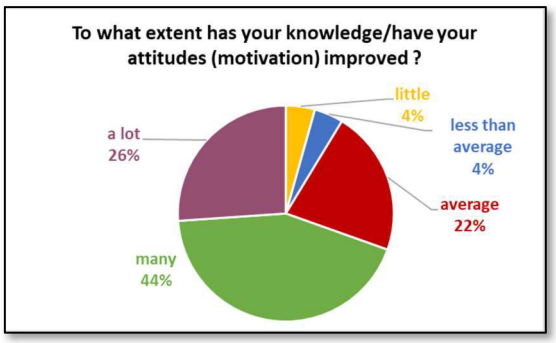
After having gone through the complete course (including the final examination at the end), the trainees were asked to provide their feedback on the course, namely in the topical areas of *Overall rating of the course and its importance for the trainee* / *Organization of the course* / *Training material and trainer*, see Annexes 8 and 9. And finally, they were asked to evaluate the test statements, i.e. the same as were presented to them in the course preparation questionnaire. In all, 23 trainees provided their feedback through responding to the course evaluation questionnaire.

As for the first topical area, the following responses were given:









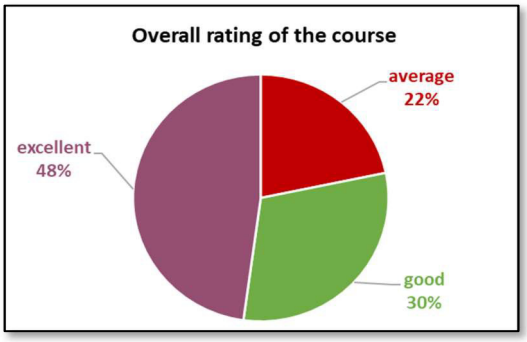


Figure 25. Overall rating of the course and its importance for the trainee

About 80% of the trainees made an overall rating of the course as excellent or good, supported by a general statement given by one trainee in the comment box: *My general opinion is very positive. The course provides a lot of important information in a short time, and in a clear way. It is not even boring.* This is consistent with the fact that for more than 80% of trainees stated that their expectations had been delivered as well as the course objectives had been achieved fully or mostly. And for more than 90% the subject of the course was important to them, consistent to the fact that for only 8% of the trainees their knowledge /their attitudes had improved little or less than average. Unfortunately, no further detailed comments were given by the trainees in the latter case.

As for the second topical area (*Organization of the course*), the following responses were given:

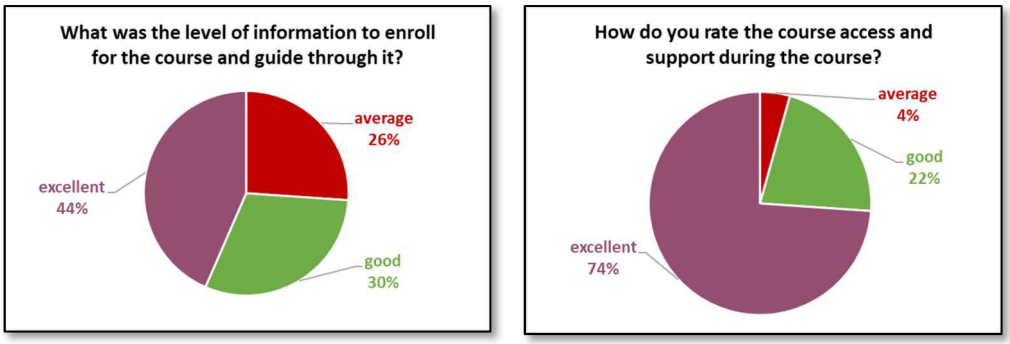
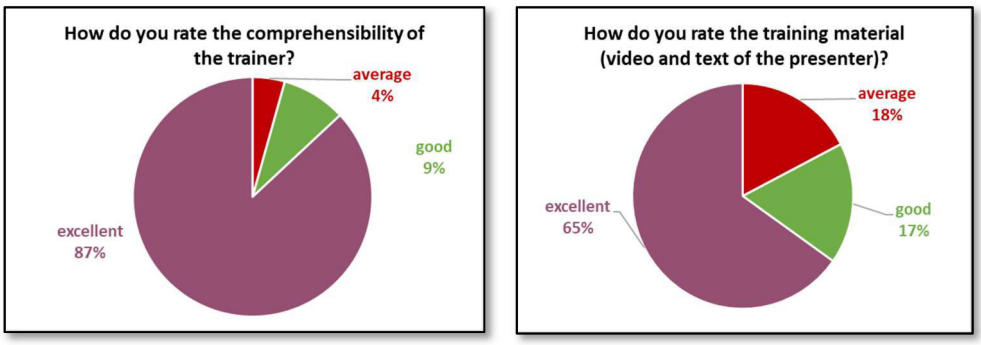


Figure 26. Overall rating of the course organization

Apparently, it was quite easy for the participants to access the course and attend it (i.e. watch the videos). Only enrolling and guiding through the course obviously may require some improvements.

And finally, for the last topical area (*Training material and trainer*), the following responses were given:



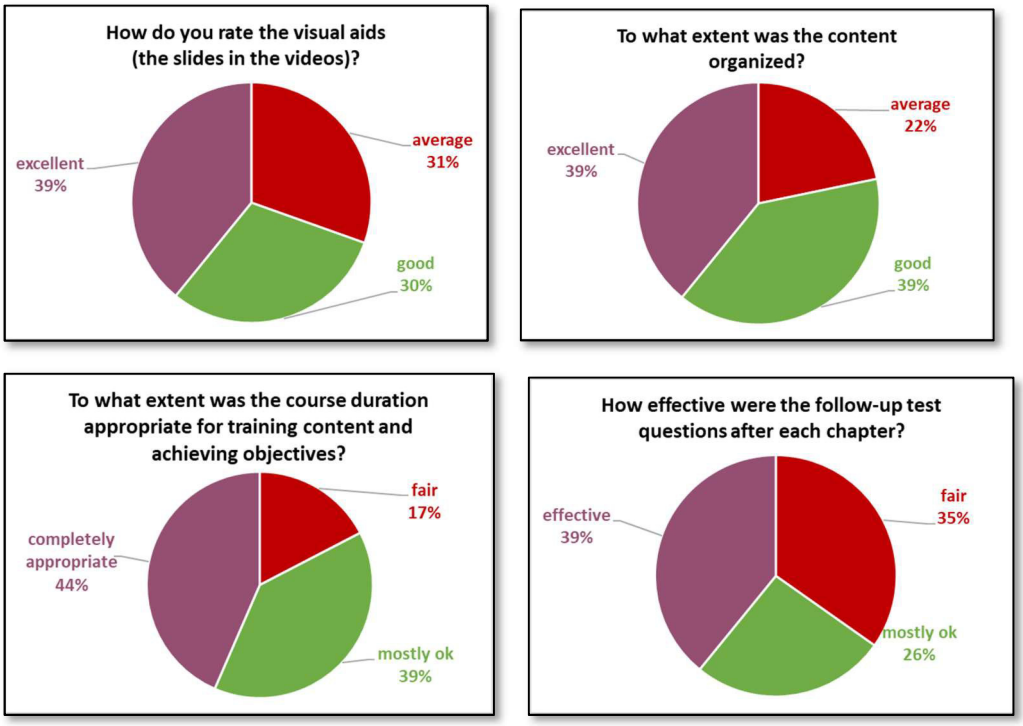


Figure 27. Overall rating of training material and trainer

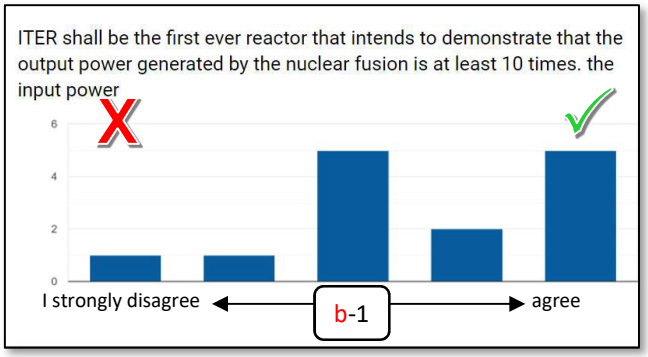
Nearly unanimously the trainer was rated as excellent. This certainly contributed not only to a good acceptance of the videos and thereby the course, but also to a very favorable learning climate. Comparably, the training material, content organization, and training duration were rated well. However, the slides as well as the follow-up questions after each chapter obviously may require some improvements. Unfortunately, no further comments were given by the trainees (except one: *slides are a little blurry*).

5.6 Comparison preparation ./. evaluation

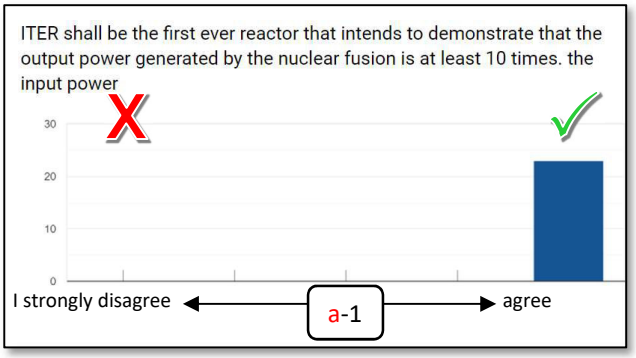
As already noted, some test statements were included to become informed about the existing knowledge and attitudes of the trainees before working with the course, and to allow for observing the evolution of the competences through the course.

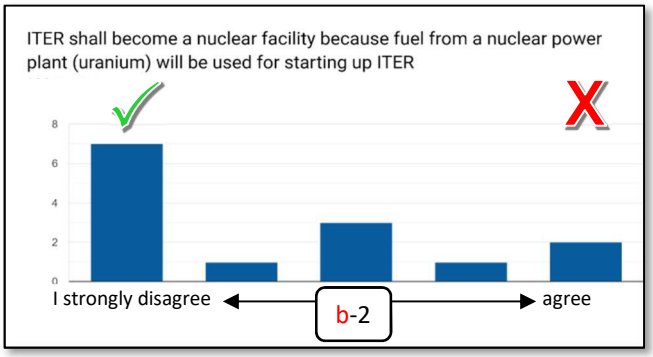
The results are as follows:

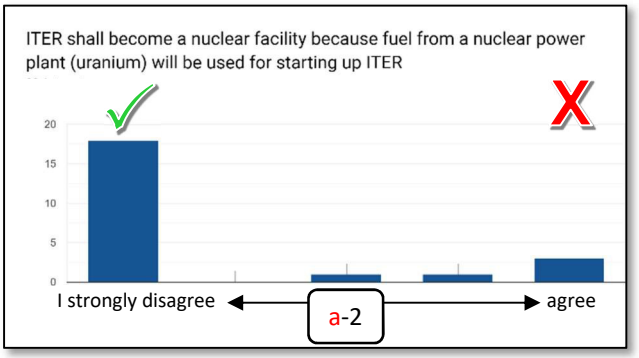
- before the course -

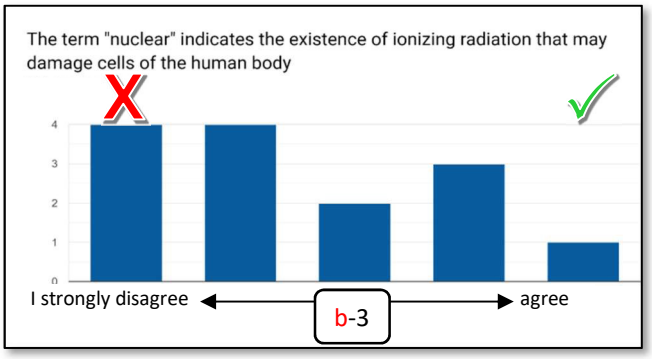


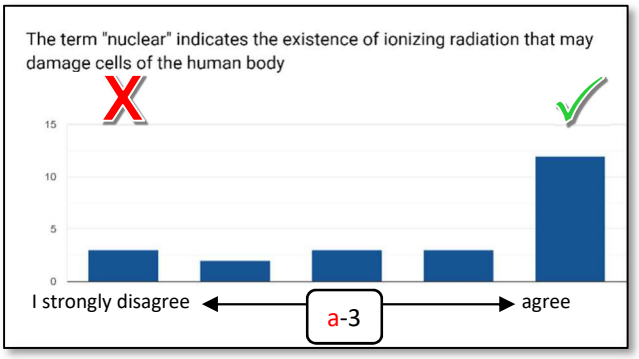
- after the course -

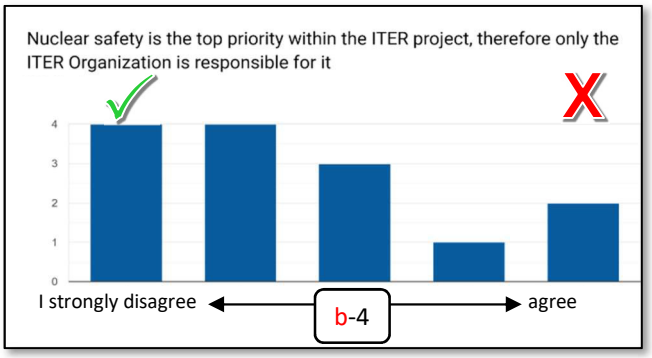


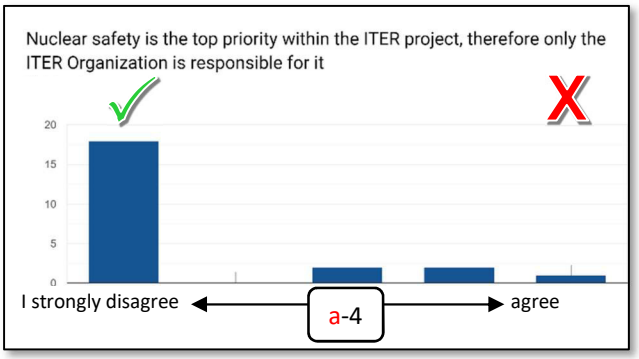

ITER shall become a nuclear facility because fuel from a nuclear power plant (uranium) will be used for starting up ITER
I strongly disagree
agree
b-2

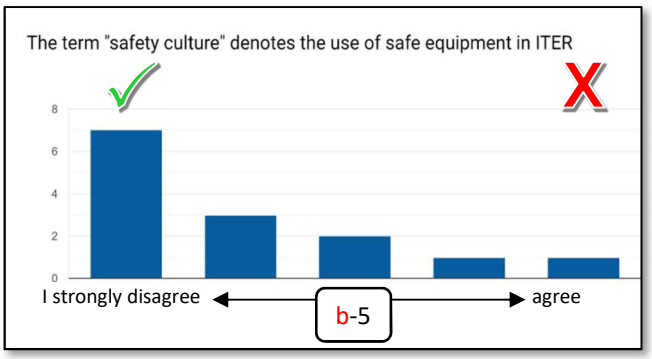

ITER shall become a nuclear facility because fuel from a nuclear power plant (uranium) will be used for starting up ITER
I strongly disagree
agree
a-2

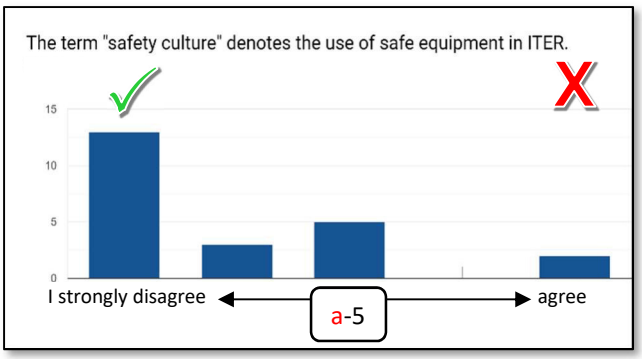

The term "nuclear" indicates the existence of ionizing radiation that may damage cells of the human body
I strongly disagree
agree
b-3


The term "nuclear" indicates the existence of ionizing radiation that may damage cells of the human body
I strongly disagree
agree
a-3


Nuclear safety is the top priority within the ITER project, therefore only the ITER Organization is responsible for it
I strongly disagree
agree
b-4


Nuclear safety is the top priority within the ITER project, therefore only the ITER Organization is responsible for it
I strongly disagree
agree
a-4


The term "safety culture" denotes the use of safe equipment in ITER
I strongly disagree
agree
b-5


The term "safety culture" denotes the use of safe equipment in ITER.
I strongly disagree
agree
a-5

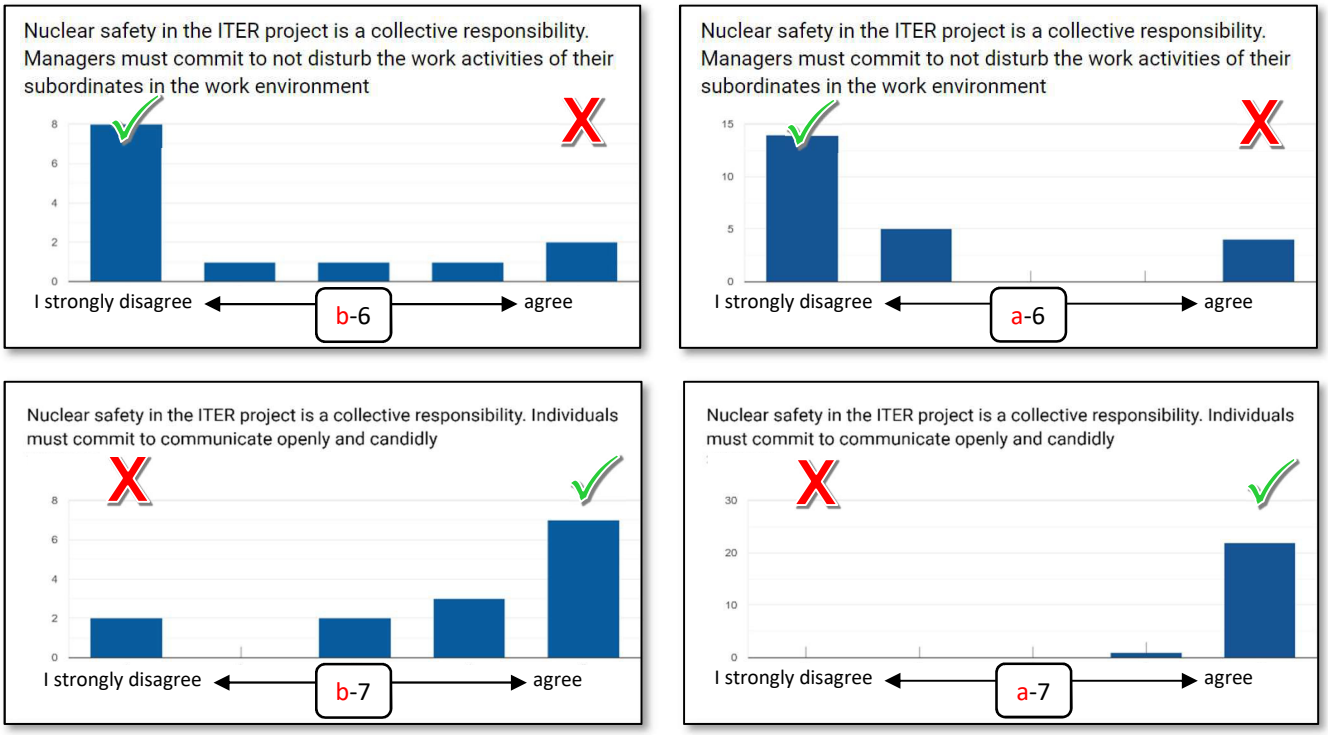


Figure 28. Results of test statements before/after course

The correct responses to test statements 1, 3 and 7 should have been *I strongly agree*, whereas for test statements 2, 4, 5 and 6 *I strongly disagree* would have been expected. A simple correct/incorrect selection also would have been appropriate for that purpose, but the selected feedback options additionally allowed to cover uncertainties with the trainees.

The trend for all assertions is to move the average selection to the correct position **after** the course. This is particularly evident for statements about fusion (1 and 2) and about the responsibility for nuclear safety (4), as well as about the individual commitment (7), so these issues were clarified by the course. However, it still was not completely resolved for the issues *What is* "nuclear" (3) and *What is* "safety culture" (5). And finally, as for the commitment of management (6), apparently this specific example has not yet become utterly clear for all participants. Considering that these test statements were taken from the test questions that were asked at the end of each chapter during the course, one would have expected that all statements would have been evaluated correctly if the trainees had taken notice of them with proper attention.

More quantitative details can be reported when looking at those trainees that used a (n anonymous) nick name, allowing to compare their selections before and after the course (unfortunately only applied by 6 trainees):

Question no.	1	2	3	4	5	6	7	Total average
average deviation **BEFORE**	33%	4%	46%	25%	25%	25%	4%	23%
average deviation **AFTER**	0%	0%	17%	21%	13%	8%	0%	8%

Table 3 ***Average deviations from correct response***

The total average deviation (i.e. difference between selected and correct value scaled to total spread of four) decreased considerably, however only slightly in statement 4, and somewhat more in statements 3, 5 and 6, while statements 1, 2 and 7 were evaluated correctly. Two trainees were able to reduce their average deviation from 29% / 32% to zero.

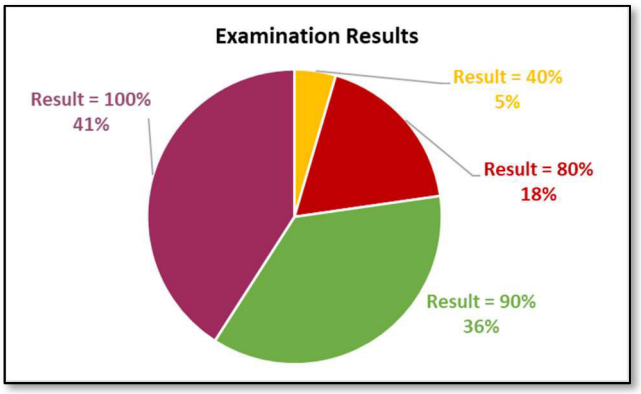


Figure 29. Examination results

Nonetheless, considering the results of the final examination, all but one of the 22 trainees passed the examination (pass threshold = 70%), and nearly half of the trainees had all responses correct, see figure 29.

5.7 Specific conclusions and recommendations

Although the trainees were asked through several mails encouraging them to register in the UNED platform in order to participate in the course and the final exam, it took very long to have a reasonable number of participants. Still not everyone participated in the course. Apparently, it seems to be necessary to provide more detailed instructions, e.g. a short self-explanatory video, how to access and work with the course. Additionally, it could be important to appoint one responsible person from the trainees' organization to remind and insist on the participation.

Finally, the pilot run of the course was attended by 23 trainees only (with 29 enrollments), while 22 trainees passed the final examination. Consequently, one may be apt to give the evaluation only a restricted validity because of this limited number. Furthermore, one drawback of the pilot run was that a part of the intended target group was not involved, namely persons that are active in construction and assembly, and persons with no academic educational background.

However, the feedback of the trainees in summary showed a high satisfaction with the course, i.e. in the overall rating of the course and its importance for the trainees, in rating the training material and especially the trainer, as well as in evaluating course access and support during the course. Only some improvements seem to be advisable for issues like slides, follow-up test questions, and course enrollment. Unfortunately, the trainees did not provide specific comments or recommendations in these cases. Therefore, as conclusion we recommend the (unmodified) course for further use in the ITER supply chain, as it provides in a compact way the important basic knowledge that is necessary for developing and fostering nuclear safety culture in the ITER project.

Regarding the initial and final survey, the total number of questions and the time estimated to answer them should be reconsidered. It might be too long, and the questions could be simplified, or

their number reduced to decrease the time needed to respond, thus encouraging this voluntary participation.

When the course will be implemented continuously in the ITER supply chain, one should regularly evaluate the feedback of the participants at specified dates and / or number of trainees having worked with the course. Thereby, the effectiveness of the course should be checked frequently, and corrective actions be initiated if required.

How the course will be used in the future will depend on several factors: first, of course, on to what extent the various companies in the ITER supply chain will be required to train their personnel on nuclear safety culture. This will have an impact on the related budget, not only for hosting the course (preferably by UNED), but also on the associated personnel costs, i.e. working hours during which the personnel will work with the course. Considering the complete supply chain, the number of persons targeted may easily reach some thousands, with a noticeable effect on the required budget. Next, the ease through which the employees of the different supply chain companies will have access to online courses in the Internet, and their experiences with online training will play a crucial role for acceptance of the course.

Here, one should note that the full potential of online training in this case has not yet been fully exploited. For example, one could install some forums for interactions:

- for technical assistance from the course providers (UNED in this case),
- for interaction between the trainees. No participation from the teaching team would be required. This would encourage participation in the course and raise of important subjects regarding the course contents and their involvement in the trainees´ organization. Closed groups for trainees from one company could also be established.
- for instructors' feedback. This would require the involvement of designated people from the teaching team, or other experts to attend the possible questions and/or to take care of the adequate answers from participants.

In these forums, one or more discussion threads could be implemented to guide the discussions. These could also be adapted to the specific needs of each organization or company in closed groups.

Furthermore, complementary material could be made available in these closed groups, e.g. links to sites with additional information on the topics dealt with in the course. Thereby, this training course could also be connected to other nuclear safety related activities within in a company, enriching it with internal, non-public material.

Of course, one may also further extend the course through including additional behavior examples, e.g. with short videos, presenting what is expected as individual or management commitment, i.e. focusing on motivation, attitudes, behavior. However, this will certainly require an additional development effort, and increase the course duration and thereby the training load on the supply chain work force.

Instead, it may certainly be beneficial to deploy the course (e.g.) when setting up a nuclear safety culture campaign at the ITER site, and when introducing personnel face-to-face at the ITER site to the site specifics in connection with an induction to occupational health and safety.

In summary, the course and its environment in the Internet (*UNED Abierta*) offer an enormous potential for reaching a large target group effectively, providing a short and concise as well as motivating introduction to nuclear safety culture, thereby contributing essentially to developing and fostering this culture.

To what extent this potential will be made use of, will depend crucially on how related senior manager in the ITER project will be made aware of it, and to what extent budget will provided to implement the course on a large scale.

6. GENERAL CONCLUSIONS AND RECOMMENDATIONS

As has become apparent during the ANNETTE project by now, there is a clear need to raise the nuclear awareness in fusion projects, especially in the ITER project. In this project you will find suppliers from different countries all over the world who apparently do not comprehend (resp. are not aware of) the specifics of French nuclear regulation, and its impact on their product life cycle activities. This impression was also noticed during the last ITER Business Forum in March 2019.

In the case of ITER, the complexity of the project, both in its technical as well as its project (budget, schedule, interfaces, communication, leadership) related terms, evidently seduces the involved stakeholders to focus on resolving the most urging technical issues. But these often are not directly related to issues of nuclear regulation, so often it is misjudged of small importance.

Furthermore, because of the inertia frequently met with industry, this often holds back companies to evolve and prepare effectively for a new, disruptive business environment, e.g. where nuclear regulation plays a significant role for approving services and products. Consequently, systematic competence development of human resources habitually is not significantly endorsed, as companies rely more on learning by doing (or on-the-job training), when new specific competence demands pop up.

Now in the ANNETTE project the systematic approach to training applied in WP6 allowed to focus on the most important topics where an urgent competence demand was identified. It could be met through the three training courses that were developed, and by now implemented in pilot runs.

Three different approaches to training implementation have been deployed. First, attracting master and PhD students as well as young professionals, i.e. the future academic work force in fusion (engineers and researchers), through a Summer School was an effective means to raise interest, as well as develop awareness and the related knowledge, e.g. on fusion. Although staying on a somewhat introductory and overview level, it nevertheless provided a motivating and stimulating out-of-the-box view on activities in the nuclear sector. In connection with the opportunity to establish international contacts and networks, this type of "training" certainly boosted the development of required nuclear competences (knowledge, skills and attitudes). On the other hand, the Summer School required many resources, which luckily could be provided through the ANNETTE project. Further editions of this successful Summer School not only will require enthusiastic organizers but also an appropriate budget, which cannot be delivered by the attendance fees only.

Here, it seems to be beneficial for the future to establish a permanent structure, e.g. under the auspices of the networking organizations ENEN and FuseNet. They preferably should be supported by interested industries or other organizations, with the mission to organize and implement repeated editions of the Summer School. Thereby the future nuclear (fission and fusion) work force could be regularly attracted, providing them with significant competences to start their professional career in the nuclear sector (including fusion, of course!).

Next, the pilot training course on nuclear regulation (A-NF-02) appeared to meet a real demand for a short but effective introduction to nuclear regulation. With the aim to bridge the gap between non-nuclear and nuclear activities in engineering, this course not only provided knowledge, but also fostered the development of skills to deal with nuclear regulation requirements. The short duration

of a two days course seems to be most adapted for the needs of industry, requiring for them only a modest investment in training their employees. The course will also create competences that will enable the participants to continue their competence development through finding and selecting further specialized training providers, e.g. to attend training focused on codes and standards[13] important for complying with nuclear regulation.

Therefore, it will be advisable to continuously offer this training course through (e.g. Internet) sites or forums that will address industry at large in relation with contracts to nuclear new builds, either in fission (like in the United Kingdom, Hinckley Point 2) or in fusion (ITER in France, or soon to come DONES in Spain). Framatome, a significant nuclear vendor active on an international level, certainly is best suited for this task through its training center, which was also responsible for development and implementation of the pilot run.

Related to this, another future task would be to develop and provide supply chain industry with a comprehensive overview about training offers and opportunities, possibly also recommend training curricula. Without doubt this would help industry to identify a suitable training course required to quickly build up required competences in certain circumstances. In the case of the ITER project, this training hub should ideally be developed and hosted by the ITER Organization itself.

Finally, in view of a large and locally as well as timely and organizationally dispersed target group of employees in the industry supply chain of nuclear projects, an e-learning method like the one applied in A-NF-03 appears to be the most effective way to deal with this group comprehensively. However: depending on the training content and objectives, of course, it is often not easy to decide on the appropriate level of investment in course development that is necessary to achieve the wanted outcome. Especially when launching a campaign to change and foster motivation, attitudes and behaviors of employees into a certain direction, training like A-NF-03 can only contribute to a certain degree to the desired result. Therefore, it would not really make sense to invest more in expanding this type of training, e.g. by including videos that could show unwanted or expected behavior. In the case of A-NF-03, the effort spent appears to be completely suitable for the purpose it was developed for.

When informing about and advertising the use of A-NF-03, it is necessary to point out that this course is not a silver bullet ready to solve any nuclear safety culture issue. Instead, because of its informative, motivating and general although introductory content it is well suited to be used in diverse ways, thereby constituting an important brick stone in a well-organized culture curriculum.

To continue WP6 in the ANNETTE project with its next sub-task (T6.4 *Support the participation in nuclear training activities*), it seems to be of the utmost importance now to get connected to senior management in key organizations, e.g. to the heads of the nuclear safety divisions in ITER Organization, Fusion for Energy, or comparable organizations. They must be made aware on the availability of the ANNETTE fusion training offer, which is now ready for recurrent application, as it can be deployed with no further costs for training development. Furthermore, all available communication channels to fusion industry must be used to inform about the training offer, as well as to provide information about further important training that is available to raise nuclear awareness in the fusion environment.

[13] e.g. ASME, see https://www.asme.org/about-asme/standards, or RCC-MRx, see https://afcen.com/en/publications/rcc-mrx

7. REFERENCES

[1] IAEA Technical Reports Series No. 380: Nuclear Power Plant Personnel Training and its Evaluation, International Atomic Energy Agency, Vienna / Austria, 1996

[2] ANNETTE Deliverable D6.2: Available Nuclear Training Programmes for Fusion and Identification of Gaps, 2017

[3] ANNETTE Deliverable D6.3: Developed Fusion Specific Training Courses, 2018

Annex 1: Training Description A-NF-01
Fundamental Knowledge on Fusion and Nuclear Aspects

Target group of training

The training shall target fusion (industry) professionals, scientists and students to facilitate the further migration of nuclear competences into this group, thereby supporting the current and future research and development activities for the roadmap to fusion energy.

Alternatively, the training also targets (industry) professionals, scientists and students from the nuclear/fission field. They have already many of the nuclear competences, but they lack the fusion basics. By providing them with that knowledge they can easier interact with the fusion field and bring in their competence in this field.

Prerequisites of target group

The targeted trainees should have undergone a suitable engineering education, preferably in a technical subject matter important for their actual job position, at an academic level. They shall be able to understand the general engineering and physics principles at a bachelor level. For the specific nuclear knowledge (in case for the fusion students) or the fusion knowledge (for the population from the nuclear field) no prerequisites are needed. The training aims at providing this information in a comprehensive way.

Training objectives

The training should impart knowledge on the specific nuclear aspects of fusion: the issues concerning the neutron irradiation, material damages, tritium breeding, tritium handling and safety, radio-active waste, and nuclear codes and standards.

After the training, the trainees shall be able to explain:

1) The impact of neutron radiation on materials
2) How to shield neutrons effectively
3) How to breed tritium
4) What are the safety aspects concerning tritium
5) What are the worst-case scenarios concerning safety for a fusion reactor
6) How the radioactive waste is reduced
7) What implications the nuclear aspects have for the design and licensing of a fusion reactor

In addition, the Nuclear community will be able to explain:

a) Why the D-T reaction is the exploited in a fusion reactor
b) How to breed the tritium
c) What the criterion is to achieve fusion and why a temperature of 150 MK is needed
d) Why superconducting magnetic fields are needed, and why bigger machines are better
e) How to exhaust the power and the particles from a reactor.

Training content

Training will consist of a mix of plenary lectures, group assignments and technical lectures.

The following learning content should be dealt with in the training (in the fusion part):

1. Introduction to and overview of the fusion reactor*: details why fusion is nuclear, and the implications on design /construction/ operation of fusion facilities, overview of further important technologies to be mastered when constructing fusion power plants, e.g. plasma/ vacuum/ cryogenic/ electromagnetic/ tritium/material technologies (plenary lecture)*
2. The 7 challenges of the fusion research programme: to give an overview of the state of the art, and how the nuclear aspects play a determining role in this: tritium breeding, material aspects upon neutron irradiation, confinement and control of instabilities etc. (plenary lecture)
3. An interactive session to discuss the implication of the nuclear aspects have on the design of a fusion reactor (group assignment)
4. A dedicated session on tritium: the safety aspects, the breeding, the recirculation, the confinement etc. (technical lecture)
5. A dedicated session on neutron irradiation on materials (technical lecture)

In addition, the generic nuclear part of the programme (nuclear technology, rad. waste management and radiation protection) is detailed elsewhere.

Training development

Experts on the topics to be addressed in the training shall develop slides that will be presented in the knowledge-oriented part.

Training method

The training has a mix of activities: plenary lectures discussing the basic ingredients, technical lectures to discuss in an interactive manner with a smaller audience the nuclear issues in more detail. Smaller exercises or assignments will be part of these lecture. Finally, one group assignment (“design a fusion reactor that can deal with the nuclear aspects”) will have to be worked out, so that the students apply the knowledge gained in the lectures.

Training duration

In total, two days will be an ideal duration to discuss the fusion specific aspects, i.e. all the content as listed above can be addressed in the training. However, the fusion students will also benefit from the generic nuclear training (aimed at the fission-oriented students) and an extra 2-3 days for these topics is advantageous, making the fusion students ‘Nuclear Aware’. Therefore, a duration of one week will be necessary to cover the complete training content in the summer school.

Training material

The slides must not be overloaded with text (if only text on a slide: about 7 lines with 7 words each). The text and associated photos / figures / diagrams shall logically sub structure the content as outlined above. They should be fit for purpose to achieve the training objectives.

It is recommended to develop a training manual that includes all the text that shall be presented by the expert (trainer) when the corresponding slide is shown. Spoken text and slide should correspond, it is recommended to present a slide part by part, in parallel to the talk of the expert. The manual possibly could be used later for the development of an e-learning course.

These slides should be useable for self-study afterwards. If not, the lecturer should provide a concise description of his presentation, or a video recording of the presentation will be made.

Evaluation of training effectiveness

After the training, feedback from the trainees shall be collected to evaluate how the trainees liked the course – with respect to course organization, fulfilment of their expectations, achievement of training objectives, quality of training material, competences of the trainer (i.e. expert as presenter).

Finally, a test (best: a “kahoot –like quiz) shall be passed by the trainees to check whether they have achieved the training objectives.

Annex 2: Training Description A-NF-02
Regulation and its Application in Nuclear Projects

Target group of training

The training shall target engineers that are employed by the ITER Organization, Fusion for Energy, or their sub-contractors in the ITER project (down to the lowest level), and active in ITER related design, procurement, manufacturing, construction, assembly, and commissioning of ITER equipment.

Prerequisites of target group

The targeted trainees should have undergone a suitable technical engineering education, preferably in a technical subject matter important for their actual job position. They shall be able to understand the basic design of a power plant and its systems and components, and the technical basics (physics/chemistry resp. design/operation) of a nuclear (fission or fusion) reactor.

Training objectives

The training should impart specific knowledge on nuclear licensing and the impact of licensing requirements on design as well as on subsequent down-stream activities. Furthermore, it should be complemented by additionally training the skills that are necessary in the nuclear environment of a fission or fusion project like ITER.

After the training, the trainees shall be able to

1. shortly describe some national / international nuclear law(s) and related regulation, and their impact on design/manufacturing/construction/assembly/commissioning activities,
2. list and shortly describe some important Codes and Standards (C&S) and their impact on regulation or licensing,
3. list and shortly describe some basic safety principles and their impact on management / technology / project processes,
4. shortly explain the importance of safety analysis, and their application in licensing, design/manufacturing/construction/assembly/commissioning activities,
5. integrate important nuclear regulation requirements into fission or fusion projects, and perform basic requirements management activities,
6. apply important nuclear regulation requirements in some design / manufacturing / construction / assembly / commissioning activities.

Training content

Training will consist of a knowledge-oriented part, and a skills-oriented part.

The following learning content should be dealt with in the training:

1. Introduction to and overview of national / international nuclear law(s) and related regulation, involved national and international organizations (e.g. ASN, IAEA),

2. Main licensing activities / deliverables / responsibilities,
3. Overview of Codes and Standards (C&S) and introduction to relevant C&S, their impact on regulation or licensing,
4. Introduction to and overview of nuclear risks, safety objectives, and derived requirements,
5. Basic safety principles: management / technology / process oriented (e.g. defense in depth),
6. Introduction to (deterministic and probabilistic) safety analysis and related tools used by different technical disciplines for simulations in support of licensing,
7. How to integrate nuclear regulation requirements into fusion projects, and perform requirements management,
8. How to apply nuclear regulation requirements in design/manufacturing/construction/assembly/commissioning activities.

The knowledge-oriented part shall deal with topics no. 1 to 5, whereas the skills-oriented part shall focus on topics no. 7 and 8. To some extent the content no. 1 to 5. may be known to some participants, but a summary and overview shall be presented, and discussed in the first part of the training. Thereby it shall provide the basis for the second part, which shall develop the skills required to apply important nuclear regulation requirements in design, procurement, manufacturing, construction, assembly, and commissioning of ITER equipment.

Training development

Experts on the topics to be addressed in the training shall develop slides that will be presented in the knowledge-oriented part.

As for the skills part, examples provided by ANNETTE partners from industry or from IO or F4E shall be taken to develop case studies. They must describe a fission/ fusion relevant scenario, e.g. based on their past experiences with contract follow-up, collected e.g. through reports on findings or non-compliances during contract execution, and provide all relevant information thereof. The case study will contain several exercises that must be solved / worked through by the trainees.

Training method

Face-to-face presentation during the knowledge-oriented part, where appropriate slides (altogether about 50 – 60) are shown and explained by topic related experts with good training experiences. During presentation, the trainees shall be animated to discuss the content with the trainer(s).

Principally, the first (knowledge oriented) part could be transformed into an e-learning course. However, the current restrictions of the ANNETTE budget will only allow for the development of slides and possibly also a training manual. In a next step, this material could be used to develop the e-learning course.

Case studies will have to be used that shall be worked through by the course participants during the skills-oriented part.

Training duration

In total, two days will be an ideal duration, so that all the content as listed above can be addressed in the training. The first part (knowledge related) should last for one day, the second part (skills related) should also last for one day.

Training material

The slides must not be overloaded with text (if only text on a slide: about 7 lines with 7 words each). The text and associated photos / figures / diagrams shall logically sub structure the content as outlined above. They should be fit for purpose to achieve the training objectives.

It is recommended to develop a training manual that includes all the text that shall be presented by the expert (trainer) when the corresponding slide is shown. Spoken text and slide should correspond, it is recommended to present a slide part by part, in parallel to the talk of the expert. The manual could be used later for the development of an e-learning course.

Evaluation of training effectiveness

After the training, feedback from the trainees shall be collected to evaluate how the trainees liked the course – with respect to course organization, fulfilment of their expectations, achievement of training objectives, quality of training material, competences of the trainer (i.e. expert as presenter).

Finally, a test (best: a set of about 5 multiple choice questions / one correct answer) shall be passed by the trainees to check whether they have achieved the training objectives.

Annex 3: Training Description A-NF-03
Nuclear Safety Culture in the ITER Project – The Supply Chain

Target group of training

The training shall target workers that are employed by sub-contractors of the ITER project (down to the lowest level), and active in ITER related manufacturing, construction, assembly, and commissioning of ITER equipment.

Prerequisites of target group

The targeted trainees should have undergone a suitable vocational training, preferably in a technical subject matter important for their actual job position. They shall be able to understand basic technical descriptions (including schematics) of a power plant and its systems and components.

Training objectives

After the training, the trainees shall be able to

1. shortly describe the main mission of ITER,
2. shortly explain why ITER is a nuclear facility, and what are the resulting risks that must be handled during its operation,
3. list some measures to protect the ITER machine, the ITER staff and the environment from the radiation,
4. describe the main elements of a nuclear safety culture,
5. list some responsibilities of managers regarding nuclear safety culture,
6. list some responsibilities of individuals regarding nuclear safety culture,
7. list important personal behavior that reinforces nuclear safety culture,
8. describe how this can contribute to a healthy nuclear safety culture.

Training content

Training shall be implemented as e-learning, where appropriate slides are shown and explained by an expert on nuclear safety culture for ITER (see below).

The following learning content should be dealt with in the training:

1. Basics of ITER: its mission, layout, nuclear reaction (about 5 slides)
2. Why nuclear is different to other high-risk industries: nuclear risks and entailed safety objectives, and the resulting implications on licensing, design, manufacturing, construction, assembly, and commissioning *(about 3 slides)*
3. ITER design and the safety functions that shall achieve safety objectives *(about 4 slides)*
4. Contribution of a safety culture to achieving safety objectives, and its main elements as well as actors *(about 4 slides)*
5. Traits of a healthy nuclear safety culture: management commitment *(about 2 slides)*
6. Traits of a healthy nuclear safety culture: individual commitment *(about 2 slides)*

7. Implications for behavior of personnel that is active in manufacturing, construction, assembly, and commissioning of ITER components, either at manufacturers' sites, or at ITER construction and assembly site *(about 5 slides)*

No. 5 and 6 and consequently also no. 7 could rely on the INPO document Traits of a Healthy Nuclear Safety Culture *(INPO 12-012, April 2013).*

Training development

Experts on the topics to addressed in the training shall develop slides that will be presented in an e-learning course. The slides will be reviewed by representatives of IO or F4E to ensure that the IO safety policy is implemented in the training. The slides will also be reviewed by the ANNETTE WP6 team to ensure that they are fit for purpose to train the target group.

Training method

e-learning, where appropriate slides (altogether about 20 – 30) are shown and explained by an expert on nuclear safety culture for ITER. The trainees shall be invited to access and work through the e-learning via the Internet.

Training duration

In total, 1 hour could be an ideal duration, so that all the content as listed above can be addressed in the training.

Training material

The slides must not be overloaded with text (if only text on a slide: about 7 lines with 7 words each). The text and associated photos / figures / diagrams shall logically sub structure the content as outlined above. They should be fit for purpose to achieve the training objectives.

As the training shall be delivered as e-learning, where an expert presents and talks about the slides, it is recommended to also develop a training manual that includes all the text that shall be spoken by the expert when the corresponding slide is shown. Spoken text and slide should correspond, it is recommended to present a slide part by part, in parallel to the talk of the expert.

Evaluation of training effectiveness

After having worked through the e-learning, feedback from the trainees shall be collected to evaluate how the trainees liked the course – with respect to course organization, fulfilment of their expectations, achievement of training objectives, quality of training material, competences of the trainer (i.e. expert as presenter).

Finally, a test (best: a set of about 5 multiple choice questions / one correct answer) shall be passed by the trainees to check whether they have achieved the training objectives.

Annex 4: A-NF-02 Framatome Course Feedback Questionnaire

framatome

Feedback - A look back at training!

Training course, training no., date
Place, building – room number

Rating scale:

+ + = Fully applies
+ = Largely applies
+/- = Partially applies
- = Does rather not apply
- - = Does not apply at all

To improve the quality of our trainings, we would be pleased to receive your feedback.

Note: For data protection purposes we may only take your feedback into consideration, if you do not enter any personal data (such as the name of the trainer) on this feedback form.

Training support	+ +	+	+/-	-	- -
Support before and during the training and the information on training were very good.	☐	☐	☐	☐	☐
The training rooms and service (refreshments, catering) were very good.	☐	☐	☐	☐	☐

Content of the course and its implementation	+ +	+	+/-	-	- -
My personal expectations were met	☐	☐	☐	☐	☐
The content structure was logical, the central theme was clear.	☐	☐	☐	☐	☐
The duration of the course was just right	☐	☐	☐	☐	☐
The trainer(s) conveyed the content proficiently	☐	☐	☐	☐	☐
The trainer(s) responded to questions from participants	☐	☐	☐	☐	☐

Course materials	+ +	+	+/-	-	- -
The quality of the course documents was very good	☐	☐	☐	☐	☐
The amount of course documents was adequate	☐	☐	☐	☐	☐
I can handle the training documents very well	☐	☐	☐	☐	☐

Using the training measures	+ +	+	+/-	-	- -
I have acquired new knowledge and gained experience	☐	☐	☐	☐	☐
I can put what I have learnt into practice	☐	☐	☐	☐	☐

Overall impression	+ +	+	+/-	-	- -
On the whole I am very satisfied with the course	☐	☐	☐	☐	☐

What I especially enjoyed:

Suggestions and tips:

I heard about the course on: Intranet, internet, from brochures, flyers, push-message, colleagues, management, project

Framatome GmbH
Learning Solutions
Training Center

Thank you for your feedback!

Annex 5: Course Overview of A-NF-03, presented in the UNED LMS

Title of the Course:
Nuclear Safety Culture in the ITER Project: the Supply Chain
Organization:
FuseNet Association (www.fusenet.eu, Eindhoven, The Netherlands)
Person responsible:
Christian Schoenfelder (christian@schoenfelder.training, Schoenfelder.Training, Köln, Germany)
Person to present the videos (i.e. slides):
Neill Taylor (neill.taylor@ukaea.uk, UKAEA, Culham, UK)

No.	Title of video	Slide nos.	Appr. Duration [min]	Synopsis	Key words
1	Introduction and Overview	1 - 4	4	Provides an introduction into the course, and an overview of its content, as well as its training objectives	introduction, overview, table of content, training objectives, learning outcomes
2	Basics of Fusion	5 - 19	22	Delivers some technical content that is a basis for the rest of the course, namely an introduction to ITER and its main characteristics and equipment (tokamak, magnets, tritium, heating, fuel cycle, heat extraction)	tokamak, fusion criterium, confinement, magnets, tritium, heating, fuel cycle, heat extraction
3	Why Nuclear is different!	20 - 24	6	Explains the notion of risk and the specifics of nuclear: ionizing radiation, and its impact on people, hence the ITER safety equipment and their safety functions are introduced	risk, ionizing radiation, safety objective, ITER safety equipment, ITER safety functions
4	Safety objectives and functions at ITER	25 - 28	5	Nuclear safety is the top priority in the ITER project, so ITER safety functions are explained to achieve nuclear safety	nuclear safety, top priority in ITER project, ITER safety functions
5	Contribution of a safety culture to achieving safety objectives	29 - 33	8	To ensure nuclear safety, a safety culture must be implemented. Safety culture is explained, the stakeholders involved are presented, and how to achieve safety objectives through safety culture	nuclear safety, safety culture, stakeholders
6	Nuclear Safety Culture: management /individual commitment	34 - 43	10	As nuclear safety is a collective responsibility, the commitment of managers and individuals to safety culture is introduced and explained. Expectations on attitude and behavior of course students are presented.	nuclear safety, safety culture, commitment of managers and individuals, expectations on attitude and behavior

Annex 6: A-NF-03 Course Preparation Questionnaire (complete content)

Course Preparation Questionnaire

Dear colleage, as you are entering the course with the aim of testing it in this BETA version, we have added at the end a special space for feedback about this questionnaire. Please feel free to comment on any relevant issue for you. Also you can put your complete name if you wish in the "Nick" field if you don´t mind us to know who you are.

Dear course participant, we may kindly ask you to respond to this questionnaire as fully as possible on all relevant items. This will greatly contribute to continuously improve the course.
Of course your data will be kept confidentially.
Completing the questionnaire (14 questions plus 7 checks of your pre-knowledge and attitude) should take no more than 5 minutes.
Please select (where scoring ranges are given) the score that most closely represents your views, and provide us with further comments if deemed appropriate.

In order to relate your data before and after the course, and given the anonymous character of the questionnaire, we kindly ask you to fill the field " Nick " with any combination of letters and numbers you choose, and keep it where you can recall if, to use the same one when we ask for it in the questionnaire at the end of the course. This will allow us to study the evolution of the course participants.

1	**Nick**	
2	**Sex**	❍ **Male** ❍ **Female** ❍ **Other**
3	**Year of birth**	**Please select …** *Years ranging from 1940 to 2000*
4	**Country of residence**	**Please select** *List of countries ranging from Afganistan to Zimbabwe / Other*
5	**Educational level**	❍ **no formal education** ❍ **high school degree** ❍ **college / academic degree** ❍ **vocational education** ❍ **other**
6	**What is your organizational assignment in the ITER project?**	❍ **ITER Organization** ❍ **F4E** ❍ **ITER supply chain** ❍ **Other**
7	**How long have you been active in the ITER project?**	❍ **more than four years** ❍ **one to four years** ❍ **less than one year**
8	**What is your hierarchical position?**	❍ **Senior management** ❍ **Supervisor** ❍ **Team member** ❍ **Other**
9	**How would you describe your main activity in the ITER project?**	❍ **Design / engineering** ❍ **Construction** ❍ **Assembly** ❍ **Commissioning** ❍ **Project management** ❍ **Procurement /administration /licensing** ❍ **Other**

10	**Do you have past experiences with nuclear projects?**	**Not at all**	**1**	**2**	**3**	**4**	**5**	**Many**
11	**Do you have past experiences with safety culture issues?**	**Not at all**	**1**	**2**	**3**	**4**	**5**	**Many**
12	**Do you have past experiences with e-learning?**	**Not at all**	**1**	**2**	**3**	**4**	**5**	**Many**

13	**What are your expectations about this safety culture training?**	❍ **extend my knowledge about fusion** ❍ **extend my knowledge about nuclear** ❍ **extend my knowledge about safety culture** ❍ **improve my skills in the ITER project** ❍ **adapt my behaviour in the ITER project** ❍ **change my behaviour in the ITER project**

Other:

14	**Further comments:**

Check of pre-knowledge and attitudes:
Before starting the course, we would like to be informed about your existing knowledge and attitudes. Please select the score that most closely represents your views.

a	**ITER shall be the first ever reactor that intends to demonstrate that the output power generated by the nuclear fusion is at least 10 times. the input power**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
b	**ITER shall become a nuclear facility because fuel from a nuclear power plant (uranium) will be used for starting up ITER.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
c	**The term *nuclear* indicates the existence of ionizing radiation that may damage cells of the human body.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
d	**Nuclear safety is the top priority within the ITER project, therefore only the ITER Organization is responsible for it.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
e	**The term "safety culture" denotes the use of safe equipment in ITER.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
f	**Nuclear safety in the ITER project is a collective responsibility. Managers must commit to not disturb the work activities of their subordinates in the work environment.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
g	**Nuclear safety in the ITER project is a collective responsibility. Individuals must commit to communicate openly and candidly.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**

Further comments for the BETA version participants:

Annex 7: A-NF-03 Course Preparation Questionnaire (look&feel example)

Course Preparation Questionnaire

Course Preparation Questionnaire

Dear colleague, as you are entering the course with the aim of testing it in this BETA version, we have added at the end a special space for feedback about this questionnaire. Please feel free to comment on any relevant issue for you. Also, you can put your complete name if you wish in the "Nick" field if you don´t mind us to know who you are. Following is the regular questionnaire for regular course participants in next editions:

Dear course participant, we may kindly ask you to respond to this questionnaire as fully as possible on all relevant items. This will greatly contribute to continuously improve the course.
Of course your data will be kept confidentially.
Completing the questionnaire (14 questions plus 7 checks of your pre-knowledge and attitude) should take no more than 5 minutes.
Please select (where scoring ranges are given) the score that most closely represents your views, and provide us with further comments if deemed appropriate.

In order to relate your data before and after the course, and given the anonymous character of the questionnaire, we kindly ask you to fill the field "Nick" with any combination of letters and numbers you choose, and keep it where you can recall if, to use the same one when we ask for it in the questionnaire at the end of the course. This will allow us to study the evolution of the course participants.

Nick

Meine Antwort

Sex

- ○ Male
- ○ Female
- ○ Other

Date of birth

TT MM JJJJ

__ . __ . 2019

Country of residence

Auswählen

Educational level

- ○ No formal education
- ○ High school degree
- ○ College / academic degree
- ○ Vocational education
- ○ Other

What is your organizational assignment in the ITER project?

- ○ ITER Organization
- ○ F4E
- ○ ITER supply chain
- ○ Other

How long have you been active in the ITER project?

- ○ More than four years
- ○ One to four years
- ○ Less than one year

What is your hierarchical position?

- ○ Senior management
- ○ Supervisor
- ○ Team member
- ○ Other

How would you describe your main activity in the ITER project?

- ○ Design / engineering

Annex 8: A-NF-03 Course Evaluation Questionnaire (complete content)

Course Evaluation Questionnaire

Dear colleage, as you are entering the course with the aim of testing it in this BETA version, we have added at the end a special space for feedback about this questionnaire. Please feel free to comment on any relevant issue for you. Also you can put your complete name if you wish in the "Nick" field if you don´t mind us to know who you are.

Dear course participant, we may kindly ask you to respond to this questionnaire as fully as possible on all relevant items. This will greatly contribute to continuously improve the course.
Of course your data will be kept confidentially.
Completing the questionnaire (14 questions plus 7 final checks of your knowledge and attitude) should take no more than 5 minutes.
Please select (where scoring ranges are given) the score that most closely represents your views, and provide us with further comments if deemed appropriate.

>> ***If you score 2 or 1 please indicate below each item why you give this rating.***

Finally, please provide us with your further suggestions or recommendations.

In order to relate your data before and after the course, and given the anonymous character of the questionnaire, we kindly ask you to fill the field " Nick " combination of letters and numbers you used in the questionnaire at the beginning of the course. If you don´t remember it please state "I don´t remember" in the "Nick" field. If you didn´t answer the pre-course questionnaire you don´t have to fill this field.

	Nick								
1									
	To what extent have your expectations been delivered?	Not at all	1	2	3	4	5	Fully	
1	>>								
	To what extent have the objectives of the course been achieved?	Not at all	1	2	3	4	5	Fully	
2	>>								
	To what extent was/is the subject of the course important to you?	Not at all	1	2	3	4	5	Fully	*Overall rating of the course and its importance for the trainee*
3	>>								
	To what extent has your knowledge/have your attitudes (motivation) improved as a result of the course?	Little	1	2	3	4	5	A lot	
4	>>								
	What is your overall rating of the course?	Poor	1	2	3	4	5	Excellent	
5	>>								
	What was the level of information given to you to enroll for the course and guide you through it?	Poor	1	2	3	4	5	Excellent	
6	>>								
	How do you rate the course access (via Internet) and support during the course?	Poor	1	2	3	4	5	Excellent	*Organization of the course*
7	>>								
	How do you rate the comprehensibility of the trainer (English language and its pronunciation)?	Poor	1	2	3	4	5	Excellent	
8	>>								
	How do you rate the training material (video and text of the presenter)?	Poor	1	2	3	4	5	Excellent	
9	>>								
	How do you rate the visual aids (the slides in the videos) used?	Poor	1	2	3	4	5	Excellent	
10	>>								
	To what extent was the content organized?	Poorly organized	1	2	3	4	5	Well organized	*Training material and trainer*
11	>>								
	To what extent was the course duration appropriate for the training content and for achieving the training objectives?	Far too much / not enough time	1	2	3	4	5	Completely appropriate	
12	>>								
	How effective were the follow-up test questions after each chapter?	Ineffective	1	2	3	4	5	Very effective	
13	>>								

Suggestions or Recommendations:

14

Final check:
After having concluded the course, we also would like to be informed about your current knowledge and attitudes. Please select the score that most closely represents your views.

a	**ITER shall be the first ever reactor that intends to demonstrate that the output power generated by the nuclear fusion is at least 10 times. the input power**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
	>>							
b	**ITER shall become a nuclear facility because fuel from a nuclear power plant (uranium) will be used for starting up ITER.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
	>>							
c	**The term *nuclear* indicates the existence of ionizing radiation that may damage cells of the human body.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
	>>							
d	**Nuclear safety is the top priority within the ITER project, therefore only the ITER Organization is responsible for it.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
	>>							
e	**The term "safety culture" denotes the use of safe equipment in ITER.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
	>>							
f	**Nuclear safety in the ITER project is a collective responsibility. Managers must commit to not disturb the work activities of their subordinates in the work environment.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
	>>							
g	**Nuclear safety in the ITER project is a collective responsibility. Individuals must commit to communicate openly and candidly.**	**I strongly disagree**	**1**	**2**	**3**	**4**	**5**	**I strongly agree**
	>>							

Further comments for the BETA version participants:

Annex 9: A-NF-03 Course Evaluation Questionnaire (look&feel example)

Course Evaluation Questionnaire

Course Evaluation Questionnaire

Dear colleague, as you are entering the course with the aim of testing it in this BETA version, we have added at the end a special space for feedback about this questionnaire. Please feel free to comment on any relevant issue for you. Also you can put your complete name if you wish in the "Nick" field if you don´t mind us to know who you are. Following is the regular questionnaire for regular course participants in next editions:

Dear course participant, we may kindly ask you to respond to this questionnaire as fully as possible on all relevant items. This will greatly contribute to continuously improve the course.
Of course your data will be kept confidentially.
Completing the questionnaire (14 questions plus 7 final checks of your knowledge and attitude) should take no more than 5 minutes.
Please select (where scoring ranges are given) the score that most closely represents your views, and provide us with further comments if deemed appropriate.

>> If you score 2 or 1 please indicate below each item why you give this rating.

Finally, please provide us with your further suggestions or recommendations.

In order to relate your data before and after the course, and given the anonymous character of the questionnaire, we kindly ask you to fill the field "Nick" combination of letters and numbers you used in the questionnaire at the beginning of the course. If you don´t remember it please state "I don´t remember" in the "Nick" field. If you didn´t answer the pre-course questionnaire you don´t have to fill this field.

Nick:

Meine Antwort

Overall rating of the course and its importance for the trainee

To what extent have your expectations been delivered?

	1	2	3	4	5	
Not at all	○	○	○	○	○	Fully

>>

Meine Antwort

To what extent have the objectives of the course been achieved?

	1	2	3	4	5	
Not at all	○	○	○	○	○	Fully

>>

Meine Antwort

To what extent was/is the subject of the course important to you?

	1	2	3	4	5	
Not at all	○	○	○	○	○	Fully

>>

Meine Antwort

To what extent has your knowledge/have your attitudes (motivation) improved as a result of the course?

	1	2	3	4	5	
Little	○	○	○	○	○	A lot

>>

Meine Antwort

What is your overall rating of the course?

	1	2	3	4	5	
Poor	○	○	○	○	○	Excellent

>>