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**Ensuring and Evidencing Excellence in Skills for the UK Nuclear Industry**

**Part 5: An overview of the integrated approach developed by the UK nuclear industry to address the current and future skills, training and education needs and challenges of this dynamic and growing sector.**

Previous papers have described the challenges facing the UK nuclear industry to ensure it can maintain and develop a skilled and professional workforce to deliver the nuclear agenda safely and effectively, for the breadth of the sector including: decommissioning, the fuel cycle, new build and defence. A range of solutions have also been detailed in these papers. This paper outlines how employers from across the UK nuclear industry have come together to bring these solutions together in an industry wide system to develop a coordinated and unified approach to skills, training and education in skills for the nuclear industry.

The Skills Academy was established by employers in 2008 with some development and start up funding from Government. Moving into 2011 it will be a fully self sustaining business, owned and run by its employers. There are now over 80 nuclear companies that are members of the Skills Academy; this includes all major sites, vendors and operators plus a wide range of supply chain companies.

The Skills Academy responds to the industry wide research produced by its strategic partner Cogent Sector Skills Council and the outcomes of the employer action plans developed with all employer members. This has led to the Skills Academy developing solutions across the breadth of the Skills Pyramid i.e. from attraction and entry to the sector, through vocational and technical training to graduate and post graduate level programmes. The focus is on ensuring excellence in skills for the nuclear industry to deliver the agenda safely in an industry wide manner rather than each company operating in silos. Delivery is via a network of High Quality Training Providers, employers and Universities.

Key to all of this is the development and implementation of the **Nuclear Skills Passpor**t. This is a major development that is being rolled out across every nuclear company in the UK for all individuals working in and with the nuclear industry. The Nuclear Skills Passport (NSP) is a highly secure online facility enabling companies to record the training, skills and educational development of all their employees, validating that this has been done to the industry agreed standard. This is aligned to the role profiles developed for the industry via Cogent SSC enabling companies and individuals to carry out a training needs analysis and to plan and access quality training and development accordingly. The NSP is being stated as 'Highly Desirable' in supply chain tenders and it will be a crucial tool to support the supply chain demonstrate their competence and capacity to deliver projects effectively and safely. With this approach of industry wide implementation there will be a drive on improving on quality and excellence across the sector, the NSP will also support the transferability and mobility of the workforce to respond to the peaks and troughs of demand. At this conference we are keen to explore with partners how this system could be adopted and implemented on a European wide basis. www.nuclearskillspassport.co.uk

# IAEA EFFORTS ON NUCLEAR SECURITY TRAINING AND EDUCATION

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## ABSTRACT

The threat of nuclear terrorism has not diminished. In response to the concern at the ongoing threat, States have developed an international nuclear security framework through the establishment of a number of binding and non-binding legal international instruments which obligate or commit States to carry out a number of actions to protect against nuclear terrorism.

The need for human resource development programmes in nuclear security has been emphasized at several International Atomic Energy Agency (IAEA) General Conferences and Board of Governors' Meetings. In the pursuit of this need, the IAEA has developed a comprehensive nuclear security training programme that is provided to States on a regular basis. This programme includes an eLearning module that was published in 2010. In order to support these efforts and to accelerate nuclear security competence building, the IAEA has developed a concept that seeks to effectively pass ownership of nuclear security knowledge and skills to States through the establishment of a *Nuclear Security Support Centre* (NSSC).

In order to meet the identified need for professionals with in-depth knowledge of nuclear security, the IAEA has developed a technical guidance entitled *IAEA Nuclear Security Series No. 12 - Educational Programme in Nuclear Security* that consists of a model of a Master of Science (M.Sc.) programme that aims, inter alia, at assisting educational institutions to develop nuclear security educational programmes. This guidance document was published in April 2010.

The paper sets out IAEA efforts in the area of nuclear security training and education, including the assistance available to States for establishing a NSSC. The paper underlines the objective and content of the *IAEA Nuclear Security Series No. 12*, discusses different concepts on how to establish nuclear security at universities and, highlights the IAEA efforts to support and harmonize nuclear security education worldwide through the collaborative *International Nuclear Security Education Network* (INSEN).

## 1. Introduction

Nuclear threats are real and immediate and have become more dangerous and more complex during the past ten years. Throughout the world, too much nuclear and radioactive material is not properly secured. On average, every two days, the IAEA receives one new report on incidents involving illicit trafficking of nuclear or radiological material. Terrorists have become bolder and are not afraid of using weapons of mass destruction. Therefore, States have to meet the challenge of building an effective national nuclear security regime including highly qualified human resources in order to ensure and strengthen global security.

The need for human resource development programmes in nuclear security was emphasized at a number of IAEA General Conferences and the Board of Governors Meetings. In September 2009, the Board of Governors considered and approved a new *Nuclear Security*

*Plan* (the Plan) covering the period 2010–2013[1], which recognizes that education and training is critical for States to be able to implement nuclear security and, that nuclear security culture is vital in the management of activities involving nuclear or other radioactive material.

## 2. The IAEA Nuclear Security Human Resource Development Programme

Education and training play an essential role in ensuring that experts are well prepared and qualified to analyse national nuclear security needs, to prevent and combat the threat of sabotage or the use of nuclear and radioactive material for criminal or unauthorized acts, and to prepare effective response measures to nuclear security events.
The IAEA has developed a comprehensive overall strategy ranging from short term types of training, such as ad hoc specialized training courses, to a guidance document that provides a model of a *Master of Science Programme in Nuclear Security* supporting the development of qualified experts in States. The *IAEA Nuclear Security Human Resource Development Programme* therefore contains two main areas: training and support for nuclear education.

### 2.1 The IAEA Nuclear Security Training Programme

The *IAEA Nuclear Security Training Programme* is geared to support States in their efforts to develop nuclear security human resources and covers the full range of national functional responsibilities for nuclear security. It targets audiences at all levels of nuclear security responsibility. The training, which is tailored to the needs of the various organizations responsible for nuclear security, is provided in a national, regional or international setting.
Annually, the IAEA conducts more than 50 training activities in the area of nuclear security. In 2010, the IAEA provided 72 nuclear security training courses to more than 1800 people from 120 States. The training efforts are based on the findings and insights resulting from the various nuclear security advisory services and the requests formulated by the IAEA Member States. The range, depth and number of training activities have continuously expanded in the past years and cover thematic and skills-building topics:

- *Nuclear Security Management for CEOs*
- *Guard Force Management*
- *National Regulatory System for Nuclear Safety, Security and Safeguards*
- *Physical Protection of Nuclear and other Radioactive Material and Facilities*
- *Practical Operation of Physical Protection Systems*
- *Physical Protection Inspections at Nuclear Facilities*
- *Security of Radioactive Sources*
- *Nuclear Security in Practice: Field Training for Academics*
- *Information and IT Security*
- *Increasing Nuclear Security through Process Control and Material Accounting*
- *Physical Protection against Sabotage: Assessing Vulnerabilities & Identifying Vital Areas*
- *Design Basis Threat*
- *Nuclear Security Culture*
- *State System of Accounting for and Control of Nuclear Material*
- *Security of Radioactive Material in Transport*
- *Combating Illicit Trafficking in Nuclear and other Radioactive Material*
- *Radiation Detection Techniques: Experts Training*
- *Operational Coordination for Effective Response to Detection Alarms*
- *Radiological Crime Scene Management and Introduction to Nuclear Forensics*
- *Response to Criminal and Unauthorized Acts Involving Nuclear or other Radioactive Material*
- *Malicious Acts involving Radioactive Material at a Major Public Event*
- *Development of Mobile Expert Support Capability in Nuclear Security Applications*

1 GOV/2009/54-GC(53)/18

In order to complement the comprehensive training programme provided to States, in 2010 the IAEA has published its first interactive computer based training programme on the use of radiation detection equipment. This eLearning programme is addressed to front-line officers, border guards, custom officials and law enforcement officers around the world using handheld radiation detection instruments. The programme aims at improving skills in the use of radiation detection instruments and increasing knowledge about the basic functions of radiation detection instruments resulting in an overall improvement in the operation of instruments.
Once the learner has completed the 'Basic Training' modules she/he will be prompted to select the interactive role-play scenarios. The scenarios take place in virtual settings at 'borders/port of entries', put learners in realistic situations and require them to make decisions based on the knowledge gained in the 'Basic Training'.
Different mentors guide the learner through the eLearning programme. The mentors' role is to introduce, emphasize and summarize key points of the programme and to provide the learner with hints and feedback on her/his answers. The estimated time for completing the programme is 4 ½ hours maximum. Upon successful completion of the programme, the system will generate a personalized certificate. A number of IAEA nuclear security training activities require the successful completion of the eLearning programme prior to attending training.
In addition, the IAEA supports States that wish to develop a *Nuclear Security Support Centre* (NSSC) based on a concept developed by the IAEA Secretariat. A NSSC aims at supporting and facilitating the systematic development of sustainable human resources through the implementation of a tailored *National Nuclear Security Training Programme* based on the assessed needs. Such a centre, which could be a virtual centre, will ensure long-term sustainability of nuclear security capabilities in individual States. In addition to the human resource development function, a NSSC can be geared to provide t*echnical support services* for lifecycle equipment management and s*cientific support services* for the detection of and response to nuclear security events that could also be provided to neighbouring countries.
The IAEA support countries in this effort by assisting in the design of a NSSC, assisting in the development of a tailored national training programme, in the training of nuclear security instructors and providing appropriate teaching material, as well as facilitating on-the job training for technicians or mobile expert support team members.

## 2.2 The IAEA Educational Programme in Nuclear Security

Currently there is no educational institution worldwide providing a comprehensive academic programme in nuclear security that combines selected courses from across the multiple disciplines mentioned above. Therefore, the IAEA has taken the lead, and has developed — together with academics and experts from Member States a technical guidance for a Master of Science (M.Sc.) programme and a certificate programme in the area of nuclear security to assist States in adapting such programmes in the future.
This technical guidance was published in April 2010 as *IAEA Nuclear Security Series No. 12 - Educational Programme in Nuclear Security* [2]. This document should be considered as a guide to facilitate the development of comprehensive nuclear security academic programmes with the purpose of ensuring the availability of nuclear security experts who are able to deal with future nuclear security challenges at the national or regional level.
The main objectives of this publication are to provide a comprehensive and current overview of nuclear security educational needs and to provide guidance for the development of a Master of Science programme and a certificate programme in nuclear security. The *IAEA Nuclear Security Series No. 12 - Educational Programme in Nuclear Security* (NSS 12) is designed to provide both the theoretical knowledge and the practical skills necessary to meet

[2] For download see: http://www-pub.iaea.org/MTCD/publications/PDF/Pub1439_web.pdf [2]

the nuclear security requirements outlined in the international legal framework and in the *IAEA Nuclear Security Series* publications[3]. This IAEA guide is intended for university curriculum developers, nuclear security instructors and human resource development managers working at academic institutions or entities responsible for nuclear security. It might also be of value for decision makers, operators, managers at regulatory authorities, law enforcement agencies and managers working at other government nuclear organizations responsible for nuclear security.

**Master of Science programme (M.Sc. programme)**
The structure of the recommended M.Sc. programme consists of 12 required courses and eleven elective courses. The design of each course is characterized by a combination of theoretical and practical sessions, such as demonstrations, laboratory exercises or case studies which should be in line with the teaching policy of the implementing university and defined by the individual faculty.
The 12 required courses cover the main nuclear security areas 'prevention, detection, and response' and other basic areas, such as nuclear security culture, legal framework, nuclear technologies and applications, and radiation protection.

**Different concepts on how to establish nuclear security at universities**
The establishment of a new discipline at the academic level is a challenging endeavour. The following concepts are based on peer exchanges and could be used by universities as a starting point to define the most appropriate way to establish an academic programme in nuclear security at their institution. However the indicated concepts should be further elaborated, once experience has been gathered in their application.

- Expansion of existing academic programs, including nuclear security elements

The systematic establishment or expansion of the new specialty of nuclear security can be tackled in different ways. One concept could be that universities or other institutions might adopt, as a first step, some courses or modules from the recommended IAEA guide NSS 12 that fit well into the existing specialization of the university. In this way they can expand students' knowledge in one or more particular nuclear security areas. Once the teaching staff of the university has gained the required nuclear security knowledge and skills, the number of courses could be increased with the goal to provide one day a certificate programme in nuclear security, if the need for such a programme has been identified in a country/region.

- Establishment of a certificate programme

The implementation of a certificate programme, which is also set out in the NSS 12, tailored to the State's nuclear security educational needs and nuclear infrastructure could be another concept. This might be suitable for any country with limited nuclear activities and/or with a currently limited number of specialists in this area.

- Establishment of a specialization in nuclear security

In some countries the following options could be suitable. Depending upon the State's educational system and governmental needs, it may be most effective to set up an M.Sc. programme in nuclear security as a specialty in *Nuclear Engineering*. In some other country, nuclear security might be best presented as part of an *Honors Programme* where all core topics could be covered in the first year, with specialization during second or even later years.

- Establishment of the academic specialty of nuclear security at the international level

Nuclear security is multidisciplinary and requires, therefore, experts from several different disciplines to be successfully established and implemented at universities. This might pose some difficulties as it will not be easy to find experts covering all nuclear security areas at one university. Most of the time these experts will not be easily available in one State, hence, a multinational approach seems to be another reasonable concept. This approach could

[3] For more details see: http://www-pub.iaea.org/MTCD/publications/ResultsPage.asp

embrace different States in a region where universities with a certain profile have built an official network.
Given that there is an agreed education policy in a region, as e.g. in Europe, the following option could be taken into consideration by the university network. We assume that there is an identified need for an educational program in nuclear security in this region. Further, we assume that at the respective universities are faculties available with expertise in certain areas of nuclear security. This group of universities could develop jointly an educational program based on the *IAEA Nuclear Security Series No 12 - Educational Programme in Nuclear Security* to be taught at different universities in the region. This would allow both, the provision of the program to students from an entire region, and in parallel the development of adequate faculties at different universities in various countries. In considering this option, it is important to take into account that this approach would imply high mobility of students and faculty members.

## 3. International Nuclear Security Education Network (INSEN)

In order to better address current and future requests for assistance in this area, the IAEA organized a workshop in March 2010. During the workshop, a group of experts from academia, international organizations, and professional nuclear material management associations discussed, inter alia, on how to facilitate collaboration among educational and research institutes and other stakeholders[4] in order to ensure the sustainable and harmonized establishment of nuclear security education. There was consensus that the establishment of a collaborative network for higher education in nuclear security would be an important and suitable mechanism to support this endeavour. The experts and the IAEA took immediate action and established the *International Nuclear Security Education Network* (INSEN) in the framework of the workshop.
The INSEN is defined as a partnership between the IAEA and educational and research institutions and other stakeholders. Its mission is to enhance global nuclear security by developing, sharing and promoting excellence in nuclear security education. The overall objective of the INSEN is to support the promotion and establishment of nuclear security education.
This objective will be achieved through collaborating in the following areas/activities:

- Development of peer-reviewed textbooks, computer based teaching tools and instructional material, including exercises and materials for laboratory work;
- Faculty assignment and development in the different areas of nuclear security through mutual faculty exchanges and/or joint development and implementation of in-depth nuclear security training programmes or schools;
- Joint research and development activities to share scientific knowledge and infrastructure;
- Student exchange programmes to foster international cooperation and exchange of information;
- Quality assurance: consistency with IAEA defined terminology described in the IAEA Nuclear Security Glossary, the Fundamentals and the Recommendation documents;
- Theses evaluation, coordination and improvement;
- Performance of surveys on the effectiveness of nuclear security education among students and faculty.

At this stage, the INSEN membership is informal and open to any educational and research institution already involved or, that plans to be involved in nuclear security education in the future. Currently INSEN has 45 members and four observers and is guided by all members of the network. It consists of currently three working groups.

[4] Other stakeholders: governmental entities, such as regulatory authorities, the Ministry of Justice, Finance, Health, Environment, Science, Transport; law enforcement agencies, such as Customs, Police, the intelligence services; the nuclear industry; companies with security expertise in other fields and other related organizations.

### Working Group I: Exchange of information and development of materials for nuclear security education

The role of Working Group I is to establish a mechanism to coordinate and assist in the development of peer-reviewed text books as well as instructional materials for nuclear security academic programmes and to foster the exchange of materials through the Nuclear Security Web Portal (NUSEC). Further, its role is to incorporate results of nuclear security research in instructional materials on a regular basis, and to liaise with other INSEN working groups.

### Working Group II: Faculty development and cooperation among universities

The role of Working Group II is to enhance faculty development in the area of nuclear security. Activities in this area include:

- Identification of educational institutes willing to host nuclear security in-depth courses for teaching staff provided by leading experts;
- Assistance in the development of tailored curricula for nuclear security in-depth courses;
- Liaison with INSEN Working Group I for the development of instructional materials for nuclear security in-depth courses;
- Assistance in the implementation of these courses;
- Development of a nuclear security teaching staff roster;
- Establishment of a mechanism to facilitate the exchange of students, teaching staff and researchers;
- Provision of materials/information to be uploaded to the NUSEC.

### Working Group III: Promotion of nuclear security education

The role of Working Group III is to engage with all nuclear security stakeholders, and to promote nuclear security education. In addition, the role of this group is to identify requirements for nuclear security specialists, to assist in the development of nuclear security job descriptions and to provide materials/information to be uploaded to the NUSEC.

## 4. Conclusion

Training and education play an essential role in developing qualified specialists and experts to be prepared for the current and future challenges in the area of nuclear security. The IAEA provides a comprehensive training programme to Member States and non-Member States to continuously support their efforts to build-up nuclear security human capacities in their countries. In addition, the IAEA has developed an eLearning tool to enable frontline officers to train themselves any time they want on the use of radiation detection equipment. Furthermore, a concept was developed by the IAEA Secretariat to build-up and/or to strengthen in a systematic way national human resource development and technical and scientific support services in countries. This concept can be tailored to both, countries with nuclear programmes and countries using radioactive sources for medical, industrial and research purposes.

Nuclear security is by nature a multidisciplinary field of study that contains in addition to the technical elements of nuclear security, several traditional academic disciplines including nuclear engineering, nuclear non-proliferation, information technology, history, international security studies, and law. Until recently there was no university worldwide providing a comprehensive academic programmes in nuclear security that combine selected courses from across the multiple disciplines mentioned above. This traces back to the fact that faculty member from more disciplines need to come together in order to be able to transfer comprehensive nuclear security knowledge and skills. This is the real challenge in establishing nuclear security at universities, apart from the development of textbooks and the establishment of nuclear security laboratories for education purposes. This is a long term project which needs support from individual States and the academic community in order to succeed.

The IAEA through INSEN facilitates the cooperation and collaboration among educational and research institutions interested in providing comprehensive and harmonized academic programmes in nuclear security in the future. All these efforts will ultimately strengthen the global nuclear security regime and protect humans and environment from nuclear terrorism.

## References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Educational Programme in Nuclear Security, IAEA Nuclear Security Series No. 12, Vienna (2010).

# NUCLEAR EDUCATION AND TRAINING IN AN ANTI-NUCLEAR ENVIRONEMNT

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**Abstract**

The Chernobyl accident in 1986 further reinforced the Austrian anti-nuclear policy adopted in 1978 through legislation prohibiting nuclear power production. Since that time, the country has been facing a strong anti-nuclear political environment. Out of its three operating research reactors, two were permanently shut down in 1999 and 2005 for various reasons. The only remaining research reactor is the TRIGA Mark II which is operated by the Vienna University of Technology/Atominstitut (VUT/ATI). Due to this research facility, the ATI not only sustains the Nuclear Education and Training (NE&T) in the country but also promotes and further develops its NE&T activities. Presently the world faces a serious situation of the managing and transfer of nuclear knowledge to the next generation. Therefore the ATI supports the European- and International NE&T efforts through the European Nuclear Education Network (ENEN) and through the International Atomic Energy Agency (IAEA). This paper highlights the ATI NE&T activities and points out the challenges/difficulties to NE&T at ATI and also suggests several improvements in the NE&T process.

## 1. Background

Austria does not operate any nuclear power plant due to the legislation prohibiting NPP on Austrian territory which was adopted as a result of a referendum rejecting the NPP project Zwentendorf in 1978 [1]. The Chernobyl event in 1986 reinforced this parliamentary decision and further strengthened the public opposition against nuclear power production. The main objective of the Austrian nuclear education is its interest in the safety of nuclear facilities related to environment, health and safety issues arises from the NPP in neighboring countries.

To sustain the nuclear knowledge in the country, the uninterrupted nuclear knowledge transfer from one generation to the next has a key importance for knowledge sustainability in nuclear science and technology. Unfortunately, the present world is facing a severe shortage of qualified nuclear manpower especially in industrialized countries since the early nineties. Europe is also seriously affected by this situation which arises mainly due to the retirement of ageing workers, a lack of adequate replacement due to a negative public perception of nuclear technology and a lack of interest from the young generation to a nuclear career [2]. Europe has responded to this nuclear knowledge eroding situation by taking several measures including the development of an European Nuclear Education Network (ENEN). Since the ENEN establishment, Europe is an active promoter of NE&T [3].

The E&T processes look similar but they are in fact different facets of learning, however their history, purpose, and methodology are evidently different. Education is broader than training as it focuses on the needs to maintain completeness and continuity of competences across generations. It is essentially a knowledge-driven process, involving academic institutions as suppliers and students as customers. While training is learning a particular skill needed to deliver a particular result: training activities follow other patterns than the regular academic education schemes. It is essentially an application-driven process, involving industrial training organizations as suppliers and professionals as customers [4].

Particularly at the higher education level, the training at academic institutions may not be adequate for specific subject therefore for this purpose training institutes for those specific subjects are needed. It is a world-wide practice that educational and training institutions work separately but in close cooperation. The cooperation between education and training bodies is not only realized but recognized at an international level leading to the concept of national and international networks, these networks have been now established since about one decade. For example the objective of ENEN was realized through the co-operation between European universities involved in education and research in nuclear disciplines, nuclear research centres and the nuclear industry [5].

## 2. ATI's NE&T activities at national level

Austria has a strong anti-nuclear policy therefore to preserve and keep nuclear knowledge alive in this country is very difficult due to political reasons. Nevertheless the VUT/ATI is involved in many NE&T activities at a national level. There is no university or institute offering a nuclear engineering degree, but there are some pure nuclear courses (i.e. courses in nuclear engineering, reactor physics, reactor experiments, dosimetry and radiation protection etc) which are offered at the VUT Technical Physics curricula on a BS,MS and PhD level [6].

## 3. Atominstitut NE&T infrastructure and activities

The Institute of Atomic and Subatomic Physics (former Atominstitut) is functioning under the departments of physics [7]. As this paper focuses on the NE&T activities of the ATI, the nuclear experimental facilities available at the institute are briefly described [6].

### 3.1 TRIGA Mark II research reactor

The ATI [8] operates a TRIGA Mark II research reactor since March 1962 with a thermal power of 250 kW which is today the only operating research reactor in Austria. The reactor is equipped with a thermal column, a radiographic collimator, four beam tubes and three in-core pneumatic transfer systems. Inside the core, there are about 16 irradiation positions for irradiation experiments while outside the core, the four beam tubes supply neutron for basic and applied neutron research.

### 3.2 Routine experiments available at ATI

About 20 experiments in the field of practical reactor physics, reactor kinetics as well as reactor instrumentation and control system (I&C) are offered by the ATI using the TRIGA Mark II reactor. These are standard experiments and can be applied to other research reactor types with some modifications. The detailed theoretical and experimental description of these experiments is available in ref [9].

### 3.3 NE&T activities at university level

The NE&T activities at university level involve mainly the academic (BS, Master and PhD) programs and some training programs. Through the ATI about twenty Masters and five PhD students graduate in nuclear related subjects per year. An increasing trend of students in nuclear related subject is presently observed at the ATI [6]. The obvious reason for this growing trend may be the awareness level of public in general and students in particular, about the potential of safe utilization of nuclear energy in the coming future which is also influenced by the growing public climate discussions on fossil fuel usage.

## 4. NE&T activities at EU-level

Europe being an active promoter of nuclear education has taken a wide range of measures. These measures include the development of nuclear educational programs at universities/research institutes, enhancing students' and professors' exchange programs and improving public information in the nuclear field at an European level. The establishment of ENEN is a major step to promote the NE&T in the region [5]. The main objective of the ENEN Association is the preservation and the further development of expertise in the nuclear fields by higher education and training. The ENEN Association has established the delivery of the European Master of Science in Nuclear Engineering certificate (EMSNE) [5]. Education and training courses have been developed and delivered to materialize the core curricula and optional fields of study in a European exchange structure. Austria, as a member of OECD, is actively contributing in nuclear educational and training activities in Europe. Further the ATI is an energetic member of ENEN, therefore contributing its activities for preserving, enhancing and managing nuclear knowledge by offering its NE&T services to ENEN. The following courses are contributed by the ATI at an EU level [6].

- Eugene Wigner Course
- NTEC course (www.ntec.ac.uk)
- MTR+I3 project
- MOL courses
- Slovak NPP courses

## 5. NE&T activities at an international level

The ATI is situated very close to the IAEA headquarters in Vienna, therefore the ATI provides NE&T services to IAEA Member States (MS) since many years. Due to this fact the ATI has long-term experience in organizing international training courses under the IAEA Technical Cooperation projects.

### 6.1 East European Research Reactor Initiative (EERRI) [11]

To satisfy the MS requests, the Eastern European Research Reactor Initiative (EERRI) was established by the IAEA to organize and to implement a Group Fellowship Training Program on Research Reactors (GFTPRR).

The program is organized in collaboration with the Vienna University of Technology/Atominstitute (VUT/ATI). The first iteration involved the VUT/ATI, two Hungarian Nuclear Research Institutes, and staff members from the Jozef Stefan Institute/Ljubljana (IJS), Slovenia. The duration of the training program was 6 weeks and covered about 30 topics ranging from theoretical lectures to practical experiments at the TRIGA reactor Vienna and at the training reactor of the Budapest Technical University grouped into three main areas; organizational matters , research reactor operation & maintenance and radiation protection. Currently the following institutes are involved in EERRI:

1. Vienna University of Technology/Atominstitute (VUT/ATI), Austria
2. KFKI Budapest, Hungary
3. Budapest University of Technology, Hungary
4. Institute Jozef Stefan, Ljubljana, Slovenia
5. Technical University of Prague, Czech Republic
6. Research Centre Rez, Czech Republic

The first course was carried out for six weeks in spring 2010 with great success; the demand was so high that since the first course four more courses with similar structure have been carried out with IAEA financial support.

### 6.2 IAEA Safeguard Trainee Courses

These training courses have been carried out for the IAEA Safeguards Traineeship program since 1984 especially for participants from developing countries. These courses last about 4 weeks and the trainees undergo a very tight theoretical and practical training. About 90 trainees from all over the world have passed through the ATI safeguard training courses since 1984.

### 6.3 IAEA fellowship program

Since mid-1970 the ATI is hosting IAEA fellows from all over the world to spend (two weeks to one year) in specialized nuclear training. The fellow is attached to one ATI working group according to his/her training area. Within this program more than 110 fellows have passed through the ATI. In addition, in many cases a long-term cooperation between the ATI and the fellow's home institute has been established.

## 7. Improvements in NE&T

The NE&T is an indispensable element to develop and maintain a continuous nuclear development and to contribute to the sustainability of human resources capabilities. It has been shown that the ATI conducts a wide range of NE&T activities and contributes to international efforts to address the concerns about the future of nuclear education. Following are some suggestions for the improvement of the NE&T activities.

**Primary education:** Beyond the academic and training programs, the early information at the secondary school level is very important to attract the young generation toward nuclear fields which may later lead towards an academic nuclear education. Though this is a long term target it would improve the process of nuclear education due to following reasons.

- It is easier to attract young people towards nuclear education when they have already some fundamental nuclear knowledge. This is only possible if they receive such knowledge already starting at the secondary level of education.
- Most of the students decide their future career when they finish their secondary education. The basic know-how of nuclear technology can help them to select this direction for their future and increase their interest.
- It would also strengthen the decision makers (politicians, economists, journalists etc) at national- and international level if they have some basic knowledge in nuclear technology.

The ATI has recently established a new program for secondary school pupils just before their certificate for university studies (17 to 18 years of age). In co-operation with dedicated physics teachers, two full day courses have been carried out in December 2010 to attract the future university students in nuclear physics. A final discussion and a very positive course evaluation concluded that it increases the interest of future students in nuclear subjects. Due to the overwhelming success It was decided to repeat this project for the subsequent years.

**Experimental facility:** The ATI reactor may have to return a few high enriched FLIP fuel elements back to USA in this decade due to the "US Spent Fuel Return Program" policy. This return may put the future operation of this research reactor at risk as there is presently no other alternative for the fuel back-end. To keep this reactor in operation for research and NE&T purposes, either the fuel return program has to be extended or another solution for the TRIGA fuel back-end has to be found.

**Scope of the course:** The NE&T programs should be part of the overall national E&T program and should be offered in every country at various levels. The scope of this NE&T program is directly related to the national nuclear policy. Evidently it would attract more students if there is a firm governmental commitment to a smooth nuclear development.

**Curricula:** The curriculum of any academic program mainly defines its quality. The NE&T has to follow a firm quality assurance program similar to any industrial product which plays an important role in the industrial achievements. To maintain and further improve the quality of the product (or NE&T), every industry (or educational institute in this case) has to establish a quality management system. The most important factor in the quality of NE&T is the consolidated and standardized curricula of academic program. To take up the challenges of offering top quality in nuclear education, new, attractive and relevant curricula, higher education institutions should cooperate with industry, regulatory bodies and research centres, and more appropriate funding from public and private sectors is necessary.

**Academic Background of the candidates:** The same background of the candidates for a particular course provides good results. In case of different backgrounds, the common course contents should be designed according to their different backgrounds. It is recommended for the candidates to have at least good knowledge of basic nuclear physics and applied mathematics.

**Prerequisites for participants (eligible criteria for course):** It is difficult for students to join a training institute directly without having any academic degree. An academic degree provides the student with the basic knowledge of general subjects such as physics, mathematics and computer science etc. These subjects play the role of prerequisite requirements in training. The educational institution, as in broad sense, provides input to training institutions for some specific subject.

**Course material:** The course material (PPTs, CDs, notes) should be provided in advance so that students should prepare themselves for an expected course. This increases the student's curiosity and also facilitates the retention power of the students due to their curiosity.

**Harmonization/Integration:** The integration of European E&T is under process. A certain inefficiency of activities related to education and training in nuclear science area is relieved by reason of a lack of European integration and harmonization of education and training activities. The acceleration in harmonization process of European E&T would improve the knowledge transfer through the nuclear E&T program in more efficient and effective way.

**Educational methodologies:** New methods using the latest information- and communication technologies with the appropriate software tools for NE&T should be applied such as virtual- and e-learning as the latest techniques to spread the NE&T activities and efforts worldwide.

**Fukushima Hotline:** The recent problems with the Fukushima NPP's created a panic reaction in Austria, Iodine pills were almost sold out. To inform the media and public two days after the accident the Austrian Nuclear Society Young Generation established an information hot-line which kept about 5 YG members busy from morning to evening and through the week-ends. This hotline placed the ATI in the center of public interest, journalist called and even national and international offices contacted the YG for detailed and objective information. Fukushima showed that even in a strong anti-nuclear environment nuclear competence is of utmost importance.

## 8. References


1. OECD publication (2003) Nuclear Legislation in OECD Countries, ISSN 1727-3854.
2. R. Khan, H. Böck, , "Status and Patterns of European Nuclear Education and its Best Practices", ENS news, Issue No. 23 winter, Feb. 2009.
3. P.Beeley et al., "Nuclear Education, Training and Knowledge Management in Europe", ENS news, issue no. 27 winter, 2010, http://www.euronuclear.org/e-news/e-news-27/hsc-statement.htm.

4. IAEA Technical Meeting on the "Role of Universities in Preserving and Managing Nuclear Knowledge", Technical Meeting on the Role of Universities in Preserving and Managing Nuclear Knowledge IAEA, 10-14.12. 2007 IAEA, Vienna, Austria.
5. European Nuclear Education Network (ENEN) Association, http://www.enen-assoc.org/.
6. R. Khan, H. Böck, M. Villa, "The Status and Patterns of Nuclear Education in Anti-nuclear Environment", International Journal of Nuclear Knowledge Management (IJNKM), Vol. 4, number. 3, 2010.
7. Vienna University of Technology homepage: www.tuwien.ac.at
8. Atominstitute homepage : www.ati.ac.at
9. H. Böck, R. Khan, "Typical Experiments with a Low Power Research Reactor", Vienna University of Technology/Atominstitute, ATIR 1008, Nov. 2010.
10. OECD publication, "Nuclear Education and Training: Cause for Concern? OECD/NEA, ISBN 92-64-18521-6. 2000.
11. H. Böck, et al., "A multinational practical training course for nuclear candidate countries organized by EERRI", Int. Conf. on Research Reactor Fuel Management, 22-25 March, 2009, IAEA, Vienna, Austria.

# TRAINING OF CONTRACTORS AT LOVIISA NPP

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ABSTRACT

Loviisa NPP has two pressurized water reactors which started their commercial operation 30 years ago and which are the first nuclear reactors in Finland. The aging of the power plant units and the generation change among the staff, both own employees and external work force, bring new challenges to training. In the annual outage 2010, 50% of the contractor workers were newcomers. Even though the contractors are specialists in their own field, they have no experience of working in a nuclear facility. All these factors together set requirements to training and its development.

Co-operation in the field of education with the other nuclear power plant in Finland was initiated in its present form in the 90's and it has been expanded to other Nordic countries. For example the general employee training has been developed together with the Swedish nuclear power plants. The aim is to get similar practices to the Nordic power plants, a general employee training gone through in one of the power plants is valid in all of the others. This is also a way to deliver a unified message regarding the practices.

In the present situation a new person goes through a certain training schedule when starting work at Loviisa power plant. This includes general employee training, profession specific familiarisation and both a radiation protection familiarisation and project related radiation protection training for those working in the radiation controlled area. It can also be stated that project and work related pre-job briefings complete this schedule. All of this aim at the person being able to work safely at his/her own work site taking into consideration the special conditions of a nuclear power plant.

There is already proof of the benefits of this training; the number of occupational accidents leading to absence has decreased, the collective radiation doses have become smaller and contamination cases have decreased.

The aim in the future is to further improve safety both in respect of occupational safety and radiation protection and to give a comprehensive overall idea of safety.

## 1 Introduction

### 1.1 Loviisa nuclear power plant

Loviisa NPP consists of two pressurised water reactors, Loviisa 1 and Loviisa 2 (LO1 and LO2 respectively). LO1 started its commercial operation in 1977 and LO2 in 1980 with the expected operating life of 30 years. The staff employed then was very devoted and committed and turnover of employees during the first three decades was low. In 2007 the operating license was renewed and it is now valid for the next 20 years leading to 50 years of operation. This decision raised a need to replace a majority of the staff within a few years because of retirement. The largest challenges have been met at passing tacit knowledge to new professionals and getting them to the same level of expertise as the original personnel has been. Also the contractors are retiring, the older generation is reaching its retirement age and a new generation of specialists is being raised.

## 1.2 Contractors at Loviisa NPP

Fortum's power plant in Loviisa employs ca. 500 people, permanent and temporary personnel included. In addition to this, there are ca. 150 permanent contractor workers at the NPP and during the outages further ca. 800 contractors work in the power plant area. Fortum has put extensive efforts to promoting safety during the last few years and the main task in the training of contractors today is to give them the same overall idea of safety that Fortum's own personnel has adopted.

### 1.2.1 Training of contractors

When a contractor starts work at Loviisa NPP, there is a certain training path obligatory to all workers. Every third year all contractors, as well as Fortum's own employees, have to take part in General Employee Training (GET), which lasts for 4 hours. For own personnel the training acts as refresher training. After GET the contractor is taken to his/her own work site to get acquainted with the surroundings and the environment. This helps in recognising the general safety issues and gives a deeper meaning to the profession specific familiarisation which is obligatory every year. The familiarisation has a job specific focus with related material and can last from 4 hours to two days. The most extensive familiarisation is given to the cleaning personnel. Their familiarisation is an addition to their vocational training with emphasis on the special features of industrial cleaning and cleaning inside the RCA.
After familiarisation, a contractor worker can either start working, or if the work is located inside the radiation controlled area (RCA), he/she will get extended training in radiation protection, focused on the specific task. The classroom training is finished after the radiation protection training but before initiating work, the workers still have to participate in a pre-job briefing, which can also be classified as training promoting safety.

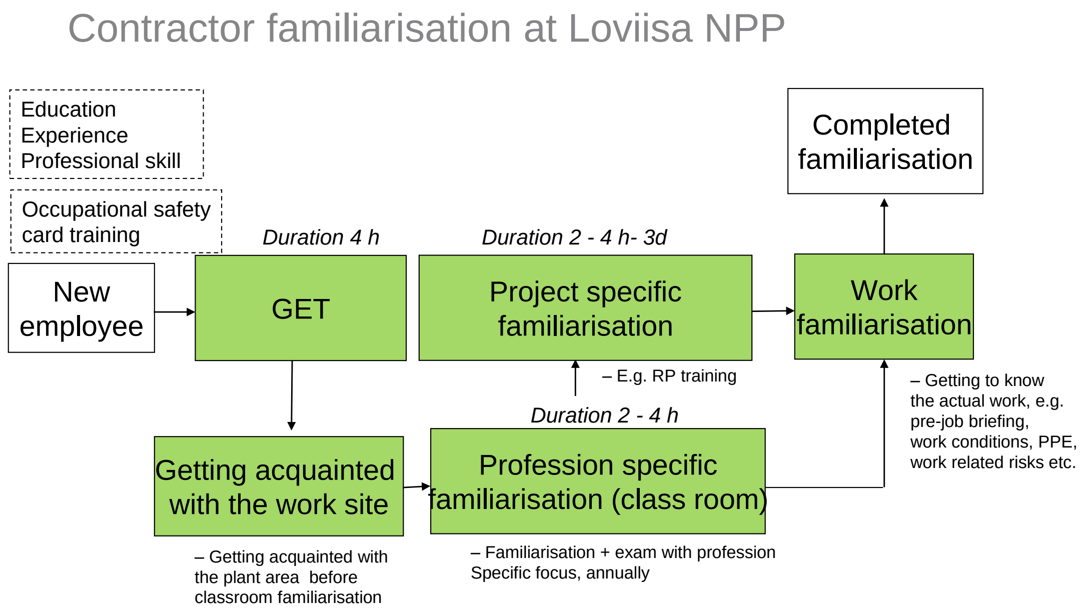


Figure 1 Contractor familiarisation program

## 2 Objective of trainings

### 2.1 Objective of General Employee Training

The objective of GET is to give an overall idea of the safety level Fortum's management expects from all workers and to give general information of the shared workplace, the local practices related to work arrangements, practical advice and the information what to do and where to go in case of an incident etc. In 2010, 49% of the contractors working at Loviisa NPP during the outages were workers who had never been in a nuclear facility before. This brings challenge to the training given to the personnel who are professionals in their own field and know their substance but know basically nothing about ionising radiation or contamination. The contractors also need to be aware of the influence of their own work to the safety of the power plant's process systems.

### 2.2 Objective of profession specific familiarisation

Profession specific familiarisation aims at giving more detailed information of the safety measures related to the specific site and the influences the audience's work can and will have on the power plant's process. Depending on the task, the familiarisation can last between four hours to two days. A group working outside the RCA and carrying out work not related to safety-classified systems can have a lighter version of the training whereas e.g. contractors working in electrical rooms will receive a very detailed training with the accurate information of the various rooms, process states, electrical cabinets, control systems, importance of housekeeping etc. The profession specific familiarisation includes a written exam which has to be done annually.

### 2.3 Objective of radiation protection training

Contractors' extended training in radiation protection and project related radiation protection training both aim at reaching a deeper knowledge of ionising radiation, how to protect oneself against gamma radiation and both internal and external contamination. It also guides to carry in mind the importance of own working methods and how to prevent the spreading of contamination as well as the importance of cleanliness and tidiness.

## 3 Harmonisation of training

### 3.1 Scandinavia

Since the 1990's there has been co-operation between nuclear power plants in Scandinavia, i.e. in Finland and Sweden, related to training. The GET gone through in any of the NPPs in these two countries is valid in any of the others. The content of the training and the material has been developed together and, in addition to benchmarking, the two Finnish NPPs have had trainer exchange, especially during outages. The nuclear power plants in Finland have produced some training films [1] together and some of them are in use in Sweden also. Co-operation between the Finnish power plants has been easy and fruitful, due to the same culture, same regulator, partially the same work force in the small country. The challenges are similar and the other power plant's staff are seen as colleagues, not competitors.

### 3.2 In-house harmonisation

The training of contractors is not only harmonised to correspond the training of the company's own personnel because of the obvious benefits of proficient staff but also because of the requirements set by the authority. The Nuclear Act [2] sets demands for the training of own personnel but also for training given to contractors. Thus e.g. the GET is the same for all people working inside the area, regardless their employer.

## 4 Impacts of training

The history of profession specific familiarisation dates back to 2007 when the management group of Loviisa power plant decided, based on a bachelors thesis on the management of external work force in a nuclear facility [3], that GET does not give contractors enough detailed information of how to carry out work at the power plant site. The group also stated that training must be given more often than every third year. Thanks to the Scandinavian co-operation, before 2007 it was also possible that a contractor came to work in Loviisa after having attended GET in another country which has different legislation and set of rules. The familiarisation program was initiated in 2007 but it reached its present form in 2008 when a specific familiarisation program was created for 22 different professions. This division still exists today; the material is updated every year.
The impact of the familiarisation and other trainings can be seen in many improved statistics. There is a clear drop in the Lost workday injury frequency, the best year being 2010 with no injuries, the radiation doses have decreased, the share of human errors in operational event reports has decreased. Due to an alteration in the classification, there seems to be an increase in the amount of human errors in 2008 but still the overall trend is decreasing. The next challenge for training could be seen in further decreasing the share of human errors, and this concerns both own and contractor work force. The training itself may not have had a direct influence on the positive trends and is probably not the only factor contributing to these improvements but showing the effort and engagement put to these trainings gives the contractors a clear message that these matters carry a great importance and it affects their attitudes towards safety and careful work.

Lost workday injury frequency LWIF, contractors, 2004-2010

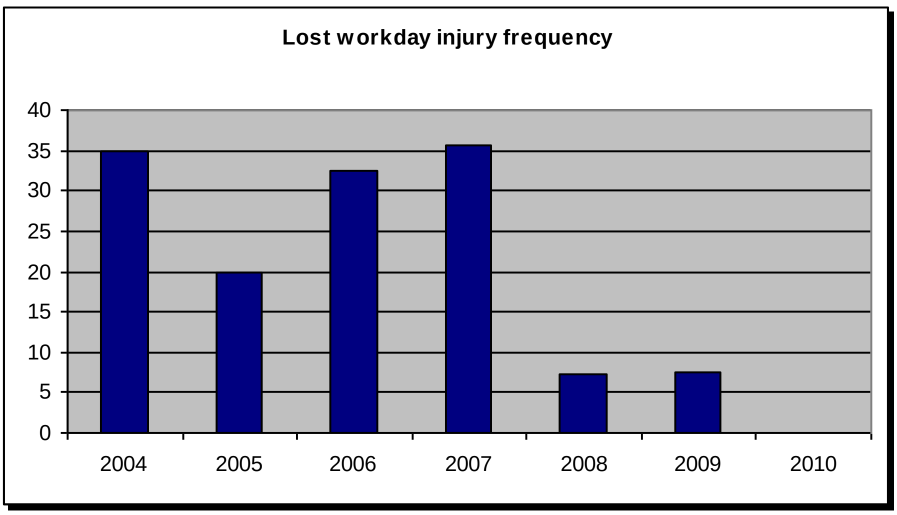


Figure 2 Lost workday injury frequency 2004-2010

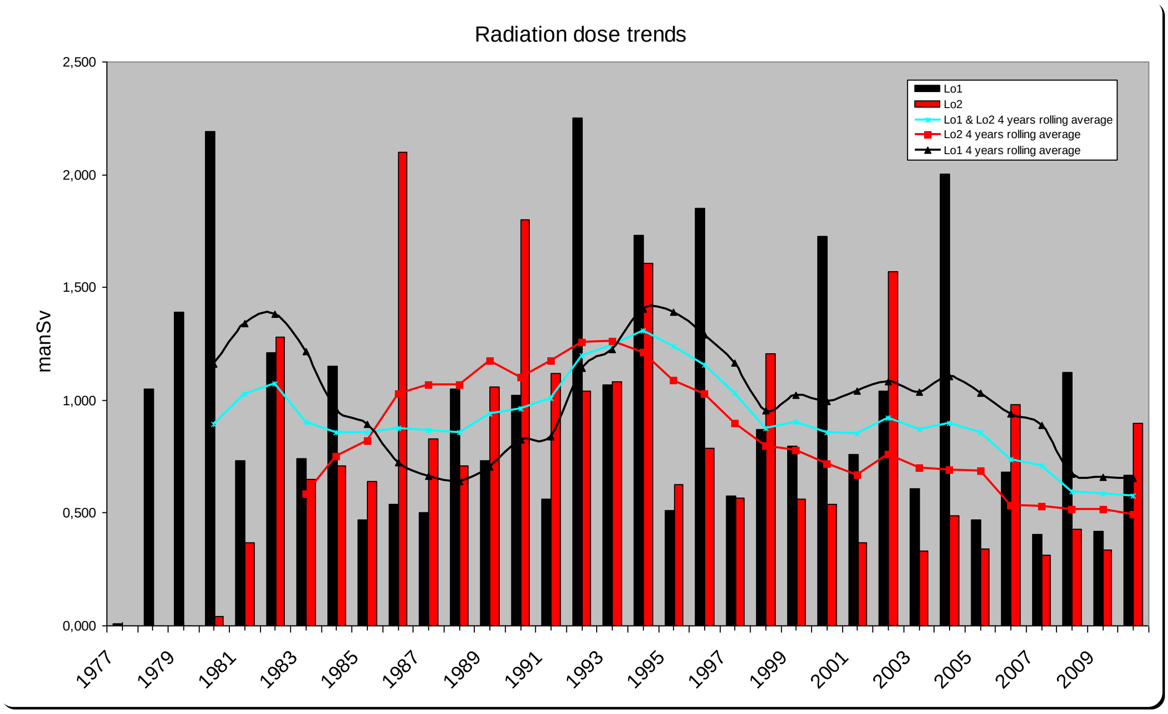


Figure 3 Radiation dose trends 1977-2010

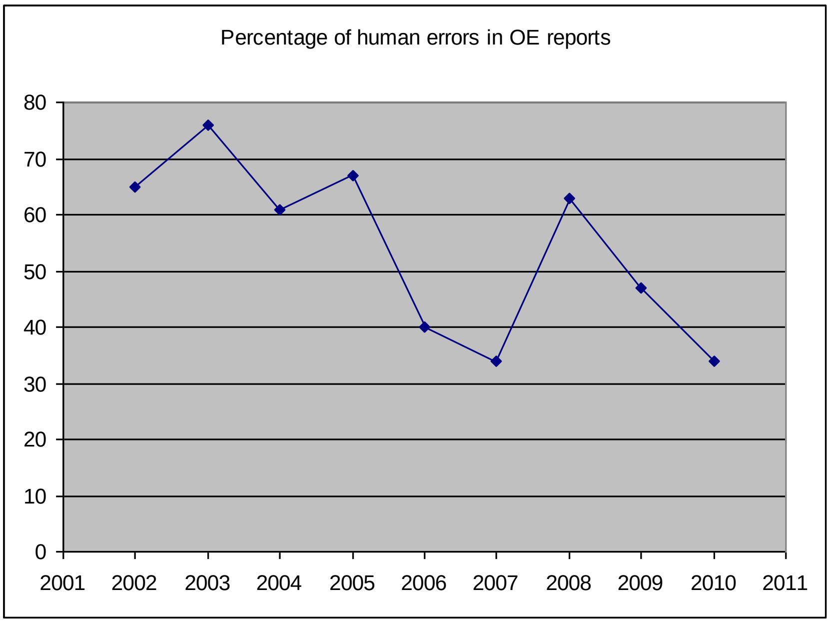


Figure 4 Percentage of human errors in OE reports 2001-2010

## 5 References

[1] Film: Prevention of the spreading of contamination, Fortum Power and Heat Oy and TVO Oy, produced by M-Cinema (2008)

[2] Nuclear Energy Act 990/1987, translation: http://www.finlex.fi/en/laki/kaannokset/1987/en19870990.pdf

[3] Bachelor's Thesis "Ulkopuolisen työvoiman hallinta ydinvoimalaitoksessa", Juho Vanhanen, Kymenlaakson amk (2008)

# DEVELOPING NUCLEAR CAPABILITY THROUGH INDUSTRY-ACADEMIC PARTNERSHIPS

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## ABSTRACT

Skills, resource and knowledge are the biggest challenges the UK nuclear industry is faced with across all sectors; from decommissioning through to building a new nuclear fleet. Closing this skills gap has brought the nuclear industry together and resulted in collaborative initiatives across government, academia, professional bodies and industry.

The Atkins capability assessment model and training academy is the first of its kind to be aligned with the UK's Nuclear Skills Passport scheme. One of the outputs from the assessment process is the identification of technical learning needs within the business. In turn, this enables the review of the existing academy curriculum and the development of new courses by the academy to be closely aligned to business and client requirements.

Atkins has formed a partnership with the University of Central Lancashire (uclan) to provide fully accredited university standard courses and CPD modules. This partnership, the Atkins Academy@uclan, will build upon both partners' curricula creating a set of uclan accredited and Skills Academy endorsed qualifications available to UK and international students. This offering will be aligned to the higher education skills development strategy outlined by the National Skills Academy for Nuclear and be compatible with the industry wide Nuclear Skills Passport scheme.

In partnership with Assystem and delivered through the *n.triple.a* joint venture tailored programmes can be offered across the globe to support the HR development and training needs of nations considering a new nuclear programme.

## 1. Introduction

In order to support the strategic intent to develop a new build nuclear programme in the UK, research has been undertaken by the nuclear sector skills council to define the skills gap. Sponsored by Government a programme has been created to develop tools and processes to help close the gap. Industry has taken up the challenge and has developed additional arrangements to resolve their internal needs. Atkins has taken a lead in this area and this paper discusses Atkins' journey and how these solutions are now being offered to the global community to support the development of new build programmes for new entrants to nuclear power.

## 2. The UK Context

The UK is experiencing a "renaissance" of its nuclear industry [1] with manufacture due to commence on new reactors later this year. The parallel demands from the decommissioning, generation, fuel processing and military programmes means that the demand for skills at all levels over the next 15 years is one of the key risks to achieving these programmes. This has been recognised centrally and the UK Government has put in place collaborative programmes to assess and stimulate this market.

## 3. The Demand for a Skilled Workforce in the UK

Cogent, the UK's Sector Skills Council for the nuclear industry has undertaken labour market research to establish the current state of skills in the industry and to model the future skills requirements. The results show that the civil nuclear industry today provides employment for 44,000 people. Of these, 24,000 are employed directly by the nuclear operators across three sectors – electricity generation, decommissioning, and fuel processing. The remainder is employed in the direct supply chain to the nuclear industry. The sectors are split across both public and private ownership, with the latter being prevalent in electricity generation. The skill levels of the workforce are high, as would be expected for a safety critical industry. The combined technical, professional and senior management skill levels are typically close to, or in excess of, 70% in any of the sectors.

The age profile is the main factor in driving a general skills gap of up to 14,000 by 2025 (see Fig 1 below). This converts to an industry requirement of the order of 1,000 new recruits per year, mainly as new apprentices and graduates. However, the new build driver of demand will draw in experienced personnel from related industry sectors and possibly globally.

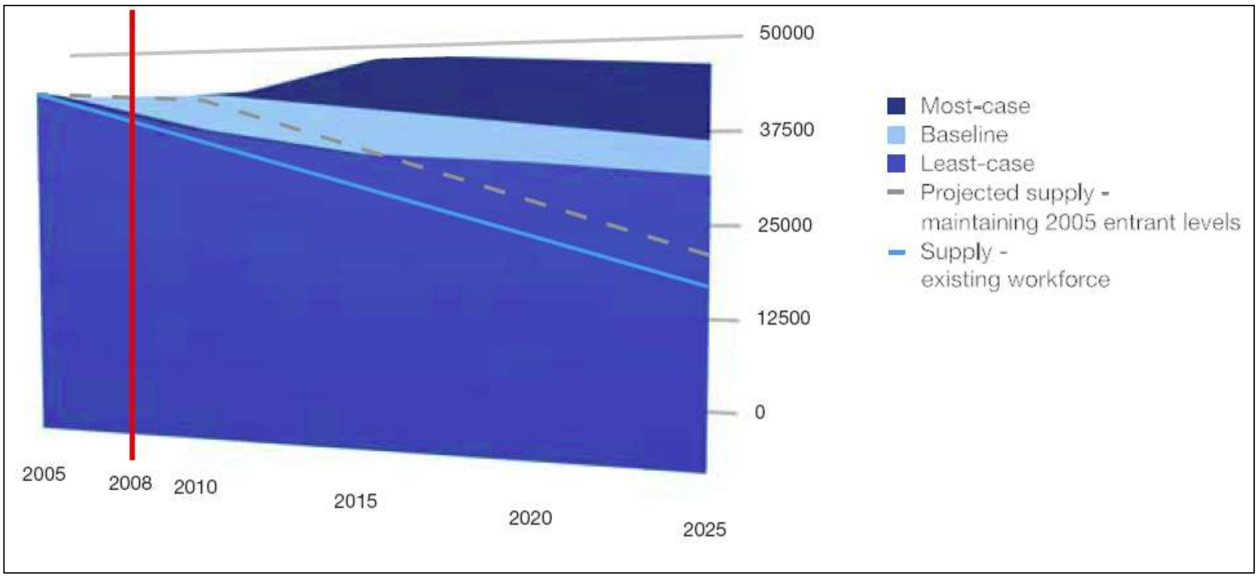


Fig 1. Skills Shortfall Prediction [2]

In addition to the demand for skills to support the operations of nuclear facilities, there is the need for a skilled consultancy sector to support the operating companies and *new build* developers. This is driven by two factors: firstly the extent of the new build programme and secondly the supply chain strategies adopted by the operating companies and developers. Over the last 10 years there has been a trend in the UK for the operating companies to adopt a more inclusive approach to partnering with strategic suppliers in the technical arena. A number of commercial approaches have been adopted, including outsourcing, strategic alliances and design and build contracts for construction of new facilities. This has created a current demand for approximately 3,000 engineers in the consultancy sector; rising to 3,500 as the Tier 1 companies reach the full capacity of their outsourcing strategies. Using the replacement generating scenario of 12GWe this is likely to create an additional peak demand around 2013 of approximately 2,500 engineers. This requires the consultancy sector to provide approximately 6,000 engineers into the nuclear sector. The skill levels of these workers will be high, generally graduate, professional engineers.

### 3.1 National Skills Strategy

In recognition of the need to adopt a national approach to addressing the skills gaps in the nuclear industry the UK Government launched an employer led *National Skills Academy for Nuclear* (referred to as the *Skills Academy*) in January 2008. This is a wholly owned subsidiary of Cogent and since January 2011 is solely funded by its industry members.

The Skills Academy is working throughout the entire spectrum of the skills pyramid (see Fig 2 below). Working with the Department of Business, Innovation and Skills to improve schools provision of science, technical, engineering and mathematics (STEM) education right through to higher level post-graduate qualifications.

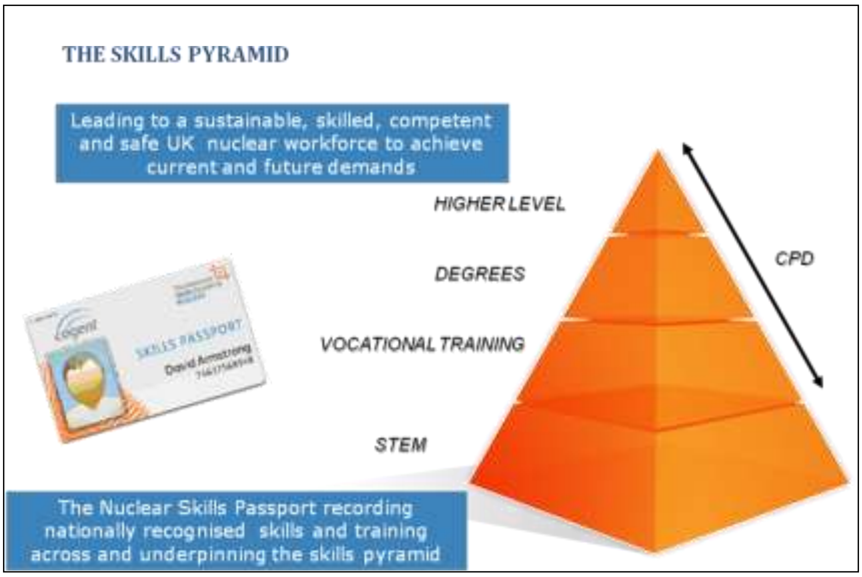


Fig 2. The Nuclear Skills Pyramid

A key concept of the Skills Academy provision is that skills and training are recorded on a *Skills Passport* that is common to all employers and is accepted by them enabling a greater flexibility of resource across the sectors and individual employers. This is particularly important for the supply chain, enabling suppliers in critical skills to demonstrate their capability to customers when they have not previously worked for them before. Essentially this is creating a nationally recognised record of Suitably Qualified and Experienced Persons (SQEP). This will create a more mobile workforce enabling the UK to get maximum effectiveness out of its limited resources. Some interest has already been expressed at the European Nuclear Education Network (ENEN) and other forums about this concept being rolled out on a pan-European basis.

## 4. The Atkins Training Academy

Atkins is the UK's largest engineering consultancy and a key player in the nuclear sector with a presence in all sectors of the industry. In 2006 it launched the *Atkins Training Academy* (ATA) in response to the perceived skills gap subsequently confirmed by the Cogent study. This was driven by a commercial recognition of the opportunity created by the skills gap and a determination to be a leader in the UK nuclear consultancy market for decommissioning, generation, defence and new build. The purpose of the ATA was to provide fast track training for new graduates and the ability for staff in other industrial sectors to re-train and learn skills relevant to the nuclear sector.

A market assessment was carried out to identify the key skills required to support the nuclear industry. This identified 48 skills in 10 subject areas. To cover this demand, 13 in-house courses were developed and 16 existing external courses were identified. The in-house courses developed were:

- Introduction to the Nuclear Industry
- Nuclear Safety Case
- Engineering Substantiation
- Understanding Nuclear Safety Culture
- Radiological Protection Pathway
- Introduction to Nuclear Physics (see **Error! Reference source not found.**)

- Nuclear Conversion Course
- Decommissioning and Radioactive Waste Management
- Introduction to Contaminated Land
- New Generation Reactor Technology
- AGR Familiarisation
- Fissile Materials – Systems and Processes
- Control & Instrumentation in the Nuclear Industry

Fig 3. Introduction to Nuclear Physics Course

To-date over 550 engineers have used the ATA to develop their nuclear skills. Many of these are engineers from Atkins' businesses outside the nuclear sector but with related skills, such as building service engineers from the design industry, systems engineers from defence and stress engineers from oil & gas. This ability to access relatively large numbers of engineers with the relevant technical skills and develop them into capable nuclear engineers is considered to be a significant source of SQEP staff to support the ambitious demands of the UK nuclear industry over the next few years.

## 5. The Atkins Academy@uclan

To support the development of the wider skills base in the UK, Atkins has taken the decision to make its training available to other companies and individuals. In doing this it has recognised the need, the efficiency and the value in working with academia and other organisations to develop professionally delivered and accredited programmes which align with industry requirements. For this reason Atkins has now formed a delivery partnership with the University of Central Lancashire (uclan) called the *Atkins Academy@uclan* to make this training available to the UK sector in general. The full range of courses is still in development. It is a modular programme and can be used by students as part of a certificate, diploma or masters programme. If desired a single module can be undertaken to support continued professional development. The first open programme will be offered later in 2011.

## 6. Understanding Training Needs

In order to understand its complete training requirements Atkins has developed a new software application called *MySkills* which enables people to create a personal job profile (or load a standard job context – e.g. the Cogent nuclear safety engineer job context) and assess their current level of competence such that their training needs can be identified. The training needs of all staff are then added together to create a corporate training needs analysis. The training delivery can then be planned using the ATA, the Atkins

Academy@uclan and commercially available training (see Fig 4). The Atkins Academy@uclan is a Skills Academy accredited training provider and Atkins is going through the process of accreditation of its internal processes using the NEF scheme. This means that any training provided through the Atkins Academy@uclan can be added to an individual's Skills Passport as an approved course (see Fig 4).

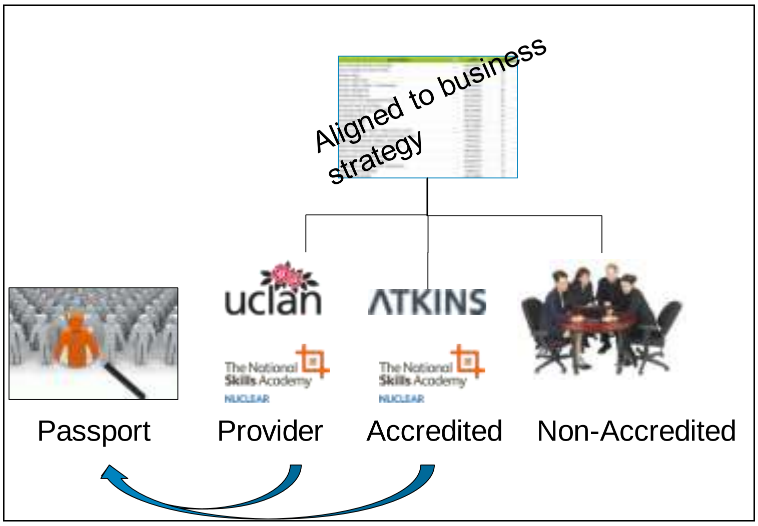


Fig 4. The Atkins Training Delivery Model

## 7. Global Delivery with n.triple.a

Atkins has joined forces with Assystem to form a joint venture to address the global demand for nuclear new build. Together Atkins and Assystem can offer 3,000 qualified nuclear engineers with a track record of delivery in the nuclear sector. Assystem has considerable experience of designing and delivering training programmes to utilities and developers in France and globally. Like Atkins, Assystem has also developed an internal training capability called the *Assystem Nuclear Institute* (ANI), which has been developed using the knowledge gained from its external training programmes. n.triple.a is therefore able to offer the MySkills assessment process together with the Atkins Training Academy, Atkins Academy@uclan and the Assystem Nuclear Institute offerings to provide world leading nuclear education and training to governments, regulators, operators and supply chain companies world-wide. Working in conjunction with the Skills Academy n.triple.a can also offer the training framework, skills passport, accreditation processes and tools developed in the UK. Fig 5 shows how this would work conceptually.

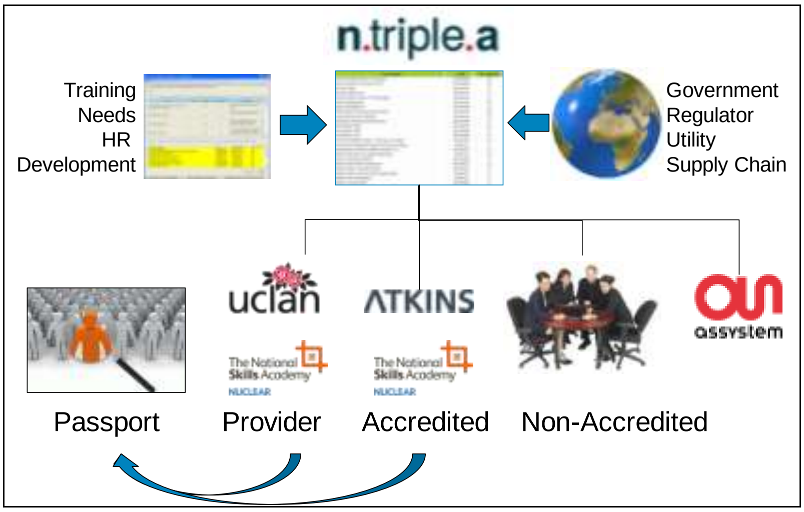


Fig 5. n.triple.a Global Education and Training Scheme

## 8. Conclusion

The programmes developed in the UK have made a significant contribution to starting to close the skills gaps that threaten the delivery of the UK new build programme. Atkins has developed processes, tools and training solutions to support its needs and is now offering these to the wider UK community through its partnership with uclan. The n.triple.a joint venture between Atkins and Assystem is able to offer these services, together with Assystem's training programmes globally to new entrant nations interested in developing a nuclear new build programme.

## 9. References


1 Meeting the Energy Challenge, A White Paper on Energy, Department of Trade and Industry, May 2007

2 Renaissance 1 – Power People: The Civil Nuclear Workforce 2009 – 2025, Cogent, September 2009-11-08

# EXECUTIVE EDUCATION: EXPERIENCE FROM TWO LEADING EUROPEAN NUCLEAR COUNTRIES, UK & FRANCE. BIRTH OF A TRANSNATIONAL COOPERATION.

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## ABSTRACT

Today there exists a severe aging of the nuclear workforce and a shortage of nuclear skills in both France and the UK. Consequently nuclear education has been revived in both countries at all levels from high school to master & PhD degrees, up to the executive level.

France & UK are leading European nuclear countries with respectively 58 & 19 nuclear reactors in operation. Most of these plants have been installed in the 70's and the 80's so Executive nuclear education is particularly needed because there are many young decision makers and future leaders working within utilities or within the supply chain who are lacking this nuclear background. There are many companies willing to enter that market, too, so their directors have to obtain this knowledge to make sound strategic business decisions about future involvement in nuclear new build. Nuclear new build is starting to happen all around the world but here in Europe France is building a new NPP currently and the UK has plans to build 10 new reactors by 2025 so there will be a continuing need for nuclear skills well into this century. Recent studies by Cogent Sector Skills Council estimate a need for 1000 new nuclear engineers and scientists in the UK alone for the next 15 years.

The Dalton Nuclear Institute in the UK and the International Nuclear Academy in France are prime movers for nuclear skills training in their own countries and have combined forces to develop new and innovative courses: this paper describes the portfolio of their courses and conditions of their implementation. It provides a global view of market conditions in both countries, too.

Late in 2010 an agreement was reached between both providers and a first joint Nuclear Senior Managers course was held in Manchester in March 2011 and other events are planned to follow in France and elsewhere. This paper indicates features of this recent event as well as the rationale behind such transnational cooperation and how it may benefit the nuclear community worldwide.

## 1. Introduction

There exists a severe aging of the nuclear workforce and a shortage of nuclear skills in both France and the UK. Consequently nuclear education has been revived in both countries at all levels from high school to master & PhD degrees, up to the executive level. France & UK are leading European nuclear countries with respectively 58 & 19 nuclear reactors in operation. Most of these plants have been installed in the 70's and the 80's so Executive nuclear education is particularly needed because there are many young decision makers and future leaders working within utilities or within the supply chain who are lacking this nuclear background.

Nuclear new build is starting to happen all around the world but here in Europe, France and Finland are building new NPP currently and the UK has plans to build 10 new reactors by 2025 so there will be a continuing need for nuclear skills well into this century. Recent studies by Cogent Sector Skills Council estimate a need for 1.000 new nuclear engineers and scientists in the UK alone for the next 15 years. So the demand for nuclear skills education and training across Europe will be high. Similarly other countries around the world are facing a need for nuclear skilled personnel to operate and support their new fleets of reactors that are planned.

## 2. Overview of market conditions & nuclear jobs market in France & UK

### 2.1 Situation in France

France has a long nuclear history initiated in the 70's after the first oil shock. As a consequence a huge fleet of 58 nuclear reactors is now in operation providing 75% of the electricity used by the country.

Majority of these reactors is now around 30 years old and only one new construction is pending (EPR reactor Flamanville 3), a second one being planned as of 2012 (Penly 3). Despite this low new build program, nuclear electricity production will remain high in France in the near future thanks to an intensive plant life extension program: EDF is considering an extension of its plants from 40 to 60 years at a cost of 400 to 600 million Euros per unit [1].

Because of its historical leading position, France has built up a solid nuclear industry which is now well positioned in export markets: the two French giants EDF & AREVA have extended their activities beyond French borders for many years now and a myriad of suppliers have aggressively entered export markets, too. There are French companies active almost in any country having a nuclear activity!

A new domestic market for nuclear dismantling operations is slowly increasing; there are a total of 9 reactors presently at that stage: 1 LWR, 1 PWR, 6 AGR & 1 FBR. This market is creating new business opportunities mainly covered by domestic companies.

Consequently French present nuclear jobs market can be divided into several categories:
- a stable workforce dedicated to operation & maintenance of 58 reactors employed by EDF & its subcontractors;
- a relatively small workforce devoted to French new build;
- a strong workforce active on export markets;
- a reduced but increasing workforce active in dismantling operations;
- a stable & traditional staff involved in R&D (CEA) or regulation (ASN) activities.

It is difficult to precisely assess French nuclear jobs market as most players are not purely involved in nuclear activities: EDF does not deal exclusively with nuclear power, AREVA & CEA are more and more involved in renewables.

We can just provide rough recent headcount figures collected from corporate web sites:
- EDF group: 169.000 employees (including 23.000 busy on NPP's);
- AREVA: 48.000 employees;
- Alstom Power: 18.000 employees;
- CEA: 15.000 employees;
- Burgundy Nuclear Cluster: 10.000 employees.

A total "French nuclear headcount" of 100.000 is considered by SFEN [2] generating a revenue of 20 to 30 billion Euros per year.

## 2.2 Situation in the UK

Over the next 15 years or so the UK is faced with the closure of all but one of its nuclear plants and that is Sizewell B. This means the UK will lose 12GW of base-load electricity generating capacity and this is at a time when there is likely to be a shift away from the use of fossil fuels for producing energy in order to meet Government set Global Warming targets. Ambitious targets for using renewables to generate electricity have been set but there is uncertainty that these can be achieved and alternative means of dealing with CO2 emissions such as carbon capture and storage have yet to be proven as reliable, economic and to have public acceptability.

The intention is for all Magnox plants and the AGR fleet to be off-line by 2023. Depending upon the outcome of the Fukushima event and the Government's plans proceed as expected then the first two reactors at Hinkley will be on-line by 2018 followed two years later by twin reactors at Sizewell. Two other phases of new build will follow at other sites around the UK periodically up to 2025. However a number of energy experts consider that this programme is just the start of a much larger build programme that could result in nuclear plants being built at the same rate up to 40GW of new capacity.

The Government also has a £70bn programme to deal with legacy nuclear plants and associated wastes and this is managed by the Nuclear Decommissioning Authority. The NDA recently published its Business Plan and this sets out planned expenditure in 2011/12 of £2.9 billion as part of a four year total of approximately £12 billion in line with the UK Government's spending review announced last October. This represents a strong and sustained investment in the UK nuclear clean-up programme.

These demands on the UK nuclear industry will require significant new man-power if they are to be realized. Cogent, the Government's appointed Sector Skills Council has studied the issue and claims in its Next Generation report that thousands of training opportunities, new apprenticeships and new jobs will be needed in the construction, manufacturing, operation and maintenance of anticipated stations over the next 15 years. Up to 30,000 new jobs could be created in an ambitious building programme.

# 3. Key nuclear executive education players in Europe

## 3.1 Key players in France

Executive education has been traditionally kept in-house by large French nuclear companies who have setup their own university, academy, institute or training center:
- EDF nuclear academy;
- GDF Suez university;
- AREVA university;
- INSTN, training arm of CEA;
- Assystem nuclear institute.

Besides improving skills of their staff, these internal organizations contribute to teambuilding & promotion of corporate identity within their employees.

Historically focused on undergraduate & graduate education, universities and engineering schools have recently significantly developed their executive education, so that a wide choice of nuclear courses is now available from these academic players, too:
- Paris engineering schools (ECP, Supelec, ESTP, ENSAM…);
- various universities with nuclear departments such as Paris or Grenoble.

## 3.2 Key players in the UK

Two key UK education players are Cogent Sector Skills Council ([3]) and the National Skills Academy for Nuclear – NSAN ([4]).

Cogent is licensed by the UK Government to develop appropriate measures to address the skills needs in the nuclear sector and It works hand-in-hand with employers to develop solutions on skills and recruitment issues that confront them individually, but are not always possible to rectify in isolation. Cogent has researched the skills needs of the UK nuclear sector and produced two of its intended four reports that identify future man-power and skills needs.

NSAN is an employer led organisation established to ensure that the UK Nuclear Industry and its Supply Chain has the skilled, competent and safe workforce it needs to deal with the current and future UK nuclear programme, including all sub sectors.

## 3.3 Key players outside France & the UK

Three important international education players are the European Nuclear Energy Leadership Academy (ENELA: [5]), the "European Nuclear Engineering Network" (ENEN: [6]) and the World Nuclear University (WNU: [7]).

ENELA mission is to equip those working in and those working alongside the nuclear energy industry with the skills and expertise they will need to become future leaders and to ensure the further development of sustainable European nuclear energy solutions.

ENEN project was established to conserve nuclear knowledge and expertise, to create a European High Education Area for nuclear disciplines, and initiated the implementation of the Bologna declaration in nuclear disciplines. The main objective of the ENEN Association is the preservation and the further development of expertise in the nuclear fields by higher education and training.

WNU is a prestigious global partnership committed to enhancing international education and leadership in the peaceful applications of nuclear science and technology.WNU programmes focus on building nuclear leadership and providing orientation on the main issues that affect the global nuclear industry today.

# 4. Portfolio of courses offered by International Nuclear Academy & Dalton Nuclear Institute

## 4.1 International Nuclear Academy portfolio

International Nuclear Academy – "INA"- was created in 2008 by Burgundy Nuclear Partnership [8] – "PNB" - which is a cluster located at the heart of French nuclear industry; this association concentrates around 150 members, mostly SME's, corresponding to a total headcount of about 10,000 employees.

"INA" mission is to provide top level executive nuclear education with the support of "PNB" resources: a wide range of short courses is available and covers various topics such as:
- general overview of nuclear industry;
- management & financials of nuclear energy;

- marketing aspects of nuclear industry worldwide;
- nuclear technologies.

Moreover bespoke sessions are proposed to French & international clients as well as summer universities and long courses similar to postgraduate programs proposed by several academic players.

### 4.2 Dalton Nuclear Institute portfolio

Dalton Nuclear Institute (or "DNI") was created in 2005 in order to coordinate nuclear education, research and training across The University of Manchester ("UoM") and to maintain the traditions of nuclear research at the university that go back to Ernest Rutherford. Since its inception "DNI" has gone from strength to strength and currently has more than 300 academics and researchers working in the nuclear field. In 2010, the Dalton CPD Centre was set up with the purpose of transferring nuclear knowledge to the industry through Master programmes and CPD courses. Although the programme is at the embryonic stage a number of nuclear executive and technical courses are on offered openly and more will follow over the next 12 months

## 5. UK-France transnational cooperation

### 5.1 Rationale for a UK-France cooperation

#### 5.1.1 France viewpoint

"INA" goal is to develop a substantial volume of activity abroad capitalizing on assets & human resources of "PNB" cluster. Consequently countries with sizeable nuclear program are targeted, particularly but not exclusively those where French technology will be used. Since UK [9] is planning a fleet of 4 to 9 EPR reactors, exporting "INA" courses across the Channel seemed to be a priority.

Instead of building up a UK activity from scratch, "INA" management opted for a strategic alliance with a local player: Dalton Nuclear Institute was naturally selected because of its solid reputation in the UK. Such blending of cultures & experiences has proved to be very rich as it allows to provide UK players of the nuclear supply chain as well as new entrants with a wide range of high quality executive courses.

#### 5.1.2 UK viewpoint

For "DNI" it has been important to establish a reputation for training that enhances its high reputation in the areas of research and nuclear education. Developing a good relationship and alignment with the goals of "INA" has meant that "DNI" was able to build upon the developments that the "INA" has brought to the market through its executive training. However the drivers for this partnership go much deeper than that and find their roots within the intention of AREVA to bring its technology to the UK and to export it around the world. Therefore our common areas of interest go much wider than just training and cover a common interest into research into nuclear materials and manufacturing and the shared goal to establish nuclear supply chains that bring the new technology into operation efficiently and effectively to the benefit of UK consumers and both UK and French industry.

As a result we have established an agreement that underpins cooperation and are cementing our relationships through recent cooperation on the senior executive programme recently held in the UK that forms the basis of a case study later in this paper and through INA's contribution to our recent nuclear new build supply chain study where the UK can learn lessons from the Burgundy Nuclear Partnership. Further collaboration is already being planned and will secure our close working relationship.

## 5.2 Case study: "EXENUC-UK" course

"INA" [10] has been proposing in Burgundy for several years its "EXENUC" course which is a 3 day-long seminar detailing an accurate SWOT analysis of worldwide nuclear industry as well as a general presentation of nuclear technologies & players active in the world. Further to a cooperation agreement signed between "INA" & "DNI" in 2010, it was decided to duplicate this course in the UK and to adapt it to specific UK features: this new "EXENUC-UK" course was first scheduled in Manchester in March 2011 and proved to be an excellent introduction for companies willing to take part to upcoming UK new build.

The basis of the UK course was formed around the content of the two senior executive courses delivered by "INA" in France already. So taking this as a starting point "DNI" decided that to be in keeping with the general approach to training and education adopted at the university, an element of the learning should be delivered through active participation that required the delegates to contribute through their own experiences, knowledge and know-how. This type of approach leads to a greater interaction between those who are learning and those that are doing the instruction and knowledge and know-how learnt in this type of environment tends to be more firmly embedded and better understood and interpreted back into a work situation.

The two day course was made up of 12 units each one lasting on average about 60 minutes. It was decided that approximately two-thirds of the course should be delivered through a traditional lecturing approach where knowledge is transferred across through power point presentations but where questions were encouraged. The other third of the course would be made up of two case studies and other presentations that although delivered through power point presentations, did require a higher level of interaction and feedback. The topics for these parts of the course were carefully chosen and focused on:
- planning and managing a substantial new build project on a nuclear licensed site;
- evaluating how low carbon energy sources such as nuclear can contribute to meeting CO2 reduction targets;
- exploring what nuclear regulation means to companies working for the nuclear industry who are not licensees;
- understanding the issues of operating on a nuclear licensed site;
- understanding what is meant by nuclear safety culture.

## 5.3 Future joint courses

The opportunities for future collaboration will focus around the shared interest in new civil reactor build. "INA" was established through the Burgundy Nuclear Partnership and benefits from its connection with the French nuclear supply chain. "DNI" is a partner with Sheffield University in the Nuclear Advanced Manufacturing Research Centre (NAMRC) that has a primary objective to develop a nuclear new build supply chain. There are potential areas for sharing knowledge and know-how on reactor technology, nuclear safety, codes and standards as well as quality assurance. Also the collaboration can extend to manufacturing research.

# 6. Conclusion

Recent nuclear renaissance has caused the emergence of multiple education players and development of international alliances. The new French-British cooperation described in this paper is particularly original and promising as it combines complementary features of France & UK industries:
- "INA" is an initiative of French nuclear supply chain whereas "DNI" is attached to the prestigious University of Manchester;
- France has a long nuclear proven history whereas UK is initiating an important new build programme;

- there are increasing links between French & UK companies at all levels: utility companies, vendors, subcontractors ….

This new transnational cooperation is well positioned to contribute to the success of French & British nuclear activities (new build, plant life extension, decommissioning) through the provision of high quality professional training courses.

## REFERENCES

[1]: World Nuclear Association Report "*Nuclear Power in France"* updated October 2010

[2]: www.sfen.org

[3]: www.cogent-ssc.com

[4]: www.nuclear.nsacademy.co.uk

[5]: www.enela.eu

[6]: www.enen-assoc.org

[7]: www.world-nuclear-university.org

[8]: www.polenucleairebourgogne.fr

[9]: World Nuclear Association Report "*Nuclear Power in the United Kingdom"* updated December 2010

[10]: www.inuclear-academy.com

# ROLE OF EERRI REACTOR COALITION IN NUCLEAR EDUCATIONAL AND TRAINING

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ABSTRACT

One the most visible trends in nuclear education and training which became visible during the last few years some became is networking and closer co-operation between universities at national and international level in nuclear education. Research reactors, which are mainly part of a research institute or university, had the same evolution in networking as universities but with a few years delay - research reactors started to create reactor coalitions. The first impulse towards reactor coalitions was done in the IAEA International Conference on Research Reactors: Safe Management and Effective Utilization, held in Sydney in November 2007, where research reactor coalitions and centres of excellence were two of the key topics of the conference. At the conference were widely discussed functioning and future sustainability of the reactor coalitions. As a result of those discussions, first reactor coalition was established three months later. In the January 2008 Eastern European Research Reactor Initiative (EERRI) was born in Budapest, Hungary. EERRI reactor coalition now covers nine research reactors from seven European countries. Main purpose why reactor coalitions have been born is the chance to offer complex services in wide range of activities which a single reactor can't offer and synergy benefit from joint effort of the coalition. The next reasons for coalition cover sharing the irradiation and experimental capacities, coordination of the reactor operation for potential shutdown one of the coalition reactor, etc. The good example how the reactor coalition could work is the oldest coalition - EERRI. Wide power range and various reactors' use allow EERRI to offer to solve any type of the experimental work usually performed at research reactors from beam experiments through various types of neutron activation analysis, fuel investigation, material science, radioisotope production to education and training. All EERRI activities are focused in the four main areas: Neutron beam applications, Radioisotope production, Fuel and material testing and Education and training. Soon after its establishment, the EERRI in collaboration with IAEA organised and successfully carried out the first two training courses dedicated for the Members States aiming to build their first research reactor. The third and fourth courses were carried out in spring 2011.

## 1. Introduction

One the most visible trends in nuclear education and training which became visible during the last few years some became is networking and closer co-operation between universities at national and international level in nuclear education started.  Research reactors, which are mainly part of a research institute or university, had the same evolution in networking as universities but with a few years delay - research reactors started to create reactor coalitions.

Research reactor coalitions and centres of excellence were two key topics elaborated at the IAEA International Conference on Research Reactors, held in Sydney in November 2007. At the conference the cooperation and future sustainability of the reactor coalitions were widely discussed. As a result, the Eastern European Research Reactor Initiative (EERRI) was established in January 2008. Soon after establishing the EERRI work started to establish the next two reactor coalitions, further the next four coalitions were already under consideration. The general term “reactor coalition” covers research reactors themselves together with reactor users, e.g. the most important reactor users from universities, research institutions, medicine, industry, etc.

The main purpose why reactor coalitions have been established is the chance to offer complex services in wide range of activities which a single reactor cannot offer and synergy benefit from joint effort of the coalition. Other reasons for coalitions cover sharing the irradiation and experimental capacities, coordination of the reactor operation for potential shutdown one of the coalition reactors, etc. An excellent example how such a reactor coalition works is the oldest one - Eastern European Research Reactor Initiative [1], [7].

## 2. EERRI Reactor coalition

The First EERRI meeting was held three month after the Sydney's conference in January 2008 in Hungary. Representatives from research reactors from Central and Eastern Europe signed a Memorandum of understanding where the main goals were defined: "In order to facilitate improved services, to make use of the synergies of regionally neighbouring similar facilities, to harmonise instrument development, and to preserve competence at research reactors." [2]

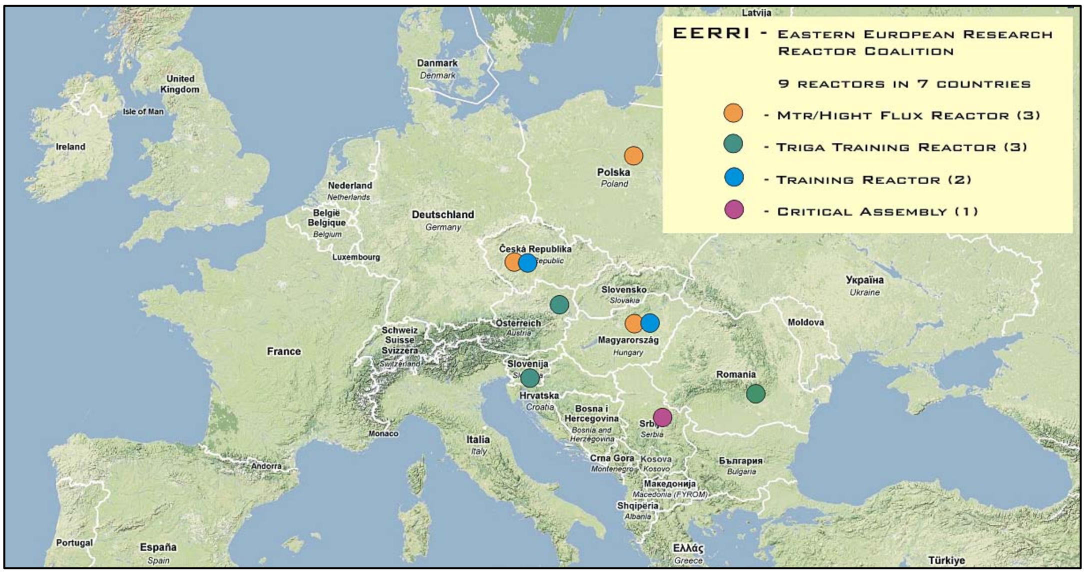


Fig. 1 EERRI - Eastern European Research Reactor Initiative [1]

| Country | Reactor name | Licensee | Power | Reactor type |
|---|---|---|---|---|
| Austria | Triga | VUT/ATI Vienna | 250 kW | Triga Mark II |
| Czech Republic | VR-1 | CTU in Prague | 1 kW | Training reactor |
| Czech Republic | LWR-15 | NRI Rez | 10 MW | MTR |
| Hungary | BME-TR | BUTE Budapest | 100 kW | Training reactor |
| Hungary | BRR | KFKI Budapest | 10 MW | MTR |
| Poland | Maria | IAE Polatom Otwock | 30 MW | MTR |
| Romania | Triga | ICN Pitesti | 14 MW | Triga-SSR |
| Serbia | RB | Vinca Belgrade | 0 W | Critical assembly |
| Slovenia | Triga | IJS Ljubljana | 250 kW | Triga Mark II |

Tab. 1 EERRI - Eastern European Research Reactor Initiative [1]

It is evident that EERRI has a big potential of nine reactors from seven countries (Fig. 1 and Tab. 1): three of them are MTR/High flux reactors (Maria, BRR and LVR-15), three are TRIGA reactors (ATI, IJS, ICN), two are training reactors (VR-1, BME-TR) and one is critical assembly (RB). EERRI can offer really wide range in reactor power from zero Watts to dozens of MW. Due to TRIGA reactors EERRI can offer both steady state and pulse mode operation. Wide power range and various reactors' use allow EERRI to offer to solve any type of the experimental work usually performed at research reactors from beam experiments through various types of neutron activation analysis, fuel investigation, material science, radioisotope production to education and training. All EERRI activities are focused in the four main areas: neutron beam applications; radioisotope production; fuel and material testing; and education and training [2].

## 3. Education and training activities of EERRI Reactor coalition

In the fourth area concentrated on education and training, which is the main topic of this paper, EERRI reactor coalition created the database of educational and training subjects (as an example part of the EERRI database is showed in Fig. 2) and the database of educational and training experiments (an example part of the EERRI database is showed in Fig. 3).

| subject reactor | VR-1 | ATI | BME- | LVR- | Maria | BRR |
|---|---|---|---|---|---|---|
| Regulatory requirements | yes | - | yes | - | - | - |
| Research reactors management | yes | - | - | yes | yes | yes |
| Research reactors review | yes | yes | yes | - | yes | yes |
| Research reactors utilisation | yes | yes | - | yes | yes | yes |
| Introduction to nuclear physics | yes | yes | yes | - | - | - |
| Reactor physics | yes | yes | yes | - | - | - |
| Thermohydraulics | yes | - | yes | - | - | - |
| I&C systems | yes | yes | - | - | - | - |
| Fuel cycle and fuel burn-up | - | - | yes | yes | yes | yes |
| Maintenance and inspection programs | yes | yes | - | yes | yes | yes |
| Waste management | - | - | yes | yes | - | - |
| Physical protection | yes | - | - | - | - | - |
| Emergency preparedness | yes | - | yes | yes | yes | yes |
| Radiation protection | yes | yes | yes | yes | - | yes |

Fig. 2 EERRI database of educational subjects (part of database, October 2010, [3])

| Training Experiments | CTU | ATI | IJS | TUB | LWR15 | Maria |
|---|---|---|---|---|---|---|
| Reactor operation - practical experience | R | R | | R | | |
| Critical experiment, approach to criticality: | | | | | | |
| * full scale experiment - duration 2 weeks | A | - | - | - | - | - |
| * mock-up experiment - by fuel adding | - | R | A | C | - | - |
| * mock-up experiment - by moving rod | R | R | R | R | R | - |
| Reactivity measurements: | | | | | | |
| * Positive Period method | R | R | R | R | R | - |
| * Source Jerk method | R | - | - | - | - | - |
| * Rod Drop method | R | - | - | A | - | R |
| * Source Multiplication method (Greenspan) | R | - | - | R | - | - |
| * Noise analysis (Rossi-Alpha methods,...) | C | - | - | A | - | - |
| * Digital Reactivity meter | C | - | R | - | - | R |
| Study of reactor dynamics: | | | | | | |
| * zero power reactor with/without neutron source | R | - | R | R | - | - |
| * delayed neutrons detection | R | - | - | R | - | - |
| * thermal effects & coefficients | C | R | R | A | R | R |
| * void effects & coefficients | R | R | R | R | - | - |
| * power& thermal effects - pulse operation | - | R | C | - | - | - |
| * various materials impacts on reactivity | R | R | - | R | - | - |
| * reactor response to step reactivity changes | - | R | R | - | - | R |
| * Xe effect | - | - | - | - | R | R |
| R - Routine, A - Advanced, U - Under construction, C - considered | | | | | | |

Fig. 3 EERRI database of educational experiments (part of database, October 2010, [3])

Soon after establishing of EERRI coalition, in the spring 2009, EERRI organised the first training course for IAEA [4]. The six week course was focused on participants from non-nuclear countries, who wish to develop nuclear competence and infrastructure as a first step to develop a national nuclear power programme. The course was aimed at young technical professionals with little or no nuclear experience who can work in future at research reactor licensee or at national regulatory body. The first course attended by eight participants from Vietnam, Azerbaijan, Colombia, United Arab Emirates and Estonia, who spent six weeks at the Triga reactor in Vienna, Austria and both reactors (BME-TR a BRR) in Budapest, Hungary. Lecturers from IJS Ljubljana, Slovenia took part at the course also [4].

The second EERRI training course for IAEA named „Group Fellowship Training Programme on Research Reactors“ was the same as the first course with minor changes (the content of the EERRI course is shown in Tab. 2) [5]. It was held in the spring 2010 at Vienna (ATI, Triga), Ljubljana (IJS, Triga) and in Prague and Rez in Czech Republic (CTU, VR-1 & NRI, LVR-15). The second course attended by eight participants from Jamaica, Brasilia, Azerbaijan, Sudan, Oman and Saudi Arabia [6].

The third EERRI course for IAEA was held on February and March 2011 and the fourth on March and April 2011. The third course will be held in Austria and Hungary (same as the first course) and the fourth one will be held in Austria, Slovenia and Czech Republic (same as the second course). The third course attended by eight participants from Jordan and the fourth course attended by five participants from Sudan and Philippines. The total number of participants attended four EERRI courses is 31 from 11 countries.

| |
|---|
| Module 01 Introduction<br>Introduction to research reactors, introduction to nuclear engineering, introduction to research reactors utilization, introduction to research reactors operation, survey of research reactors |
| Module 02 Theory<br>Reactor physics of research reactors, introduction to reactor calculations, research reactor physics, reactor core parameters and models, calculation of research reactors safety parameters, introduction to computer codes – TRIGLAV, WIMS and MCNP, thermal hydraulics of the research reactors |
| Module 03 Basic reactor experiments<br>Neutron detection, neutron flux and distribution measurement at research reactors, reactor kinetics & dynamics, study of delayed neutrons, critical experiment, calibration of control rods, research reactor operation, prompt criticality demonstration, reactivity measurement at research reactors |
| Module 04 Reactor operation<br>Technical visits of research reactors at all sites, I&C systems of nuclear reactor, practical course in individual reactor start-up & reactor operation, demonstration of fuel handling out of core, research reactors maintenance and in-service inspections, waste & spent fuel management radiation protection and waste management, personal & environmental monitoring |
| Module 05 Safe operation of research reactor<br>IAEA & regulatory requirements for safe operation of research reactors, code of conduct for research reactors, safety analysis report of research reactors, operational limits and conditions, emergency preparedness and emergency exercises, quality assurance in practice at research reactors, water chemistry in research reactors, physical protection of research reactors |
| Module 06 Research reactors utilization<br>Training of research reactors operating personnel, beam experiments, material testing & hot cells, isotope production |

Tab. 2. Content of the EERRI course [3]

The six week course for the participants with little or no nuclear experience focused on all aspects of the research reactor operation covering topics from legislative through theoretical and experimental reactor physics, reactor construction, operation to reactor utilisation (see Tab. 2) is a typical example of wide range course, which is extremely difficult to organise by single reactor or single university. Reactor coalition can organise it much more easily.

## 4. Conclusions

Theoretical lectures and courses at the universities are often supplemented with practical training at experimental facility, especially at training reactor or at other type of research reactor. Research reactors in general are suitable for education of students at all academic levels not only in nuclear engineering, but also in various non-nuclear engineering studies (power engineering, electrical engineering, natural sciences, medical sciences, physical sciences, etc.).

Research reactor coalitions as a new trend in nuclear education and training bring new potential in educational process. EERRI - Eastern European Research Reactor Initiative is good example how such reactor coalition could help to solve the problem with nuclear knowledge gap.

## References


[1.] Sklenka, L., "Nuclear education and training related issues: needs and lessons learned in national and international context", 6th African conference on research reactor utilization and safety, Abuja, Nigeria, November 2009

[2.] EERRI Memorandum of Understanding, First EERRI meeting, Budapest, January, 2008.

[3.] Sklenka, L., Böck, H., Villa, M., "Research reactor coalition and nuclear education &training", IAEA Consultancy Meeting on Regional Research Reactor Coalitions and Centres of Excellence to Enhance Availability, Utilisation and Support to Newcomer States Planning Nuclear Power Plants, Prague, Czech Republic, October 2010

[4.] Böck, H., et al., "A Multi-National Practical Training Course for Nuclear candidate countries organized by EERRI", 13th RRFM 2009 conference, Vienna, Austria, 2009

[5.] Sklenka, L., "Needs & challenges in nuclear education for extended use of nuclear energy", Does the EU have enough human potential for the nuclear renaissance? Seminar in European Parliament, Brusells, October 2010

[6.] Rataj, J., 2010, "Extensive utilisation of VR-1 Reactor for education and training", 14th RRFM 2010 conference, Marrakech, Morocco, 2010, ISBN 978-92-95064-10-2

[7.] Eastern Europe Research Reactor Initiative webpage: http://www.eerri.org/ and http://www.iaea.org/OurWork/ST/NE/NEFW/rrg_EERRI.html

# EVOLVING NUCLEAR MATERIAL SAFEGUARDS CULTURE

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## ABSTRACT´

Nuclear field has gone through three major crises in the past decades: 1) Tshernobyl Accident in 1986, 2) clandestine Iraqi nuclear weapons programme and 3) terrorist attacks in 2001. The first touched Nuclear safety, second Nuclear safeguards and third Nuclear Security. All modern nuclear energy development projects and installations should take all these three into account.

Nuclear material safeguards are a set of activities to verify that an actor is not diverting nuclear material or equipment to develop or produce nuclear weapons. Traditionally these activities include placing seals, installing cameras and verifying inventories, receipts and shipments. After implementation of Additional Protocols of Safeguards Agreements between the IAEA and the States, new tools have been added to conclude that the States do not have any undeclared nuclear activities. Internationally the safeguards measures are implemented IAEA's department of Safeguards, in cooperation with Member States. Regionally in Europe, European Commission has an cadre of safeguards inspectors and it has an authority to inspect Nuclear operators within European Union. Every State should also have a competent authority with inspection rights.

Nuclear Material Safeguards is a prerequisite for utilization of nuclear energy. There is a cultural change ongoing. The designers and providers of nuclear facilities, nuclear operators and national regulators are key players who develop this new culture. The ongoing renaissance of nuclear power emphasizes the need and increases the motivation of this change in culture. Training is also key issue. International safeguards courses have been organized in Europe for university students and nuclear professionals.

A good example of new culture is Safeguards by Design initiative. Until now Safeguards has been annexed to nuclear project in very late phase. In the future safeguards will be taken into account already on the drawing board. To accomplish this safeguards requirements should be incorporated into the national and international guidance.

Radiation and Nuclear Safety Authority, STUK, is in the process of rewriting and restructuring its Guides, which are by virtue of law binding to the operators. The Guides will be published soon, so they are ready to use for coming NPP projects in Finland. STUK has also proposed to the IAEA with incorporation of certain safeguards related topics into a Safety Standard that is in final step of preparation, namely the standard NS-R-1 Safety of Nuclear Power Plants Design. Implementing the proposed practice would improve the effectiveness of the safeguards and also result in savings in NPP construction phase.

## 1. Introduction

Nuclear industry has gone through three major crisis in the past decades: 1) Tshernobyl Accident in 1986, 2) clandestine Iraqi nuclear weapons programme and 3) terrorist attacks in 2001. (Fukushima may be considered as fourth one, but out of the scope of this paper). The first touched nuclear safety, second nuclear safeguards and third nuclear security. All modern nuclear energy development projects and installations should take all these three S's into account.

Regarding nuclear safety related accidents Tshernobyl case is well understood and analyzed in detail. Fukushima accident is more complex and still ongoing, but the time for detailed analysis will surely come. There will be more lessons to learn also for LWR type of reactors and wet storages.

In the area of safeguards the disclosure of clandestine Nuclear Weapons programme in Iraq underlined the need of change in international safeguards. Earlier IAEA had a clear mandate only to verify declared nuclear materials and programmes. IAEA had also right to make undeclared or short notice inspections, but it did not execute these rights. Undeclared nuclear programmes were completely out of the scope of IAEA's verification actions. Therefore Iraq could build its clandestine nuclear programme without any intervention from the side of International community, which the IAEA is representing. National intelligence agencies were more knowledgeable in this sense – and more capable to react: Israeli air strike to Iraqi Osirak reactor in 1981 can also be seen as one of the most successful actions in the history of nuclear disarmament. Israeli strike and its motives were of course noticed in the IAEA, but they were not able to react.

The nature of Iraqi nuclear weapons programme was fully revealed to the international community after the first Gulf War. Strengthening the mandate of the IAEA gained strong acceptance among member states in order to prevent similar cases in the future. As a result model additional protocol to Safeguards Agreement was negotiated. The original model Safeguards Agreement is named INFCIRC 153 (INFCIRC 193 in EU) and Additional Protocol is INFCIRC 540. The objective of Additional protocols is that the IAEA can draw conclusion that there are no undeclared materials and activities in the State. To make plausible conclusions IAEA needs powerful tools for that. For instance Additional Protocols provide IAEA access rights to any location in the State for collection of environmental samples. However, if the State is unable to provide such access it shall make every reasonable effort to satisfy Agency requirements at alternative locations.

Nuclear terrorism became one of the major international threats after 2001 terrorist attacks. Attacks had an influence on NPP designs and physical protection. Nowadays it is understood that not only States may want to acquire nuclear weapons but also sub national terrorist groups desire after them. Also the risk of radiological terrorism (so called dirty bombs) exist and actually one known attempt is known. Events of 2001 showed that a new type of threat is real and it became better understood that safety, security and safeguards are actually closely interrelated.

## 2. Can nuclear renaissance be challenged by safeguards failures?

Fukushima accident may chance the picture in some countries temporarily, but in the long term hard facts are not changed. The energy demand is increasing and Nuclear is one of the most viable options to fulfill this need. Safeguards issues are one of the major challenges, when nuclear energy production is increased, especially in new countries.

Some people say that nuclear material safeguards are too technical for politicians and too political for engineers. Safeguards were born in 1953, when Eisenhower kept his notorious "Atoms for Peace" speech. It subsequently led to foundation of the IAEA. Peaceful applications of nuclear energy should be available to all countries, but there is a price to pay: a state should commit that the technology is not used in military purposes. This means that a state should subject itself to the nuclear material safeguards, which is internationally carried by the IAEA. Every state should also have a State system of accountancy and control in place, which is collaborating with the IAEA.

Nuclear material safeguards are a prerequisite for the use of Nuclear power, especially in non-nuclear weapons states. Therefore it is right to say nuclear renaissance can be challenged by safeguards failures. This is true especially in the new countries seeking Nuclear power, which do not have fully functional State systems. It would be politically devastating to the acceptance to nuclear power if nuclear material or technology would be transferred from peaceful purposes for military or terrorist use. The problem should be addressed. IAEA should be given substantial resources to perform its mandate. The new countries should be assisted by the others. And finally new culture, including combination of safety, security and safeguards (so called 3S) should be brought up. Also new facilities should be designed as safeguards-friendly as possible. Proliferation resistance is one design principle for new Gen IV reactors, but also new Gen III reactors require new thinking.

## 3. New Safeguards cultural elements, 3S and Safeguards by Design

Nuclear safety and security are defined in the IAEA safety glossary (2007). Nuclear material safeguards is a control regime for ensuring non-proliferation of nuclear materials and sensitive technology, which is a precondition for the peaceful use of nuclear technology.

Why we need 3S instead of three separate S's? They all are aiming at common ultimate purpose and they share a lots of control measures. However, they are a few conflicting requirements. This calls for complementary approach which should be coordinated. We have noticed this in STUK. Our mission is to "protect people, society, environment and future generations from the harmful effects of ionizing radiation". This is not possible to fulfill by any of the S's alone without the other two.

Safety culture is better understood concept, but what is safeguards culture? It should grow on the cooperation between the competent authorities, nuclear operators and the IAEA. "Trust and verify"-principle is a good starting point. IAEA is not an authority, but an international civil servant, with obligation is to draw conclusions about the absence of undeclared activities and materials in the member state. This double negation is difficult to fulfill without cooperation from the side of the state and the operator. Actually the cooperation is urged by the states in the preamble of the Non Proliferation Treaty.

IAEA has developed a strategy, where the safeguards is turning from criteria driven to the safeguards which is information driven. Nuclear material accountancy and verification remains as a core of IAEAs safeguards system, but the intensity is lower than before. Why nuclear material accountancy and verification are needed? One may argue, that there is only one case where safeguarded nuclear material was transferred from peaceful program into the military use (DPRK), but this can also be seen as a success of the international safeguards system. Deterrence created by safeguards activities, based on accountancy and verification activities, are clearly working! It is something any credible safeguards system can not give away.

On the other hand IAEA is collecting information from other sources in order to draw boarder conclusions of the compliance. Safeguards includes also includes elements, like nuclear trade analysis in order to understand where possible proliferators are and to what they are aiming at. Here IAEA is seeking for cooperation with states and companies. This kind of analysis is not directed against the states or the companies, but the motivation is to reveal illegal trafficking, brokers and middleman.

Traditional nuclear material accounting remains as a core, but with lesser intensity, there is a need to make it more efficient. Here a concept of Safeguards by Design comes into play. New nuclear facilities should be built in a way that they lessen the burden of safeguards activities to the different parties. Especially IAEAs resources are scarce. Also nuclear operator will benefit from the fruits of well designed facility. For accountancy and verification IAEA may need to install cameras at the storage locations and attach seals to the containers. IAEA is also using various NDA systems to verify the nuclear material. IAEA also may want to have all these systems remote controlled and unattended. These equipment may require certain amount of footprint, electricity, lightning and cabling. IAEA has prepared a guide for facility designer and more work is done on this subject.

How a new facility can be made “safeguards friendly”? Safeguards needs and requirements should be made known to the designers, who are most likely accustomed more to safety and security. One pragmatic way to do this is through regulations and guides. For instance, Radiation and Nuclear Safety Authority, STUK, is in the process of rewriting and restructuring its Guides, which are by virtue of law binding to the operators. The Guides will be published soon, so they are ready to use for coming NPP projects in Finland. STUK has also proposed to the IAEA with incorporation of certain safeguards related topics into a Safety Standard that is in final step of preparation, namely the standard NS-R-1

There is also a need for sharing of information and training. European Safeguards Research and Development Association (ESARDA) has made fruitful efforts and is organizing several courses per year for mainly for university students and also for other nuclear professionals. Safeguards are also interesting area for young nuclear technology professionals to specify in. In the area technical knowledge is essential, but also other skills are of great importance, since it is a fascinating mixture of technology, politics and international cooperation.

## 4. Conclusions

Nuclear Material Safeguards is a prerequisite for utilization of nuclear energy. The aim of safeguards is to, prevent proliferation of nuclear weapons. It also should provide international community credible assurance that in the country has no any undeclared nuclear materials and activities. The need of efficiently and effectively implemented safeguards is increasing, since the nuclear renaissance and expanding nuclear infrastructure would result to the situation where more and more materials and activities are under safeguards and resources to do the work is not increasing at the same pace. In addition there are new challenged to be faced, like sub national terrorist groups who are seeking nuclear weapons. To face these challenges new safeguards culture need to be learned, synergies between security safety and safeguards need to be developed. New facilities should be designed safeguards in mind. Also raising safeguards awareness among nuclear professionals is needed.

# HARMONISING SKILLS:
# A BLUEPRINT FOR WORKFORCE DEVELOPMENT?

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## ABSTRACT

Nuclear is part of the energy mix of many European countries and, prior to the recent developments at Fukushima in Japan, the sector was emerging from a 'doldrum' decade with new build underway in some countries (*e.g.* in Finland and France). While further developments will undoubtedly pause to reflect on lessons learnt, the 'renaissance' drivers that positioned new nuclear power as a credible part of the medium-term energy mix remain; these drivers are the prospects of energy security and low carbon electricity.

Fukushima will have an impact on consideration of lifetime extensions of current nuclear estates (*e.g.* in Germany*)*. It will also inform new build designs that are under regulatory assessment or planning (*e.g.* in the UK and Italy). Decommissioning, nevertheless, remains for all countries that have had or are planning new generations of nuclear power.

The recent events serve to heighten the ever-present theme of the nuclear safety culture. The challenges for research, education, training and workforce development are well known - How can education and training requirements be quantified and verified? And, to what extent can governments and employers, in free labour markets, ensure a pipeline of suitably qualified and experienced people to support energy infrastructures?

Drawing from the peer-reviewed labour market research and standards development of Cogent in the UK [REFs 1-4] and the proceedings of OECD-NEA [REF 5], this paper will explore the potential of a ***Nuclear Skills Taxonomy*** that is underpinned by robust evidence (independent labour market research), occupational standards (independently set and verified), independent accreditation of workforce development and training, and international collaboration.

This paper will illustrate how a Nuclear Skills Taxonomy is the cornerstone for HR planning that could lead to further developments in:

- 'passports' for training and experience
- voluntary licences to practice that underpin regulatory compliance and supply chain competence assurance
- human resource observatories
- robust labour market research and future HR scenarios
- promulgation of best practice and recognition of suitable education, training and experience
- harmonisation of standards and frameworks

## 1. Quantifying a National Labour Market for Nuclear

In contrast to the wide range of econometric data collected nationally (e.g Office for Nuclear Statistics, UK) and internationally (e.g. Eurostat), there is a paucity of data on the labour market of the civil nuclear industry. By comparison to, for example, the Oil and Gas or Manufactured Fuels industries for which standard industrial and occupational classifications are specified, only the smallest part of the Nuclear industry is directly quantified under Nuclear Fuel Processing (as a subset of Manufactured Fuels). This places great emphasis in the UK on the primary labour market research reported by Cogent [REFs 1-3].

Three skills drivers are quantified in the *Power People* report [REF 1]: an ageing workforce driving replacement demand; a short-term shift in skills to decommissioning; and, a medium-term demand for skills to build and operate a new fleet of nuclear power stations. While, the sector may have been anecdotally aware of these drivers, the defining contribution of this report is in the robustness of the evidence, the in-depth primary HR data and the peer-reviewed analysis. Of particular importance to this paper will be demonstration of the results of collaboration with the industry on a skills classification system **– a national Nuclear Skills Taxonomy**. The taxonomy has allowed the **HR of Nuclear to be mapped by region, nation, skill level, age, sub-sector, and job context**. Examples of the use of the taxonomy are given in figure 1.

**<u>Figure 1 – A National Nuclear Skills Taxonomy (UK) [Ref 1]</u>**

**a. Nuclear Job Contexts and Occupational Skill Levels**

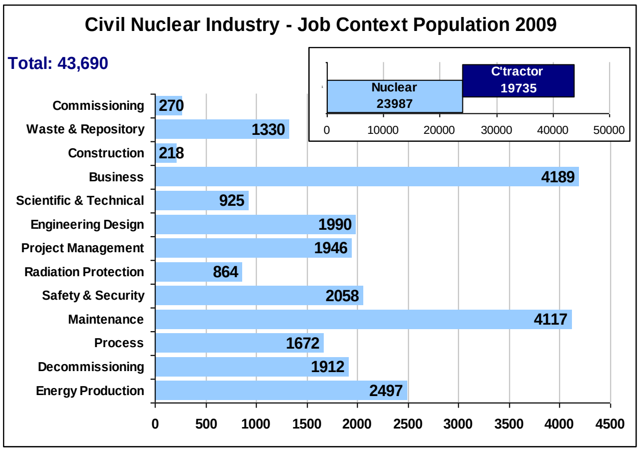
Nuclear Job Contexts

1. Energy Production Operations
2. Decommissioning Operations
3. Process Operations
4. Maintenance Operations
5. Safety & Security
6. Radiation Protection
7. Project Management
8. Engineering Design
9. Scientific & Technical Support
10. Business
11. Construction (internal estates)
12. Waste & Repository Operations
13. Commissioning

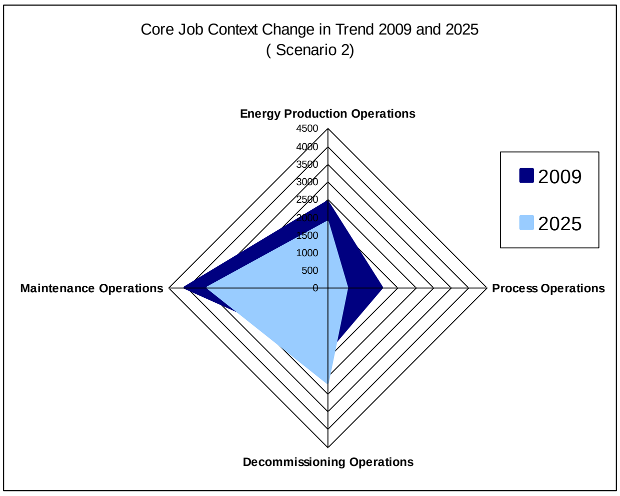
Occupational Skill Levels

1. Semi-Skilled
2. Skilled
3. Technician
4. Professional / Middle Manager
5. Senior Manager

**b. Civil Nuclear Industry by Job Context site license workforce & contractor (est)**




**c. Workforce Scenario**



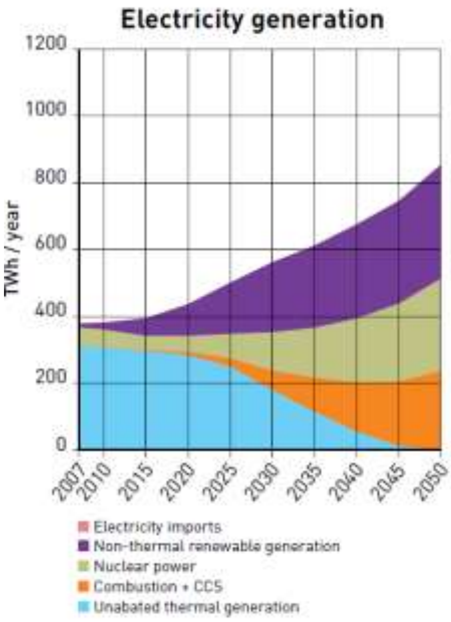
## 2. Predicting Human Resource Needs for Governments and Employers

Employment in European economies operates on free market principles driven by the supply and demand for labour. The supply of general and specialist skills of young people entering the labour market is largely funded by states through the education system. Appropriate 'nuclearisation' of employees is the responsibility of the employer. In the case of nuclear, the labour markets are also bounded by policy and regulatory frameworks on energy and, specifically, by a nuclear regulator. The state therefore has policy instruments by which it can affect the supply of education and the demand for training for its economy and infrastructure. Ultimately demand for employment and training is employer driven in response to regulation or perceived business improvement. Both governments and employers can benefit from access to high quality labour market intelligence and training standards. This can inform, for example, targeted policy interventions such as directives on training, or prioritisation on resourcing of higher education and research. For employers, independently verified standards can quality assure HR development and accreditation can inform the choice of training, be it internal, public or private provision. (See also section 3 below).

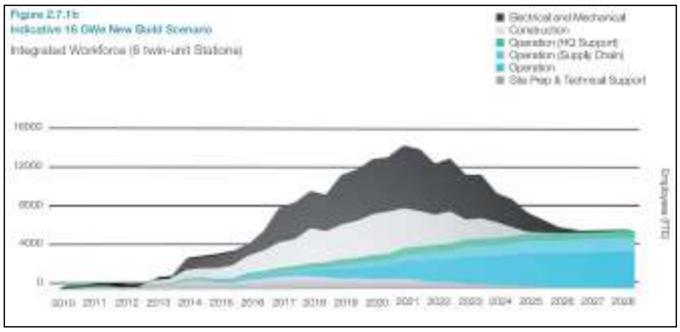
Figure 2 illustrates how the **nuclear taxonomy has worked with government scenarios on future 'energy pathways'**. Figure 2a indicates a 'balanced' low carbon energy mix with nuclear contributing one-third of supply. Figure 2b is derived from the nuclear taxonomy and relates to 16 GWe of new nuclear capacity by 2025 in line with the energy pathway analysis.

**Figure 2 – UK Energy Pathways and Nuclear HR Requirements**

**a. Energy Pathways [Ref 6]**




**b. Nuclear HR Requirements [Ref 2]**



## 3. Establishing an Independent Industry Training Framework

This part of the paper illustrates how a national nuclear taxonomy underpins a national industry training framework and ultimately a Nuclear Skills Passport. Figure 3 illustrates the process.

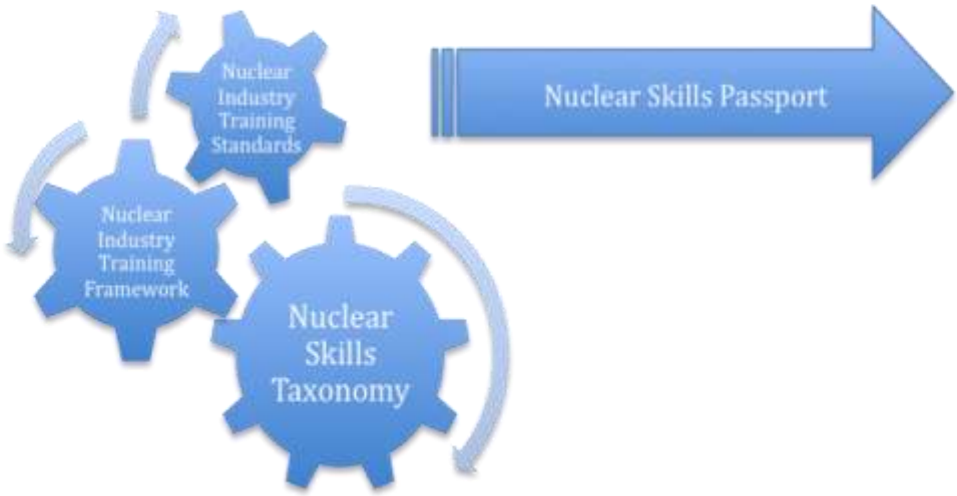
The **Nuclear Industry Training Framework** (NITF) encompasses all nuclear job contexts, qualifications and industry standards for a site-licenced company. Shaped by Cogent with the industry and for the industry, the NITF is the benchmark for employers for skills gap analysis [REF 7, 8]. The nuclear taxonomy of job contexts provides a common framework for NITF on competences, qualifications and training. The NITF identifies recognized education and training in four areas:

- Technical Competence
- Business Improvement (quality and innovation)
- Regulatory Compliance
- Functional and Behavioural Skills.

**Nuclear Industry Training Standards** (NITS) related to these areas have been developed, each with learning outcomes and assessment criteria. The development of these standards has taken place in consultation with the National Skills Academy, Nuclear (an accrediting body for training), industry groups and relevant trade, professional or training associations. The NITS provide the quality assurance aspect of the Passport.

Founded on the NITF and the NITS is the **Nuclear Skills Passport.** The Passport evidences individual and organizational competence. The Passport is underpinned by a database-driven IT platform which provides verification of accredited training. In the UK the Passport is voluntary, but it has been identified by nuclear operators as highly desirable for their supply chain.

**Figure 3 – From a Nuclear Taxonomy to an Industry Training Framework and Passport**




## 4. Harmonisation: An International Nuclear Skills Taxonomy?

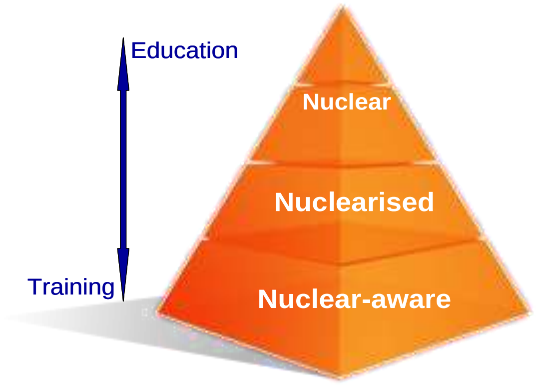
It has been demonstrated above that a national taxonomy underpinning HR development, training standards, and accreditation of training is feasible. This section of the paper looks at the potential for an **international taxonomy focusing on the degree to which nuclearisation of an occupation is required.** By reporting on an analysis of commonality in education, training and knowledge management across a number 'test' countries, this paper will demonstrate that it is possible to develop an international taxonomy [see also REF 5].

In the international context, a taxonomy could open the way to international developments in:

- workforce mobility across all occupational levels
- a robust basis for international labour market research, scenario planning and HR observatories
- international comparability and interoperability of standards, training and qualifications
- international intra-company transfers
- international 'passports' for training and experience
- voluntary licences to practice that underpin regulatory compliance and supply chain competence assurance
- the safe and secure adoption of nuclear technology by developing countries.

Drawing from the study, figure 4 illustrates through a competency pyramid the degree to which workforces require nuclearisation. The top of the pyramid represents the specialist nuclear educated and experienced occupations working on a nuclear site. The middle section represents non-nuclear occupations that may be employed on sites. The bottom of the pyramid represents the large workforces that may be transient on a nuclear site or may be providing products and services off-site to a NPP but to nuclear specifications.

**<u>Figure 4 – Harmonisation: a Pyramid of Competency</u>**




## REFERENCES

1. *Power People: The Civil Nuclear Workforce 2009-2025*, Cogent SSC, UK, 2010. http://www.cogent-ssc.com/research/nuclearresearch.php
2. *Next Generation: Skills for New Build Nuclear,* Cogent SSC, UK, 2010. http://www.cogent-ssc.com/research/nuclearresearch.php
3. *Illuminations: Future Skills for Nuclear,* Cogent SSC, UK, in press 2011
4. *Nuclear Industry Training Framework*, Cogent SSC, UK, 2011. http://www.cogent-ssc.com/industry/nuclear/nitfjs.php
5. *Nuclear Education and Training: Assuring a Competent Workforce,* M Elena Urso, B Murphy, OECD/NEA Ad Hoc Expert Group Education, Training and Knowledge Management, European Nuclear Society, NESTet, Prague, 2011.
6. *2050 Pathways Analysis,* Department of Energy and Climate Change, 2010 http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/2050/2050.aspx
7. The Nuclear Industry Training Framework, Cogent, UK *http://www.cogent-ssc.com/industry/nuclear/nitfjs.php#3*
8. Nuclear Industry Annual Report, Cogent SSC, UK, in press 2011 http://www.cogent-ssc.com/information/Skills_Aims_Nuclear.pdf

# I2EN; A Tool of the French Nuclear Energy Education System for international Community
## (Institut International de l'Energie Nucléaire)

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## Abstract
During the 21[st] century, in spite of Fukushima accident, nuclear fission, one of the safest and most dependable modes of energy production is necessarily going to play a role in the energy mix of the world. However, this will require an educated and well trained force adapted to the associated challenge. The French universities and engineer schools together with research institutes and the nuclear industry have decided to set up the I2EN as a tool towards the building and the maintenance of a national adequately sized coherent initial education system open to both French students and to the international community. The I2EN key mission is for the international level, to address the present need for competence building in nuclear energy production by offering training opportunities in both English and French, initial and continuing, education programmes.

## Context
It is now established that nuclear energy will contribute to the future electricity mix of the world. For each country, several factors (natural resources, economic and population growth …) will determine how large will be the fraction allotted to nuclear energy. Among these factors the existence of a well educated and trained national community with the ability to safely develop and maintain this demanding technology will play a key role. After several decades of neglect, preparing the human resource potential required to fulfil the requests of industry, research, control and safety organisations as well as those of teaching institutions is a formidable challenge. France, a country without any fossil resources, depends for a long time, on nuclear energy for more almost 80% of its electricity. For this reason, the nation had to maintain a high level and comprehensive education and training (E&T) system associating closely Academia with Research and Industry. It is the belief of the French government that his system tailored to the needs of the country can also be of help to other nations in the organisation of their energy future.

### 1. Education and Training Needs
For nuclear energy, the E&T needs cover a three-dimensional continuum.

- One of these dimensions is disciplinary (safety and regulation, radioprotection, the chemistry of the entire fuel life-cycle, material science, conception and building of reactors, operating and maintenance, dismantling and waste management, R&D and future systems,...).
- Another is job qualification. The needs range from technicians, operators, assistant engineers to the last levels of the higher education (Master; Engineers, PhD).
- A third dimension is that of time. A well focused initial education is certainly necessary. On the other hand, it must be conceived as being only the first step of a comprehensive training system extending over the entire professional life. This system will allow a regular updating of competences in relation with the evolution of regulations and of industry performances. It should also be compatible with a constant progression of the careers. This training process mostly driven by the industry and the control organisations relies on sharing practices of on-the-job acquired experience and on vocational training sessions designed either internally or in collaboration with Research and Academia.

For France alone, for the next years, the yearly level of recruiting of Nuclear Energy (Utilities, Engineering, Fuel cycle operators, sub-contractors) and for all firms or organisations, all fields of competence and all levels of qualification can be estimated to be of the order of ten thousands. On the other hand, not all these persons need to have received a full-fledged nuclear education. Most often, the candidates are selected for a specific general competence (civil engineering, electro-technique, thermal-hydraulics, metallurgy,chemistry etc.). They only require to be given an additional education on specifically nuclear energy subjects (safety, radioprotection...).

For instance, a recent review by the High Commissioner for Nuclear Energy estimated that every year close to 1200 students at the master or equivalently engineer level were needed by the French nuclear energy industry, control organisations and research. Out of this total, only about 300 had to have completed a dedicated nuclear training (two years, 60 ECTS each). The concerned fields were mostly reactor physics and design and plant operation. Another 300 had to have followed specialized courses in scientific fields closely related with nuclear energy (chemistry, material science, thermal-hydraulics) with additional educational modules focused on the particular requests of nuclear industry. The rest was to have obtained a high level of competence in a specific technical field, have acquired a general familiarisation with the global organizing principles of the nuclear industry and have mastered the contents of dedicated modules emphasizing the constraints (safety, radioprotection...) of any career spent within nuclear industry or research.

This categorisation into three groups of the nuclear energy educational overall content should be valid for every country, although with different weightings according to their level of technical development and their ambitions in the domain of Nuclear Energy. It is our belief that the present French system is in position to provide a useful support over the entire range of educational needs.

## 2. I2EN Missions

The main mission of I2EN is to help the French academic high level education system (universities and engineer schools) answer foreign requests in the field of nuclear energy education when these are addressed to the French government or the Industry via official channels.

This involves different tasks.

- Building a comprehensive information basis of the competences within France in matters of teaching the various disciplines relevant to nuclear energy,
- Assessment of the level of French curriculae against the best international standards such as defined for instance by ENEN and IAEA,
- Help coordinate universities and engineer schools in the design of their syllabuses with a view to fostering comprehensiveness and complementarities,
- Providing technical support to the committee which advises the high level education ministry on which syllabuses should be awarded an agreement to deliver a nuclear energy diploma,
- Presentation of the French education system and its international promotion.
- Analyses of the institutional requests in the domain of Nuclear Education addressed to France and :
    - Determination of the optimal answer the existing academic system can provide. In such a case, I2EN,notably in close collaboration with the academic partner(s) selected by the requester, ensures a follow-up of the educational process,
    - Building if necessary, a specific offer, in link with some partners, for examples like a “train the trainers program” (including tour of nuclear energy stakeholders and intense advanced training),or assist partner country to analyze its educational system, assist partner country to build up its own capabilities in nuclear education and training,…

### 3. Partnership

The partnership of I2EN includes four ministries (High level Education and Research, Foreign Affairs, Environment and Industry), the major French nuclear industries (including EDF and AREVA), the French research organisations (CNRS, CEA, ANDRA) and the main universities or engineering schools delivering a nuclear energy diploma. These partners fund the activities of the I2EN operational team.

### 4. Present Status of French Educational System

Any person (student, educator, industrial) interested in interacting with the French Nuclear Energy education system must be aware of some specificities of the organisation of the science high level education in our country. For reasons anchored in France's history, it is built as a dual parallel system as sketched in Fig.1.

A student wishing to acquire a degree in a scientific domain is offered two tracks. One (left side of the figure) which relies on Universities is very much similar to what exists in the rest of Europe. It is now organized following the Bologna system with a three year Bachelor course followed by a two year Master course. After successful completion of these two courses, the student may start a PhD in a research institution (University, CNRS or CEA). In parallel, there exists the system of engineer schools (right side of the figure). It is worth noticing that within France its reputation is as solid as that of the university. Its student flux is at least as important, if not larger (as far as nuclear energy is concerned), as the flux along the university track.

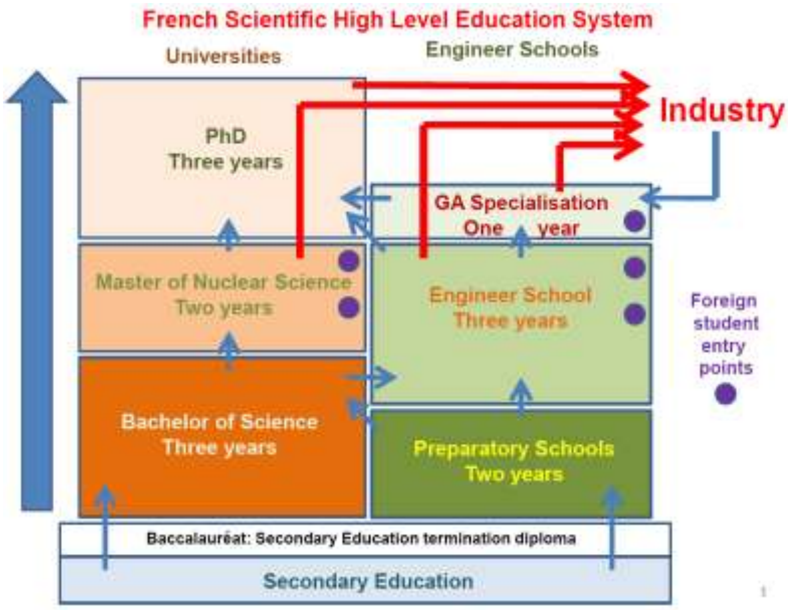


Fig.1: Organisation of the French scientific high level education system.

On the left side, the "University track" (Bachelor, Master and PhD) has been sketched. On the right side, we have drawn the "Engineer School track" (preparatory schools, engineer school, additional specialisation in nuclear engineering). Blue arrows indicate standard progression paths as well as some transfer options. Red arrows indicate where French nuclear industry presently recruits its top level engineers. Purple dots indicate possible entry points for a foreign student.

In France, the focus on Nuclear Energy proper begins either at the master level or in the last two years of engineer schools. For a foreign student with a solid knowledge in basic science (Mathematics plus Physics or Chemistry), interested in obtaining a French nuclear energy engineer or scientist diploma, this is the most natural entry point into the system.

A foreign student wishing to obtain a French master or engineering diploma in Nuclear Energy may enter the university following standard European procedures based on exchange agreements between universities of both countries. In order to merge with the European system, most French engineer schools have also negotiated education equivalences with several foreign partner universities. The students of such universities can spend a year (two years) in France and be delivered a dual diploma (master in their home university and French engineer). These equivalence agreements generally differ from one engineer school too another. I2EN might be of help in elucidating some of these technicalities.

Presently, in France, more than twenty academic institutions are delivering master or engineer diplomas in all fields relating to Nuclear Energy. The situation has considerably evolved over the last four years. The number of curriculae and the number of students has grown by a factor three. It is estimated that the present capacity almost matches the need of the French industry. Only limited evolutions are expected over the next decade. A significant number of foreign students are already taking the same courses as their French colleagues. Although, a majority of them are fluent in French language, it is worth mentioning that several universities and schools have organized master level courses entirely taught in English. Table1 gives the numbers of students according to the depth of specifically nuclear-energy-related education described above.

| Final Master or Engineer Course Academic year 2010-2011 | Total Number of Students 1014 | Foreign Students 183 |
|---|---|---|
| Dedicated Nuclear Energy Course | 391 | 91 |
| Discipline plus a strong focusing on Nuclear Energy | 277 | 60 |
| Discipline plus a familiarisation with Nuclear Energy specifics | 346 | 32 |

Table 1 : Number of students completing a nuclear energy education at the Master-Engineer level during the academic year 2010-2011.

The table 1 shows that the present “production” of the French Nuclear Energy education system is approaching the ratios between different depths of nuclear-related education which appeared desirable, according to a previous analysis of the needs of French Industry. For the first two categories the numbers are also close to the goals stated in this analysis. Only the value for the third category is too small. On the other hand, over the years, the industry has developed a strong capacity to provide those engineers or PhD with no previous acquaintance to nuclear energy with the necessary knowledge. Presently, the industry does not report any recruiting problem. Or course, very much will depend on the dynamics of Nuclear Energy at the world level. To say the least, it appears presently difficult to predict.

Expectedly, Table 1 also shows that foreign students are more interested in a strongly nuclear energy focused education.

At the present stage, what France still needs is a more detailed analysis by the industry and the education system together of the requests for various job qualifications and the adequate syllabuses. I2EN is working to help its partners on this point. On the basis of this evaluation, they will decide a progressive evolution of the system in order to improve the fit of the available initial education with the requirements of the job market.

## 5. I2EN Excellence Centre

I2EN has been mandated by its partners to organize the activities of an Excellence Centre (EC) on questions relating to nuclear energy. The intention is to become an international think tank on an extended range of specialized questions associated to major challenges such as the:

- Role of nuclear fission in the energy mix
- Waste management issues
- Proliferation Risk
- Security of nuclear plants and nuclear materials
- Environmental Issues
- Economic issues
- Public debate and political decision

Another aim of this centre is to participate to the creation of a strong shared culture of safety and security with newcomer countries and to define the associated set of knowledge needed to nurture this culture. It is also planned that it could become the French node of an international network of EC (with for instance IAEA, ENELA, KIC innoenergy; …) and define its actions in coherence with the network.

To perform its mission, the I2EN EC will

- Organize high level workshops and seminar (one to two weeks) aimed at participants from universities, industry as well as decision makers.
- Based on the outcomes of these workshops prepare tutorials for professionals on technical, economics, law and regulation
- Publish reports
- Hold public conference aimed at a broad audience

## 6. Conclusion

The I2EN is a tool set up by French Academia, Research and Industry to help organise the Nuclear Energy high level education at the level of the country. The French government strongly wishes that France's competences in this domain be widely open to foreign students and more generally to international collaboration. The government has given I2EN the specific mission to help all those interested in accessing the French education system.

The I2EN work is also designed to prepare the qualified personnel that the French industry needs to meet the energy challenges of the country during this century.

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