Grant Agreement Number: 661910
H2020 – NFRP-2014-2015

ANNETTE PROJECT

Advanced Networking for Nuclear Education and Training and Transfer of Expertise

DELIVERABLE D 1.8

Report on available nuclear facilities for LLL

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

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Date of issue: 26/06/2017

Start date of project: **01/02/2016** Duration: **48** Months

Project co-funded by the European Commission under the Euratom Research and Training Programme on Nuclear Energy within the H2020 Programme, Call NRFP 2014-2015		
Dissemination Level		
PU	Public	Yes
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the partners of the ANNETTE project	
CO	Confidential, only for partners of the ANNETTE project	

DISTRIBUTION LIST

URL: http://www.enen-assoc.org/en/training/annette.html

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European Commission All Partners	Electronic copy via email Electronic copy via website	

Scope	ANNETTE / WP 1	Version:	2
Type/No.	Deliverable Report 1.8	Total pages	29
Title:	Report on available nuclear facilities for LLL	Chapters:	7
Access:	Public	Appendices	0
Filename:	ANNETTE deliverable 1.8 nuclear facilities4LLL.PDF	Suppl. pages:	0
Internet	http://www.enen-assoc.org/en/training/annette.html		

RESPONSIBLE BENEFICIARY: JRC

DOCUMENT TRACKING

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ABSTRACT:

The outcome of the survey on nuclear facilities for Lifelong Learning (LLL) is herein summarised and discussed.
The survey was opened for participants in 2 rounds. After the first round, only 16 respondents participated in the survey and the results were analysed and discussed in an interim report. Due to the insufficient data collected to draw final conclusion, the survey was re-opened and further 14

responses were received giving a total of **30** participants filled in the survey and **45** LLL facilities were described. The full set of data and results are summarised and discussed in this report.

Facilities for Lifelong Learning (LLL) as intended in the survey prepared for this report are those facilities used specifically for educational purposes (e.g. "zero power" reactors as they are available at universities, facilities made available for student thesis work or trainees) or for training purposes. In order to give the highest level of flexibility, the survey has addressed all facilities that have an accession scheme for students, researchers and young professionals.

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1. Introduction

In the framework of the ANNETTE (**Advanced Networking for Nuclear Education and Training and Transfer of Expertise**) project and as part of the work package on "Survey and Coordination of Networking in E&T and VET in Nuclear Areas" (WP 1), JRC addressed the task 1.6 related to the assessment of the currently available facilities in support of Lifelong Learning. The main activity consisted in performing a survey on available nuclear facilities to support Lifelong Learning (LLL).

Facilities for Lifelong Learning (LLL) as intended in the survey prepared for this report are those facilities used specifically for educational purposes (e.g. "zero power" reactors as they are available at universities, facilities made available for student thesis work or trainees) or for training purposes. In order to give the highest level of flexibility, the survey has addressed all facilities that have an accession scheme for students, researchers and young professionals.

The survey on the LLL facilities was structured in order to focus on two key areas, i.e. **1)** facilities in direct relation to nuclear energy, and **2)** facilities that are directly linked to education and training.
It was decided to launch the survey on the LLL facilities in coordination with the survey activities assigned to SCK•CEN. For this purpose 10 questions addressing the topic of available nuclear facilities to support LLL were prepared by JRC in consultation with the ANNETTE project partners. These questions together with those prepared by SCK•CEN, on the other topics of WP 1, were combined for the unique survey. However, from the answers received, it could be concluded that with this approach the survey was relatively long. The questions related to the LLL facilities, which were placed at the very end of the questionnaire, received therefore maybe less attention.

The questionnaire was distributed to course providers and stakeholders from all domains within the nuclear sector and was open for answers between April 15, 2016 and June 10, 2016. An Interim report [1] was submitted by JRC to the leader of this work package. It was concluded that the data collected were not sufficient to draw proper trend. Therefore, it was then decided to re-open only the LLL section of the survey for stakeholders, in an effort to improve the previous data and to draw final conclusions. The specific part of the survey on available nuclear facilities to support LLL was then re-opened for answers between November 1, 2016 and March 20, 2017.

During the first round, a total of 76 respondents completed the survey, 48 of the respondents were course organizers. Only **16** out of the 76 respondents completed the section on the available nuclear facilities to support LLL in support for VET and E&T.
During the second round of the survey, further 14 respondents completed the survey giving a total of **30** responses. Some responses were coming from different departments of the same organisation and were therefore grouped together giving a total of **24** responses from different organisation.

2. Description and Objectives of Task 1.6 of ANNETTE project

As given in the project description [2], the development of skills as well as the exchange of experts often requires access to the high-level facilities of leading institutes in a certain nuclear field. Especially for the continuous professional development (CPD) and in the frame of LLL, it is essential to be able to rely on available facilities that are open to support VET and E&T initiatives. Based on already existing databases on facilities as those issued by for example OECD, ACTINET and others, a

survey has been conducted on the available nuclear facilities, with the specific focus on LLL, their specializations and access procedures.

Within the technical annex of the project [2] the following items have been agreed:

1. The collected information should be made available for all end users on the ANNETTE Platform (or could be a first step for their implementation in the advanced database foreseen inside the ANNETTE project).
2. To discuss the implementation of the collected data in an advanced database.

3. Methodology

3.1. Design of the Survey

For the design of the survey on available facilities for LLL two preparatory works have been done. The first was the assessment of already existing databases on such type of facilities and the second was the preparation of a three phase approach for the survey. In the following sections the outcome on the analysis of the already existing databases will be given. Next the proposed and the agreed approaches will be described.

3.1.1. Existing database

An extensive investigation on existing database publicly accessible has been performed. Here a brief description of the results of this investigation is given where the focus is mainly on the OECD-NEA and the IAEA sites, since these two sites, among those analysed, have dedicated most space to Education and Training (E&T).

The **OECD-NEA** initiated a study on research and test facilities required in the field of nuclear science and technology. As a result of this study a comprehensive database was released in February 2008 and is available for public access via the NEA website www.nea.fr/rtfdb/. This database contains over 700 nuclear research and test facilities available at the OECD countries only.
The methodology adopted by the NEA was the consultation of reports/databases on facilities previously published by NEA, JRC, IAEA and others. The output of the database gives main information on the facility as e.g. Legal name of facility; Facility Type; Application; Proposed Application; Current purpose; Status; Owner; Homepage; Keywords; Company Use Only or National or International; Education.
It has been noticed that even if there is an entry on "Education", this line is rarely filled in. Indeed, for a number of facilities dedicated to the purpose of education of students this was indicated in the line "Current Purpose" of the facility and not in the line "Education". Moreover, it was also evident that most facilities with the purpose of education where "research reactors".

Finally, the database is very user-friendly and is organised in such a way that users can search by: country, facility type (reactor, accelerator, etc.) and/or application (ADS, fuel research). Together with the details of the facilities collected within the database, it is often possible to download a file with more detailed information.

The five departments of the **IAEA** have constructed over 20 publicly available databases that are accessible through the link https://www.iaea.org/OurWork/ST/NE/Main/databases.html.

Moreover, the department of nuclear energy has created the integrated "Cyber Learning Platform for Education and Training" (CLP4NET) database - http://clp4net.iaea.org/, where numerous training and education opportunities are available or can be consulted. For what concerns the education and training facilities, also the IAEA limits this to the research reactors https://nucleus.iaea.org/RRDB.

Numerous other databases available in the internet, as e.g. the one related to **radioactive waste**: http://www.radwaste.org/index.html, have useful information on the specific fields but are not explicitly tailored on Education and Training.

Finally, for what concerns Europe, there is the ENEN database on Education and Training opportunities as well as the **ENEN-RU database** on facilities that can be implemented with the activities initiated within ANNETTE.

3.1.2. Proposed Approach for the Survey

Originally it has been foreseen that the survey should be restricted to facilities in direct relation to ***nuclear energy,*** i.e. not with a multipurpose character and should be restricted to facilities directly linked to ***education and training***, i.e. it was intended to exclude facilities for research only and without E&T dimension.
Moreover, the original survey was designed such as to perform it into three phases:

1) During the first phase the aim was to gather general information on the facility including:

- Area of application (e.g. Gen II / III reactors, Generation IV, fuel development, fuel reprocessing, waste management, etc.)
- Area of scientific focus (structural and clad materials, fuel, thermal-hydraulics, chemistry, neutronics and nuclear data, design validation, safety assessment, etc.)
- Contact person(s) for future update and direct contact (e.g. for phase 2),
- Name of facility and of owning institute
- Country and location
- Short description of the facility and internet address/link if available

2) During the second phase the aims were to gather more detailed information for analytical assessment of the current facilities, i.e.

- Main end-user of the facility (students or professionals, academic or industry)
- Access procedure (restrictions, ease of access, health check requirements, security procedures, courses to be completed prior use, etc.)
- Access time (term time, summer break, week, days, hours of work, overnight experiments, etc.)
- Finance (maintenance of the facility, fees for consumables, budgets, grants provided for end-user, etc.)
- Overall learning outcome (skills gained, contribution to nuclear science (project, reports and publications, etc.)
- Technical support (Supervision provided by the facility to the user and freedom of use)

3) Finally the third phase had foreseen an analysis in order to identify gaps as well as support needed for operating nuclear facilities.

3.1.3. Adopted methodology

During the project kick-off meeting in Pisa on February 9-10, 2016 it was decided to join the survey on E&T and VET in the nuclear fields (as foreseen in the task 1.1 of the ANNETTE project) with the survey on available nuclear facilities to support LLL. This decision was taken in order to avoid the circulation of too many questionnaires within the same community.

The combined survey had 9 sections and the last section was allocated to the topic "nuclear facilities to support LLL". A full description of the survey was provided by SCK•CEN in their report for the section of the survey on E&T and VET in the nuclear fields [2].

The present report summarises the overall results on the survey on available nuclear facilities to support LLL.

In order to keep the original idea, the questions defined within the survey were aimed at gathering information in order to build a library of contributing facilities for the LLL. Although the questionnaire was directed at facilities leaders (managers) and course organisers, a number of questions aimed to address the end-users of the facility, which were answered by the organisers.
Most items in the survey were formulated as straightforward questions with multiple choices answers where the respondent could select more than one relevant answer. For every question the respondent had the opportunity to provide more information and brief description where needed.

3.2. Structure of the Survey

The background information of the respondent was included at the beginning of the questionnaire. The respondents could leave their contact details for future communication but it was also possible to complete the survey anonymously. All participants however decided to include their names and contact details.
The respondents were asked about their area of expertise, the main scientific focus of the facility and a brief description wherein the respondent had the opportunity to provide necessary information that was not covered by the survey.
In addition to the general information, the rest of this section of the survey included specific questions highlighting the following points:

1. Access procedure
2. Access times
3. Finance
4. Overall learning outcome

The questions for this part of the survey are shown in Annex 1.

4. Data collection and analysis

The data were primarily analysed by SCK•CEN. A Word report summarising the data [2], and an excel file of the raw data were provided by SCK•CEN on the 13th of June 2016.
Herein a detailed analysis of the survey for the ANNETTE task 1.6 is given, addressing each question of the survey and report its outcome.

5. Results

The survey was run in two rounds, in the first round and as stated by SCK•CEN [2], "76 respondents completed the survey between the timeframe of data collection (April 15th, 2016 and June 10th, 2016). The survey was displayed 1190 times. 177 invalidated survey entries were registered of persons who started the survey but did not complete it. The invalidated answers were not taken into consideration". From the 76 respondents, 16 answered section (9), survey on the existing facilities for LLL. Due to this rather low number of responses received for this section, the survey was re-opened between November 1, 2016 and February 1, 2017. The OECD-NEA, IAEA, ENEN-RU II, ACTINET databases were examined by SCK•CEN and CIRTEN, in order to obtain contact details of relevant persons of different facilities. Around 90 persons were invited via email to fill in the questionnaire at the beginning of November 2016 and 14 respondents completed the survey for LLL facilities, giving a total of 30 responses. However, during the ANNETTE progress meeting in Lubljana on February 16, 2017 representative from EVN AG (Energieversorgung Niederösterreich) expressed interest to take part in the survey. Further, representative from Forschungszentrum Jülich GmbH wanted to modify their answers. Accordingly, SCK•CEN opened the survey for the third round and finally close it on March 20, 2017

Overall **30** respondents completed the survey between the timeframe of data collection (April 15th, 2016 and Feb 1st, 2017). However, out of the 30 answers, four were coming from different units of the JRC Directorate G – Nuclear Safety and Security and were therefore grouped into one. Two answers were coming from each SCK•CEN (Belgium), ENEA (Italy) and Lappeenranta University of technology (Finland) and were also grouped into one giving a total of ***24*** responding organisation. Further, 9 organisations indicated more than one facility with SCK•CEN ranking the top with 6 different facilities and ENEA with 5 facilities. Two of the 9 organisations indicated 3 facilities and four organisations owned 2 facilities giving ***45 facilities*** available for LLL distributed over ***15 European countries***. For organisations owning more than one facility, the respondent had the opportunity to fill in the questionnaire for more than one domain to describe all the indicated facilities.

5.1. General information of respondents

The details of the respondents, name of organisation, web-link, etc. were all provided at the beginning of the survey. In addition, the following questions were addressed in this part:

1. The main area of application of the facility
2. The main scientific focus of the facility
3. The direct relation of the facility to E&T
4. The level of education of the end-user

Figure 1 summarises the name of respondent organisation with existing facilities supporting LLL in nuclear E&T and the number of the facilities owned by this organisation.

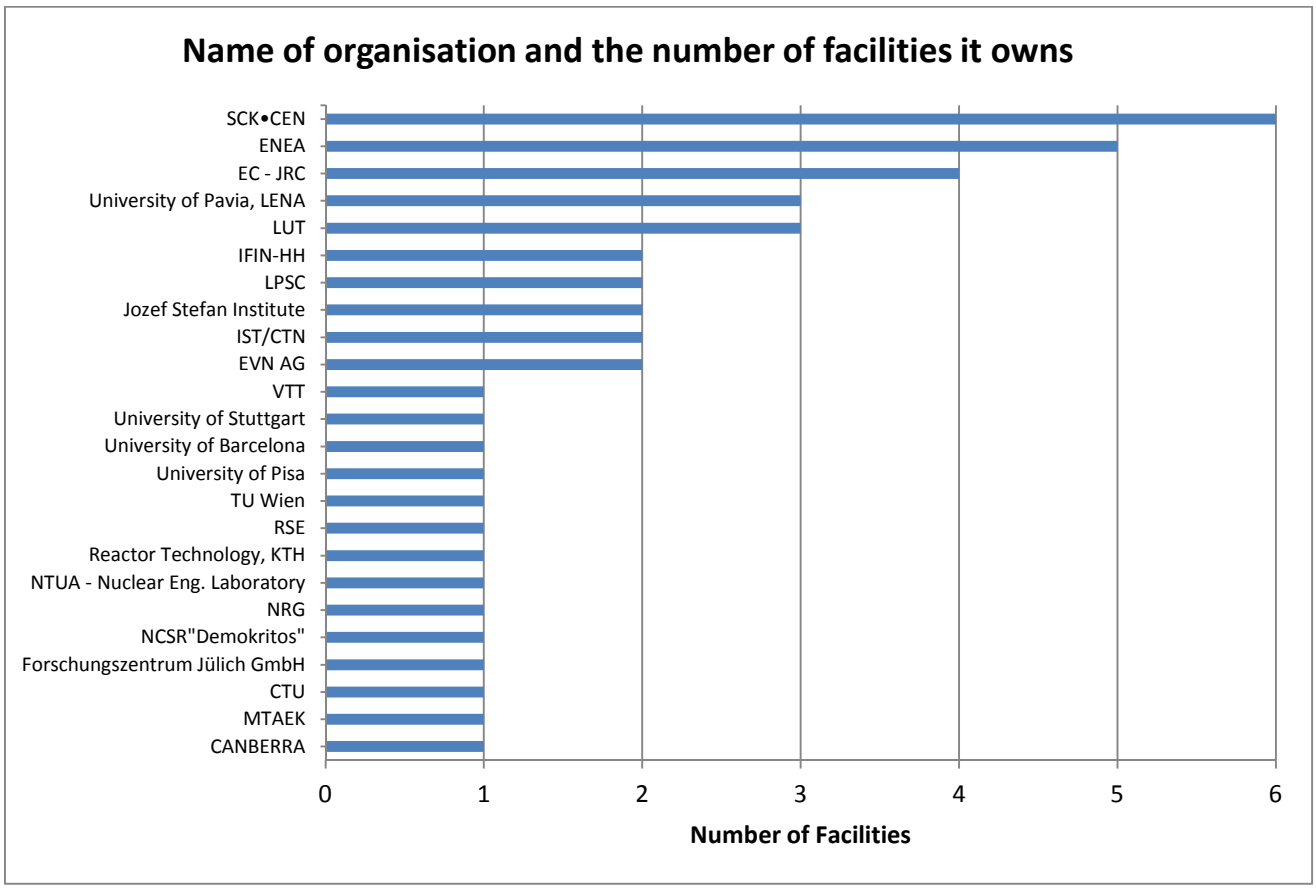

Figure 1: Name of the respondent organisation and the number of nuclear facilities owned.

The abbreviations of some organisations stand for:

- CTU (Czech Technical University in Prague)
- EC-JRC-DG (European Commission, Joint Research Centre, Directorate G – Nuclear Safety and Security) [1]
- ENEA (Italian National Agency for New Technologies, Energy and sustainable Economic Development)
- EVN AG (Energieversorgung Niederösterreich)
- IFIN-HH (Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering)
- IST/CTN (Instituto Superior Técnico, Universidade de Lisboa, CAMPUS TECNOLÓGICO E NUCLEAR)
- KTH, Reactor Technology (Royal Institute of Technology in Stockholm)
- LPSC (Laboratory of Subatomic Physics & Cosmology, Université Grenoble Alpes)
- LUT (Lappeenranta University of Technology, Finland)
- MTAEK (Centre for Energy Research, Hungarian Academy of Sciences)
- NCSR "Demokritos" (National Centre for Scientific Research "DEMOKRITOS")

[1] Note: after the delivery of the survey JRC changed organisational structure and currently the nuclear part of IET and ITU have been grouped under the Directorate G – Nuclear Safety and Security

- NTUA - Nuclear Eng. Laboratory (National Technical University of Athens, Nuclear Engineering Department)
- RSE (Ricerca sul Sistema Energetico (Research into Electro-energy Systems))
- SCK•CEN (Belgian Nuclear Research Centre)
- TU Wien (Technical University Vienna)
- University of Pavia, LENA (Laboratory of Applied Nuclear Energy)
- VTT (Technical Research Centre of Finland. Ltd)

As can be seen in Figure 1, SCK•-CEN, Belgium owns the highest number of LLL facilities (6 facilities), followed by ENEA, Italy (5 facilities) and EC- JRC (4 facilities, 2 in Germany, 1 in Netherland and 1 in Belgium).
Table 1 summarises the names, total number and country of the facilities indicated by each organisation as shown in Figure 1. In some cases for example in the case of ENEA, a total of 10 facilities (for fusion and fission facilities) were indicated by the respondent. However, only fission facilities were described by the respondent and are considered in this report.

Name of Owning Organisation	Name of facility(s)	Number of facilities	Country
CANBERRA	Canberra Mirion	1	Belgium
Centre for Energy Research, Hungarian Academy of Sciences	Budapest Research Reactor	1	Hungary
Czech Technical University in Prague	Training nuclear reactor VR-1	1	Czech Republic
EC – JRC Directorate G – Nuclear Safety and Security	EUSECTRA, Hot Cell Laboratory, Heavy Liquid Metal Experimental Facility, Education	4	Germany, Netherland, Belgium
ENEA	TRIGA-RC1, CIRCE, NACIE, LECOR, HELENA	5	Italy
EVN AG	KKW Tullnerfeld, TQF	2	Austria
Forschungszentrum Jülich GmbH	Radiochemistry laboratories of IEK-6	1	Germany
Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering IFIN-HH	Radioactive Waste Treatment Plant (STDR) National Repository for Low and Intermediate Level Radioactive Waste Baita-Bihor (DNDR)	2	Romania
IST/CTN	RPI, Physics and Accelerators	2	Portugal
Jozef Stefan Institute	TRIGA Mark II Research Reactor, 2 MV tandem accelerator	2	Slovenia
Laboratoire de physique subatomique et cosmologie	PLATINE, Salle SIREP	2	France
Lappeenranta University of Technology	HIPE test loop, (Horizontal and Inclined Pipe flow Experiments),PWR-PACTEL, PPOOLEX	3	Finland
NCSR"Demokritos"	Environmental Radioactivity laboratory	1	Greece

NRG	NRG	1	Netherlands
NTUA - Nuclear Eng. Laboratory	NTUA-NED-ER1	1	Greece
KTH, Reactor Technology,	HWAT Loop	1	Sweden
RSE	SCRUPOS	1	Italy
SCK•CEN	BR1 (Belgian Reactor 1), BR2 (Belgian Reactor 2), VENUS-F reactor, HADES, LHMA, MYRRHA	6	Belgium
Technical University Vienna	Atominstitut	1	Austria
University of Pisa	General Laboratories	1	Italy
University of Barcelona	Instal.lació radioactiva IRA-7	1	Spain
University of Pavia, LENA	LENA, LENA Cyclotron, SM1	3	Italy
University of Stuttgart	SUR-100 Zero Power Reactor	1	Germany
VTT Technical Research Centre of Finland, Ltd.	VTT Centre for Nuclear Safety	1	Finland

Table 1: List of names of organisations and their corresponding facilities for LLL and location

Figure 2 shows the country of the respondent organisation and the location of the facilities. The largest number of organisation that own nuclear facilities for LLL originates from Italy (4), Germany (3) and Belgium (3). However with the identification of 24 organisations owning 45 facilities distributed over 15 European countries, one can say that there is a fair distribution of nuclear facilities across Europe giving the end-user a wide choice of location and possibly allowing easier and cheaper access when taken into account travel cost and time.

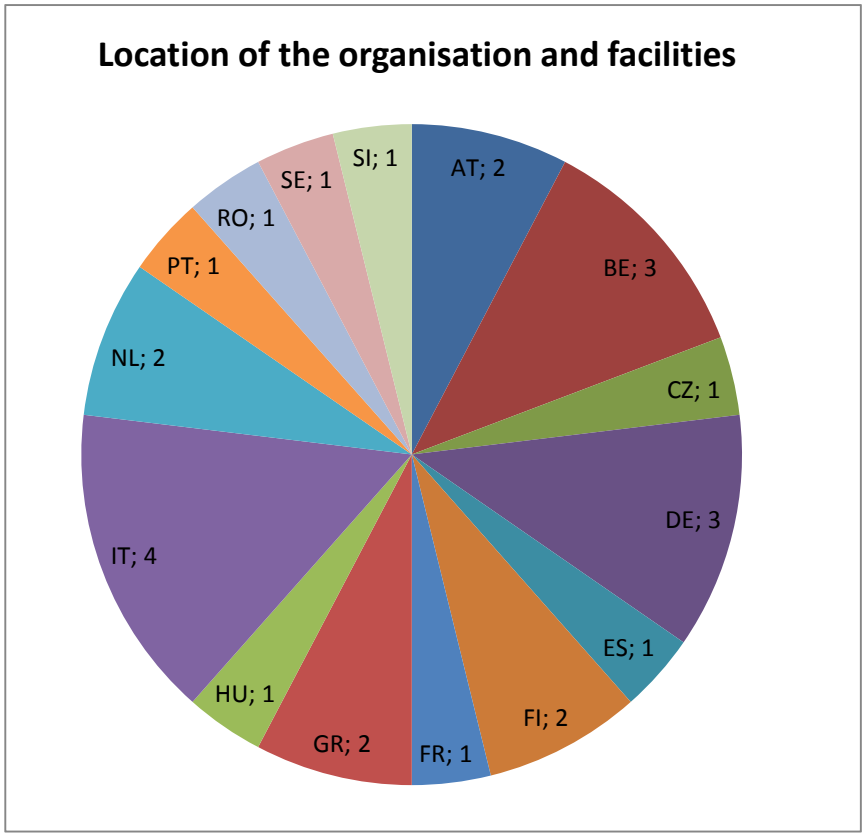

Figure 2: Pie chart showing the country of the respondent organisation and the location of its facilities

5.1.1. Area of application

Figure 3 shows the main area of applications of the facilities as indicated by the respondent and for comparison Figure 4 shows the main area in which the organisation of the respondent is active in terms of E&T / VET as reported by SCK•CEN [2]

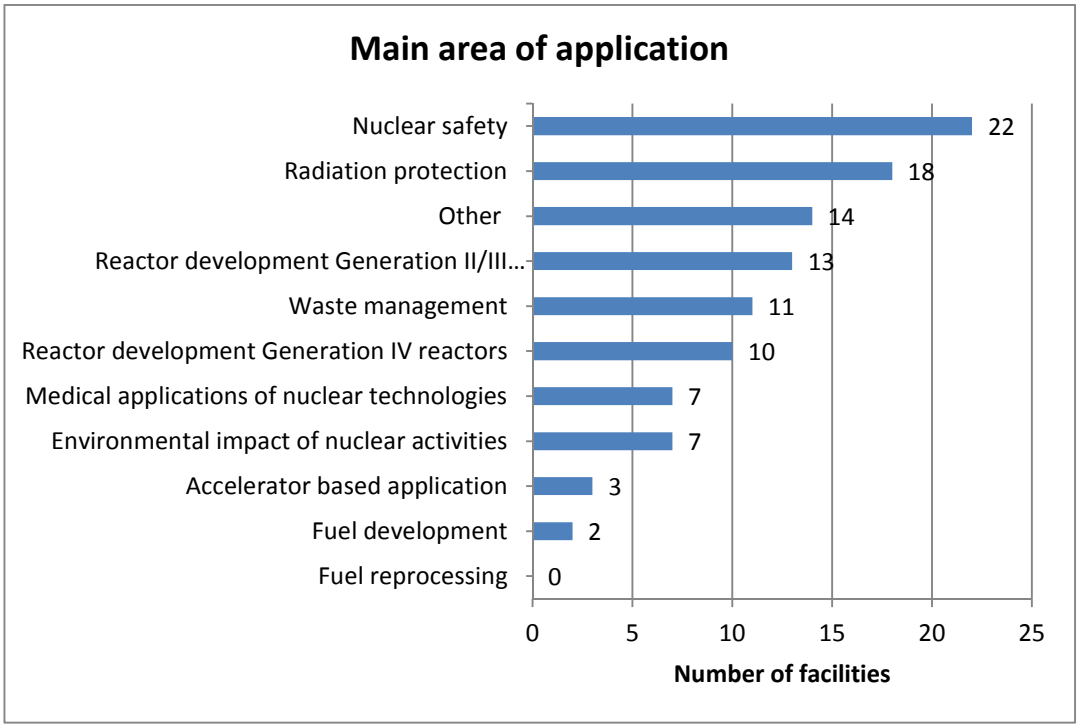

Figure 3: Bar chart summarising the main area of application of LLL facilities

Where "other" was selected, the respondents noted the following applications

- Model development and verification
- Detectors and material evaluation
- Neutron activation analysis, radiation hardness study, irradiation of samples using gamma or gamma + neutron, testing of new detector types, validation and verification of different computer codes etc.
- Integral test experiments
- NAA, Radiochemistry, BNCT
- NAA, calibration
- Nuclear training

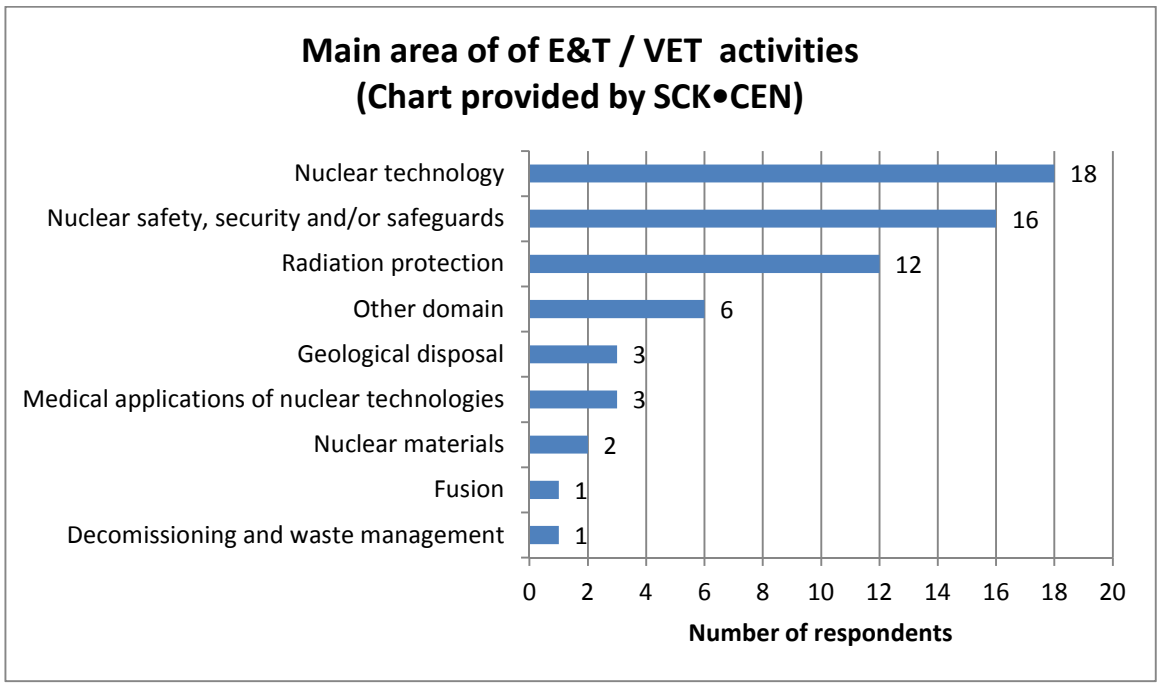

Figure 4: SCK•CEN chart summarising the main area of E&T / VET activities.

Figure 3 indicates that overall there is diversity in available facilities in terms of areas of application of the facilities with Nuclear Safety (22 facilities), and Radiation Protection (18 facilities), being on the top lead. The number of facilities for Reactor Development (13 for gen. II, III and 10 for gen. IV) and Waste Managements (11) is also considered high. The low number of facilities covering fuel development is possibly related to the complexity and expensiveness of such facilities. Furthermore, many respondents chose to select more than one application, which they thought applicable to their facility, promoting the wide range of activity of every individual facility.

Comparing the data as presented in Figure 3 and Figure 4, it can be seen that in the chart provided by SCK•CEN [2] concerning the main area of E&T / VET activities (Figure 4), the leading areas of activity are Nuclear Technology, Nuclear Safety, Security and Safeguards and Radiation Protection. A similar trend is observed for the LLL facilities (Figure 3) if one considered the association of LLL for Reactor Development to the E&T / VET on Nuclear Technology. In the area of Waste Management and Medical Application, it results that the numbers of facilities for LLL active in these areas are significantly higher than the E&T or VET offers.

5.1.2. Scientific Focus

Figure 5 summarises the areas of scientific focus of the existing nuclear facilities for support ofLLL.

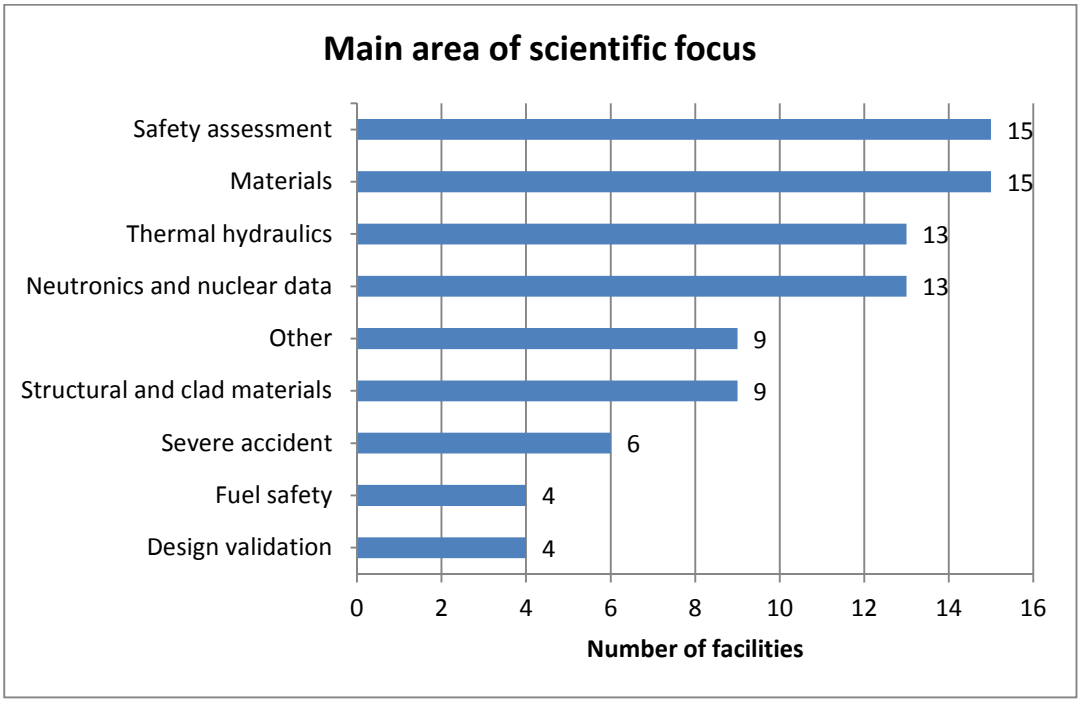

Figure 5: Bar chart summarising the main area of scientific focus of LLL facilities

Where "other" was selected, the respondents noted the following areas:

- Nuclear measurements
- Alpha beta gamma neutron measurement
- Instrumentation
- Environmental radioactivity
- Education
- Boiling Water Reactor Training
- BNCT, NAA

From Figure 5, it can be noted that there is a good distribution of areas of scientific focus with Safety Assessment (15), Materials (15), Thermal Hydraulics (13), Neutronics and Nuclear data (13) being on the top lead. Furthermore, many respondents chose to select more than one area of scientific focus which they thought applicable to their facility highlighting the multi-function and possibly the close connection of the different areas of scientific research in one sector, for example thermal hydraulics is linked to safety assessment similarly structural and cladding material to sever accident, etc.

5.1.3. Direct link of the facility to Education and Training

The aim of this question was to distinguish between the facilities that offer hands-on (vocational) training[2] and those used mainly for seminars and theoretical courses for students.
77% of the respondents indicated that the facility is used for both education and training offering both theoretical lessons and hands-on experience for PhD students, master students and trainees. The fact that 77% of the facilities for LLL offer both training and education is possibly a good indication of the importance to combine both theoretical and hands-on training in the nuclear education and training.

[2] In this case we classified the facilities to train PhD students for e.g. accessing nuclear laboratories as hands-on vocational training. On the contrary within D1.1 Vocational learning / training refers to professionals already working [note received from SCK•CEN]

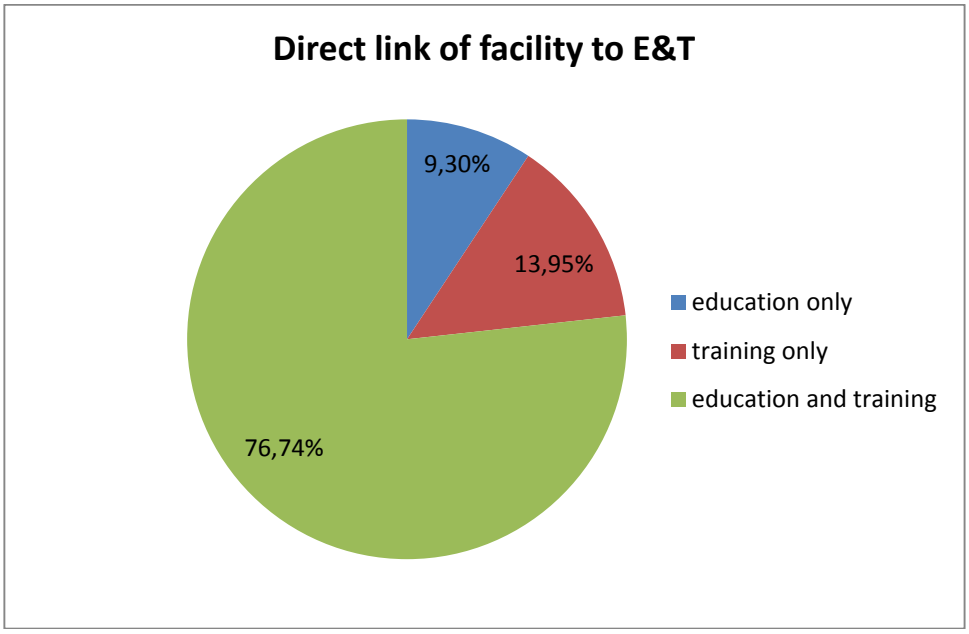

Figure 6: Pie chart highlighting the direct link of facilities to E&T

5.1.4. Level of Education of Participants

As seen from the pie chart above (Figure 6) a total of 91% LLL facilities offer hands-on training in the form of active usage of the facility by students for master or PhD thesis work, or by professionals for VET activities. In order to complement the information obtained for this section, the respondents were asked to indicate the number of end-users for each category. The results for this question is summarised in the bar chart in Figure 7.

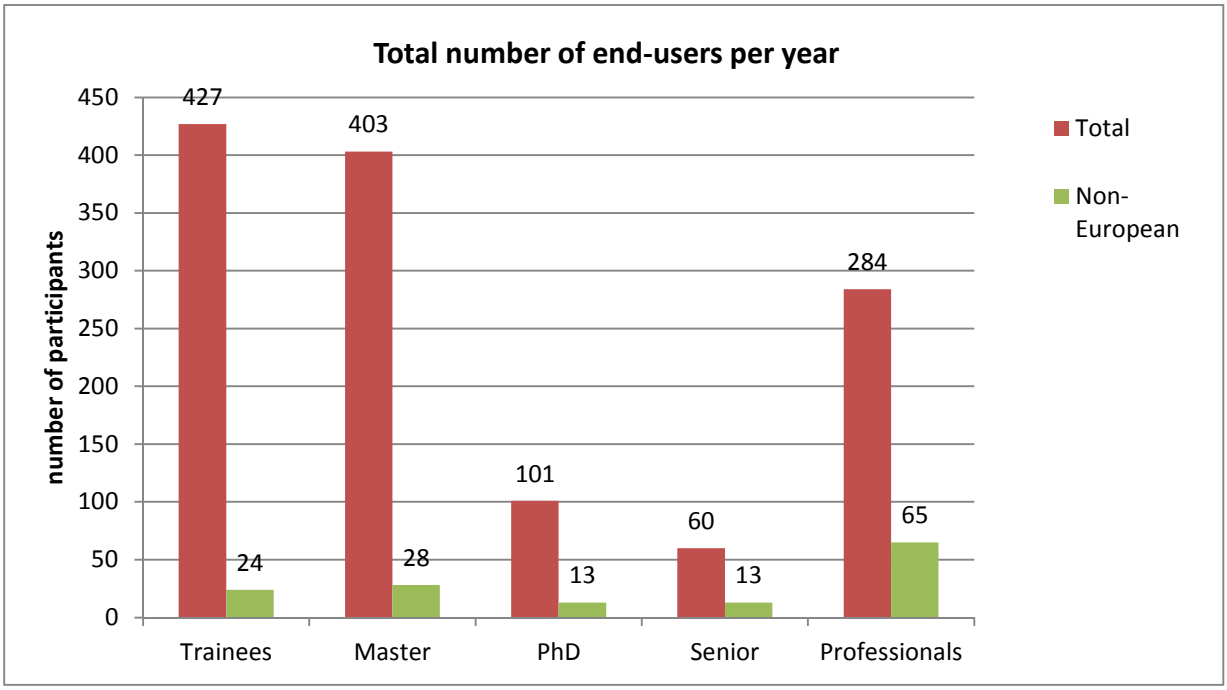

Figure 7: Bar chart showing the main end-users of the facilities

Whilst the bar chart in Figure 7 shows the overall sum of end-users of all facilities per year, the average number of end-users for each category differs depending on the nature of the organisation

that owned the facility. For example, where the organisation is a university or a teaching institute, the average number of end-users reported ranges between 10 and 200. In order to gain further understanding of the distribution of end-users per facility the following is noted:

For trainees, University of Pavia, LENA reported (200), Czech Technical University in Prague (40), NTUA - Nuclear Eng. Laboratory (40) and Jozef Stefan Institute (40) trainees, SCK•CEN (15), Technical University Vienna (8), 7 organisations indicated an average number between 2 and 5 trainees per organisation, and 11 organisations indicated 0 trainees[3]

For Master students, University of Pavia, LENA reported (100), Laboratory of Subatomic Physics & Cosmology, Université Grenoble Alpes (100), University of Stuttgart (50), SCK•CEN (50), EC-JRC (20), Jozef Stefan Institute (15), NTUA - Nuclear Eng. Laboratory (10) Czech Technical University in Prague (10), Lappeenranta University of Technology (10), 10 organisations indicated an average number between 2 and 5 master students per organisation and 5 organisations indicated 0 Master students.

For PhD students, EC-JRC reported (20), Jozef Stefan Institute (10), Czech Technical University in Prague (10), Forschungszentrum Jülich GmbH (10), 14 organisations indicated an average number between 1 and 4 PhD students per organisation. 10 organisations indicated 0 PhD students.

For senior scientists, SCK•CEN reported the maximum number of (15) senior scientist, 12 organisations indicated an average number between 2-5 senior scientists per organisation and 11 organisations indicated 0 senior scientist.

For Professionals (industry staff), EC-JRC reported (100), SCK•CEN (80), Jozef Stefan Institute (25), Czech Technical University in Prague (20), IFIN-HH (15), ENEA (10), EVN (AG) (8), 7 organisations reported an average between 1 and 5 professionals per organisation and 10 organisations reported 0 professionals.

The green bar shows the number of non-Europeans. Note that this is the sum of all responses and some facilities did not indicate a number for non-European end-users. The organisations that indicated access for non-European users are: EC-JRC, Jozef Stefan Institute, Czech Technical University in Prague, Technical University Vienna, University of Pavia(LENA). NCSR"Demokritos", IST/CTN, Lappeenranta University of Technology and SCK•CEN.

5.2. Access Procedure

This part of the survey was included to assess the simplicity of access for the end-user.
Figure 8 indicates that generally, security and health check are required by a few organisations. However, the participants reported that security clearance process varied depending on the organisation. In most cases security check involves anything from a written request for access to a background check by the national security agency. Health check was noted to be a simple medical check and an attribution of dosimeter.

[3] Where the respondent didn't indicate any number, the total number for this category for this organization was taken as zero.

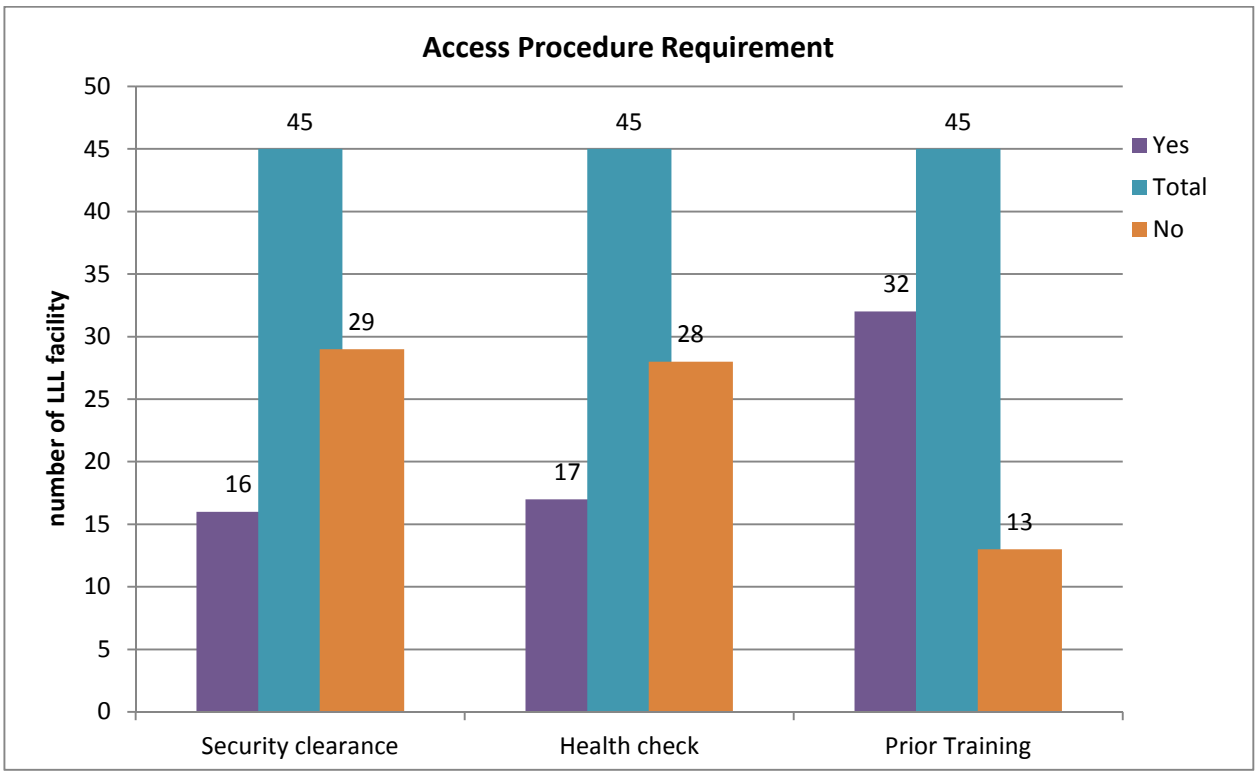

Figure 8: Summary of access procedure requirements

It is noted that security check was a must requirement for typical nuclear facilities. These are:

- Centre for Energy Research, Hungarian Academy of Science (particularly for non-Europeans)
- EC-JRC
- NGR
- SCK•CEN
- Reactor Technology, KTH
- "Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering IFIN-HH
- University of Pavia, LENA
- VTT Technical Research Centre of Finland, Ltd.
- Technical University Vienna

The respondents noted that health check consisted of a simple periodical medical examination and attribution of dosimeters to those exposed to radioactivity. Health check was indicated as a requirement for the following organisations:

- University of Barcelona
- NCSR "Demokritos"
- IST/CTN
- Jožef Stefan Institute
- Università di Pisa
- EC-JRC
- University of Pavia, LENA
- Forschungszentrum Jülich GmbH

- IFIN-HH
- VTT Technical Research Centre of Finland, Ltd.

Prior trainings were the main requirement by the majority of the facilities. These however differ slightly depending on the focus of the facility and therefore responses are listed below.

- Useless without some courses on radiation and matter
- The end user has to participate in a one-week seminar in nuclear thermal hydraulics
- Test based on information given during video messages
- Safety procedures; tele-manipulators use
- Radiation Protection Course (20 h)
- Must be suitably qualified and funded
- Introduction of the reactor and base knowledge on neutronics (e.g. point kinetics)
- Course on personal safety measures.
- Basics on radiological protection and safety.
- Specific for the task to be performed.
- Basic principles on nuclear methods and techniques and radiation safety rules
- Softwares, Toolboxes
- Treatment of environmental samples
- Course on radioactivity sources manipulation and radiation protection

5.3. Access Times

The aim of this section is to obtain an idea of the scale of which the facility is used for E&T expressed in the average number of courses offered by each facility, the sum number of courses offered by all facilities and the duration of both education and training courses.
In order to distinguish between taught courses and vocational training on the facilities, the indication given in the questionnaire was the following:

- Training facility often provides taught courses, summer schools, and or master programs. Credits and certificates are issued to the attendees after each course.
- Education facility provides hands-on training and use of equipment in a nuclear facility. The overall experience and results contribute to a particular master or PhD project and to scientific report and publication.

5.3.1. Total Number of Courses Provided by Facilities for LLL

The total number of course was calculated to be ***212 courses*** for 24 respondent organisations, with CANBERRA offering the highest number of courses per year (90 courses), followed by SCK•CEN (50 courses) and Laboratoire de Physique Subatomique et Cosmologie (50 courses). EC-JRC, Czech Technical University in Prague, University of Pavia (LENA), Technical University Vienna, NRG, and Jožef Stefan Institute offer 16, 15, 11, 8, 8, and 5 courses respectively. 14 organisations offer between 1 and 4 courses.

5.3.2. Length of Education and Training Courses

Numerous organisations offer their facilities for both Education and Training. We referred to ''Education Facilities'' as those that provide hands-on access and use of equipment in a nuclear facility where the overall experience and results contribute to a particular master or PhD project and to scientific report and publication. In contrast, ''Training Facilities'' were referred to those that

provide short courses in the form of summer schools, workshops and training modules. Credits and certificates are issued to the attendees after each course.
The length of courses for both Education and Training Facilities are summarised in the charts in Figure 9 and Figure 10.

The obtained data for the length of courses in ''Education Facility'' were slightly unexpected. Figure 9 shows that 49% of the courses were noted to be less than a week length and 32% were noted to be 2 weeks. A total of 19% of the courses offered were noted to be between one and two months.

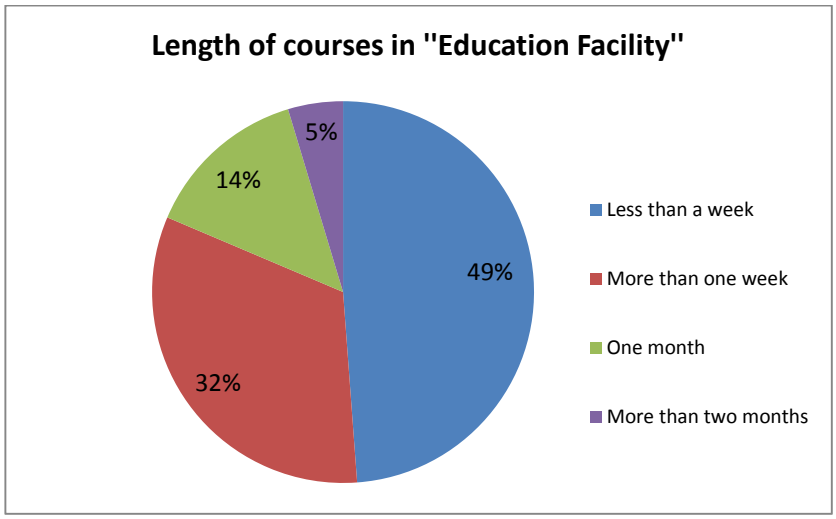

Figure 9: Pie chart summarising the length of courses in ''Education Facility''

In contrast, Figure 10 shows that a total of 72% of training courses are between one day and one week. This is usually the norm for courses offered by different organisations for the purpose of short and comprehensive courses that convey certain topics.

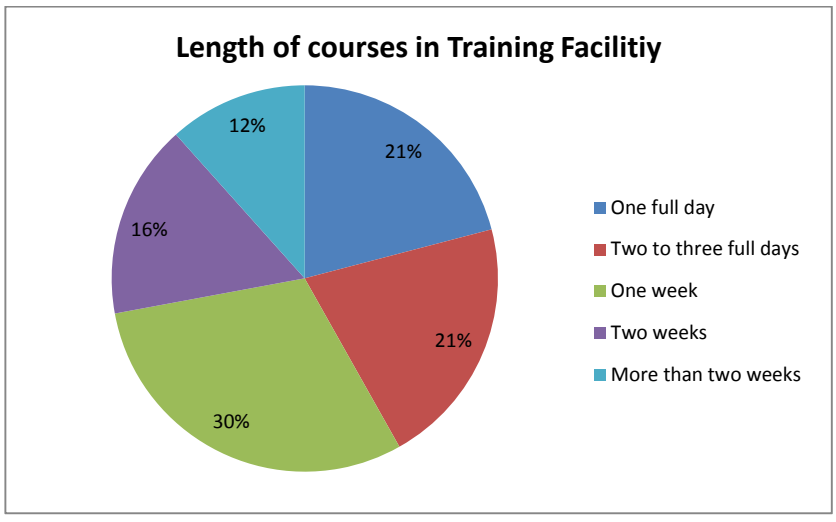

Figure 10: Pie chart summarising the length of courses in ''Training Facility''

However, the data obtained in Figure 9 and Figure 10 is in-line with the data shown in section 5.1.4, Figure 7. (the bar chart in Figure 7 is re-illustrated in terms of percentages as shown in Figure 11 for clearer comparison). When taking into account the level of education of the participants, it can be seen that an overall 65% of the participants are diploma (trainees) and master students and

only 8 % were noted to be PhD students whom may be more inclined to follow longer course and use the facilities for PhD thesis.

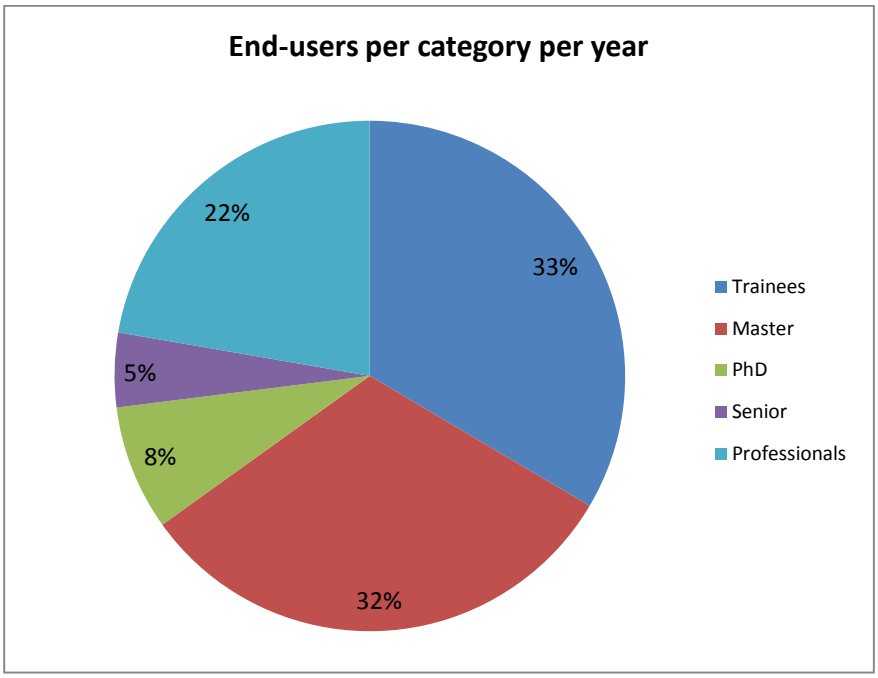

Figure 11: Pie chart showing total number of end-user per category illustrated in percentages

Figure 12 clearly reflects the data obtained and discussed above in Figure 9 and Figure 10. The majority of courses (82%) are offered to 1-10 participants only. This is related to the nature of the courses being hands-on training, which is the crucial type of courses needed in the nuclear sector by facilities for LLL.

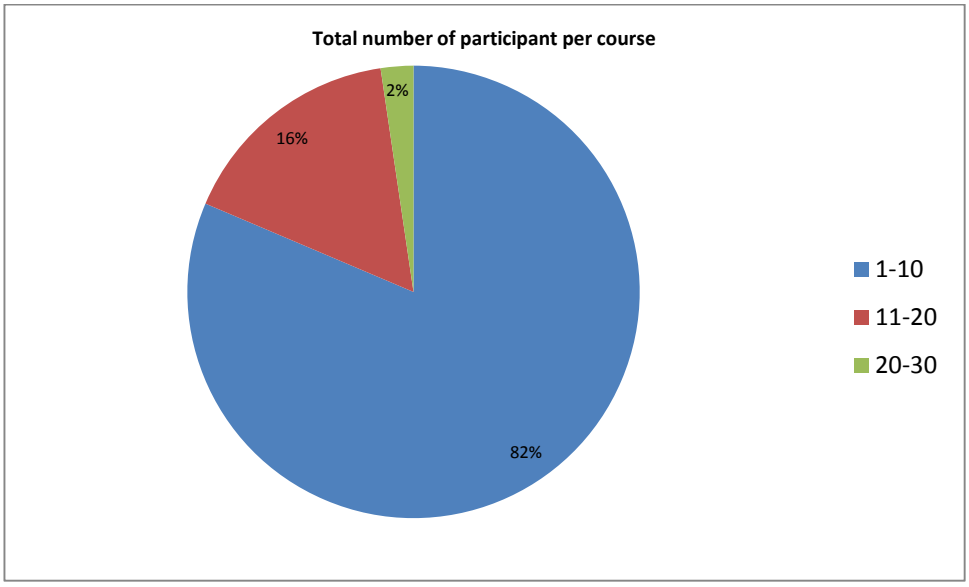

Figure 12: Bar chart showing the average number of participant per course

Furthermore, 16% of the courses noted to be offered for 11-20 students, this number was noted by slightly larger organisations and facilities. The 2% indicted for 20-30 participants is related to the training offered to high school students (17-18 years) which is offered by some national organisations such as university of Pavia (LENA).

5.4. Finance

In order to obtain further information on the ease of access to the facilities in terms of finance, a number of questions were asked and the results are summarised in the pie charts in Figure 13, Figure 14 and Figure 15.

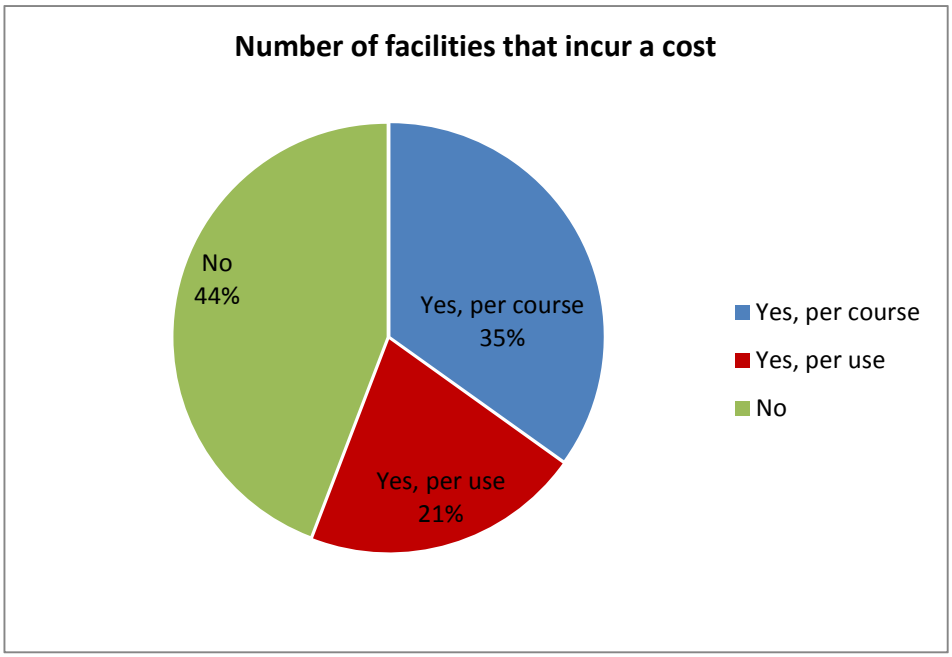

Figure 13: Pie chart summarising the percentages of facilities that incur a charge per course and use

Figure 13 shows that total of 56% of the facilities indicated a cost incurred to either the use of the facility or to attending the course.
Furthermore, it is noted that the incurred cost of the use of the facility is a consequence of the fact that the organisation is the primary financing body for the consumables and maintenance (Figure 14) attributed to the facility with some support from:

- Partner universities
- Competitive projects
- European projects funds

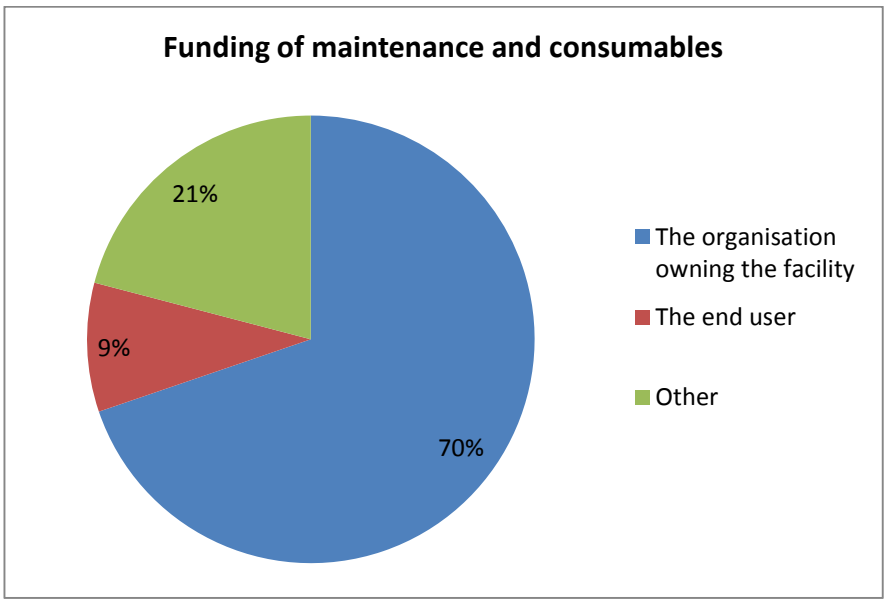

Figure 14: Pie chart summarising the percentages of facilities that incur a charge per course and use

Finally, there seem to be few mobility grants offered to the participants as shown in Figure 15, with only 42% overall availability, inefficient number which must be addressed in the future and by organisations and European programmes that aim to maintain qualified workforce in the nuclear sector.

Examples of primary financing boards for mobility grants that were indicated for end-users are:

- ERASMUS program and EU funded projects and programmes and mobility grants
- H2020 mobility funds
- IAEA, CERN
- Grants from different projects (e.g. NUGENIA).
- DAAD, Fulbright

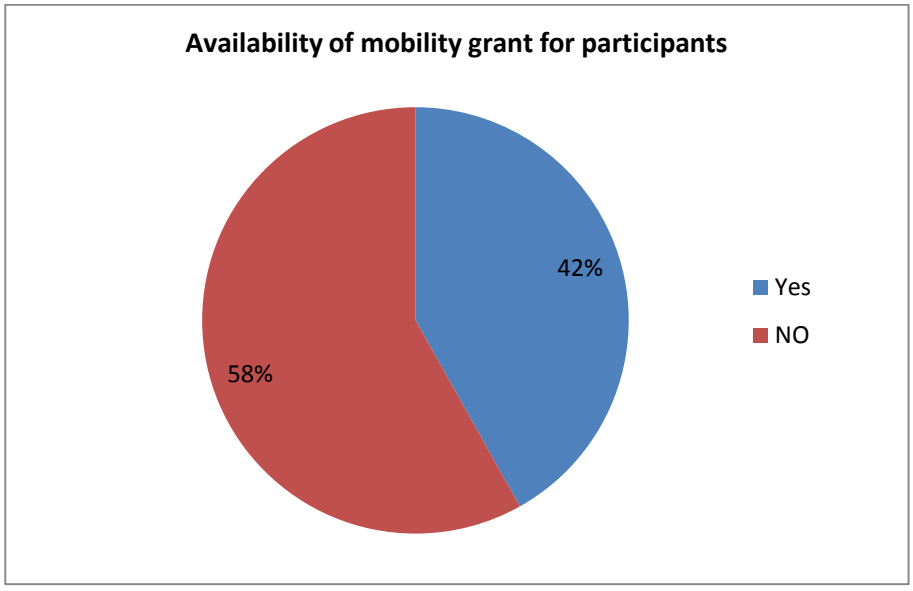

Figure 15 Pie chart summarising the percentages of overall grants available for participants

5.5. Overall learning outcome

Figure 16 shows the overall benefit of the facility to the end user. Although the highest percentages (42%) go to contributions to nuclear science in forms of publications and thesis, there is still a good percentage of benefit indicated as university credit (24%) and transferable skills (27%). This result is in-line with the data obtained on the type of participants and highlights the diversity of end-users and the benefit of courses offered by facilities for LLL.

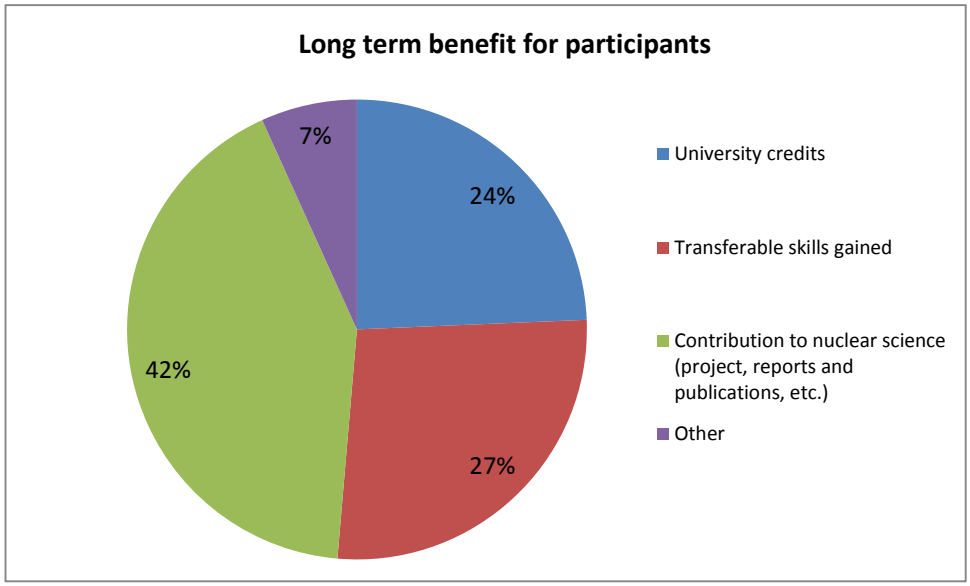

Figure 16: Pie chart highlighting the overall benefit of the facility to the end-user

6. Final Notes

It was decided within the ANNETTE consortium that an electronic survey (e-survey) would have been the best method to gather the information as collected in this report. 24 organisations delivered information on their LLL facilities. These organisations were universities, research centers and industries from 15 European countries. However, despite that not all relevant actors in EU (e.g. CEA, CNRS, CVR, CIEMAT, KIT, GRS, TUDelft, etc.) have answered the survey, it can be fairly assessed that the answers collected are representative of the EU situation in terms of LLL facilities. As show in the graph of this report the following points and trends have been observed:

1**) General information**

- It has been noticed that organisations from Austria, Greece and Portugal participated to the survey even if these countries do not have nuclear power plant. On the contrary organisations from Bulgaria, Slovakia and UK did not send a response.
- It seems that facilities for LLL are available in a number of relevant nuclear areas. A large number of facilities are dedicated for use in the nuclear safety and radiation protection area, only 2 out of 45 for fuel development and non for fuel reprocessing. This low numbers can be explained by two key items, i.e. the complexity and costs of these facilities and second the interest on topics as e.g. reprocessing might have been reduced.
- As for the main area of scientific focus, it can be noticed that materials, including structural and clad materials, (24) offer the highest opportunity for LLL followed by safety assessment (15), thermal hydraulics (13) and Neutronics and nuclear data (13). This can be explained by the fact that knowledge on materials has ''innovation potential'' and a significant relevance in nuclear.
- The answers show that the facilities for LLL are used for the major part in the fields for both Education and Training.
- The facilities for LLL are accessed by a wide variety of "end-users" with the majority being trainees followed by master students and professionals. This trend was expected due to the fact that the E&T path for these three categories foresees hands-on training.

2) Access procedure

- Access procedures are depending on the type of LLL facilities but generally involve a straightforward security clearance and health check.

3**) Access times**

- Most courses for the purpose of ''Education'' range mostly between one week (49%) and two weeks (32%). Most courses for the purpose of ''Training'' are between one day and one week (72%). This is almost in-line with activities done by trainees, master student and professionals.
- The majority of the courses (82%) are offered to 1-10 participants, due to the nature of hands-on activities.

4**) Finance**

- For what concerns the financing, the highest share has declared that the organisation owing the facility also finances the access to it.

- It has to be pointed out that only 42% of the organisations have available mobility grants for end-users to access their LLL facilities. In this context it would be certainly interesting to investigate how to improve the availability of mobility grants that would benefit the end-users.

5) **Overall learning outcome**

- The overall benefit of the facilities for LLL has shown a 27% of transferable skills, 24% ECTS and a 42% contribution to nuclear science.

For what concerns the implementation of the collected data in an advanced database, it is highly recommended to prepare such database for the entire survey (see [3]) made within the ANNETTE project in order to keep the collected data also for future projects.

As for the data collected on the LLL facilities, a further alternative could be to include it in the ENEN database through an extension of the ENEN-RU database on facilities.

7. References

[1] Interim Report. D1.8 Ares(2017)1227447-08.03.2017

[2] Technical Annex – Coordination and Support Actions - ANNETTE

[3] "D1.1. SURVEY ON E&T AND VET IN THE NUCLEAR FIELDS IN EUROPE", Report prepared by SCK•CEN in the framework of the ANNETTE project (WP1), 2016

Annex 1: Overview of the questions of the survey as submitted to SCK•CEN, including multiple choices answers and instructions for participant where applicable

Name of organisation of which the facility is owned by:
Name of contact person (ideally this is the same person filling the questionnaire):
Address:
Tel:
E-mail:

1. *General information*

Q1.1 What is the main area of application of the facility?

- Reactor Development
  Gen II / III reactors or Generation IV (select applicable)
- Fuel development
- Fuel reprocessing
- Waste management
- Nuclear Safety
- Accelerator based application
- Other… please specify

Q1.2 What is the main area of scientific focus of the facility?

- Structural and clad materials
- Fuel safety
- Sever accident
- Thermal-hydraulics
- Materials
- Neutronics and nuclear data
- Design validation
- Safety assessment
- Other… please specify

Q1.3 How would you best describe your facility in relation to training[4] and education[5]?

- It provides training courses (in the form of lectures, lab sessions and demonstrations)
  Please give a short description
- It is a used for education purposes (use by students for master / PhD thesis work)
  Please give a short description
- It is used for both education and training
- Other
  Please give a short description

Q1.4 At what level of education does the facility accommodate for? (Select all relevant)

- *Diploma students (Trainees)*
  In Average, how many trainees use the facility per year?

[4] Training facility often provides taught courses, summer schools, and or master programmes. Credits and certificates are issued to the attendees after each course.

[5] Education facility provides hands-on training and use of equipment in a nuclear facility. The overall experience and results contribute to a particular master or PhD project and to scientific report and publication.

How many of those are non-European?

- *Master students*
  In average, how many master students use the facility per year?
  How many of those are non-European?

- *PhD students*
  In average, how many PhD students use the facility per year?
  How many of those are non-European?

- *Senior scientists (post-doctoral, university lecturer or a high level researcher)*
  In average, how many visiting scientist use the facility per year?
  How many of those are non-European?

- *Industry staff (Professionals)*
  In average, how many industry staff use the facility per year?
  How many of those are non-European?

2. *Access procedure*

Q2.1 Does the end-user require a security clearance prior access?

- Yes
- No
  If yes, please give a short description

Q2.2 Does this apply for both European and non-European users?

- Yes
- No
  If No, please explain

Q2.3 Does the user require undergoing health check?

- Yes
- No
  If yes, please give a short description

Q2.4 Does the user require undergoing any training before use (for education facility) and/or preparation (for training facility)?

- Yes
  If yes, please give short description
- No
  If No, what support does the facility provide to the end user?

3. *Access times:*

Q3.1 How many training courses (for training) and/or uses (for education) does the facility accommodate for per year?

- Please give an average number

Q3.2 When do the training courses take place?

- During university break
- At a specific time set by the organisation (please specify)
- All year round

Q3.3 For training facility, what is the average length of each course?

- One full day
- Two to three full days
- One week
- Two weeks
- More than 2 weeks (Please specify)

Q3.4 For educational facility, what is the average length of one single use or visit?

- Less than a week
- More than one week
- One month
- Two months
- More than two months (Please specify)

Q3.4 What is the average number of participants taking part in each course (for training facility)?

- 1-10
- 11-20
- 20-30
- More than 30 (Please specify)

Q3.5 What are the access hours of the facility (for education facility)?

- Core hours (day time only)
- Night shifts only
- Both

  If both, are there any extra security procedures to be considered for night shift? Please explain

4. <u>Finance</u>

Q4.1 who is the facility funded by (funding include maintenance and consumables)?

- The organisation owning the facility
- An external funding board
- The end-user
- Other (please specify)

Q4.2 Are there fees for attending the course (for training) and/or for the use of the facility?

- Yes, per course (please give average cost per participant)
- Yes, per use (please give average per day)
- No

Q4.3 Can the student/researcher benefit from mobility grants?

- Yes
- No

If yes, Please give brief explanation and include examples of previously used funding boards

5. *Overall learning outcome*

Q5.1 What are the main outcomes of the use of your training and education facility?

- University credits
- Transferable skills gained
- Contribution to nuclear science (project, reports and publications, etc.)
- Other (please specify)