

# Education and Training in Decommissioning Needs, Opportunities and Challenges

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**Keywords:** decommissioning, education, training, career, competence.

## ABSTRACT

*The decommissioning of nuclear facilities is an industrial activity that is growing worldwide, creating job opportunities at all educational levels. Over the last decades, European companies have been involved in decommissioning projects that are targeted at delivering an environmentally friendly end-product, in line with the 'circular economy', as promoted by EU and national policies.*

*European industry has acquired know-how and today Europe can position itself at the top level in the world decommissioning market. However, in view of the preparation of future decommissioning programmes, efforts are necessary to ensure and share the underpinning knowledge, skills and competences.*

*In this perspective, the University of Birmingham in association with the European Commission's Joint Research Centre have organised a joint seminar to address the following questions in relation to education and training in nuclear decommissioning:*

- *What are the competence needs for the future?*
- *What are the education and training opportunities?*
- *How can we stimulate interest and future talent?*

*In answering these questions a report has been published which provides suggestions for helping the development, coordination and promotion of adequate education and training programmes at EU level in nuclear decommissioning. It highlights, in particular, the necessity to improve the long term planning of the resources and competences, addressing the specifics of decommissioning activities, to give more visibility to the career possibilities in the sector, and to enhance the cooperation between the existing education and training programmes, providing also more clarity in the learning outcomes.*

## 1 Introduction

The growing expectations of the decommissioning market create the potential for new activities over the coming decades and a clear global positioning of the European Union will be an asset. In preparation of future decommissioning programmes, the availability of qualified and experienced personnel will be essential and will be probably one of the most critical issues to address. For many years, the European nuclear sector has faced an increasing difficulty in recruiting and maintaining staff with the required expertise. It can be expected that the decommissioning industry will face a similar or even more significant shortage of competent personnel.

Over the last decades several EU countries have seen new initiatives emerging to address the issue, going from short professional induction training programmes to extensive academic graduate and

postgraduate courses. Pathways should be explored as to how these initiatives can be supported, eventually coordinated and promoted.

This paper makes suggestions on the way forward to support education and training in nuclear decommissioning in Europe. It provides extracts and the main highlights from a joint report published by the University of Birmingham and the European Commission's Joint Research Centre and the related report issued in 2015 [1].

## 2 Competence development in nuclear decommissioning: what are the needs?

Most decommissioning programmes are implemented over several years via a sequence of projects and activities of different nature. This explains, at least in part, the *variety* of the skills required. Those range from senior site managers, programme managers and project managers (including particularly the speciality area of planning, scheduling and cost estimating) , to engineers (electromechanical, chemistry, construction, geology, ..), operational managers, safety managers (safety case and licensing), operational and technical staff (decontamination, dismantling, waste characterisation, treatment and transport, maintenance) and surveillance staff (radiological protection, safety and security).

Complementary to operational staff, the usual important number of diverse contracts and their complexity will also require relying on competent financial and legal support. And the specialised nature of the activities will also require attracting, developing and maintaining the competences, and thus the implementation of an appropriate human resource management.

In the transition phase from the closure of an installation to its decommissioning, part of the competences can be acquired by professional conversion of part of facility operating staff. But experience shows that some activities require recruitment or outsourcing. Several disciplines are involved and a series of pinch point areas exist, i.e. disciplines for which shortages have been identified or are expected.

### *Main identified 'Pinch Point' areas for nuclear decommissioning*

- ❖ *Programme and Project Managers*
- ❖ *Engineers specialised in Decontamination & Dismantling Techniques and in Waste Management*
- ❖ *Safety Case/Licensing Specialists*
- ❖ *Radiological Protection Advisors*
- ❖ *Radiation Metrologists and Radiochemists*
- ❖ *Skilled technicians and operators for dedicated equipment*

Ensuring also a continuity of scientific competences linked to decommissioning should not be forgotten. Although many of the techniques have reached maturity after they were tested and applied on the first sites, there are still areas requiring R&D [2]. Particular attention is needed for the further *development* of existing techniques, to make them more efficient (less time-consuming, less waste producing) and safer (less radiation exposure risks, less occupational hazards, more ergonomically sound).

When addressing the necessary competences, some issues appear essential to be taken into consideration:

### From operation to decommissioning: dealing with a cultural change

Experience has shown that companies embarking from operation to decommissioning face an important cultural change. Targets are changing from operating and maintaining a facility using known technologies, to the dismantling and final demolition of the installations. When moving to decommissioning, the nature of the work changes significantly and will require more flexibility. Activities become mainly project, cross discipline based, necessitating a broader knowledge, especially of new technologies. The available competences do not neatly map from operations to decommissioning.

The organisation will have to adapt to the needs. It will be important to ensure an efficient programme management to support the changes. Investment in training will have to be planned to

adapt and strengthen the competences or skills. Several new competences will have to be also attracted from external organisations.

Management will have a key role in maintaining people's spirit and commitment towards an end goal which is very different to those of an operational facility.

#### Long term planning of the essential competences

The usual significant time scales of decommissioning processes require that specific attention goes into the long-term strategic planning of recruitment and training needs with an appropriate profile in terms of both time and scale. Obviously this approach is essential for the key disciplines for which currently a shortage is already experienced or is forecasted.

A clear vision should exist on possibilities for personal career development, which can be facilitated by the various job opportunities that decommissioning activities can offer.

#### The retention of knowledge

Independently of the long term planning of recruitment, training and professional development, a management system must be put in place to guarantee the preservation of the knowledge of the facility and its historical records and to ensure the knowledge transfer to future workforces. This issue can be especially challenging in cases of a deferred dismantling strategy, whereby active decommissioning only starts after a lengthy period of safe enclosure of the reactor.

Support can be provided by entities specialised in decommissioning and assisting the operators in the development and implementation of knowledge management programmes for the plant and contractor personnel involved in various phases of decommissioning activities. The IAEA is currently providing expertise in this area [3].

#### Collaboration between organisations

With the growing number of facilities reaching or approaching the decommissioning phase, it is necessary to share lessons learned and good practices in decommissioning, waste management and site remediation. Although the decommissioning market is already very competitive, advantage can be taken from collaborations between the organisations to enable the development of the right competences. Decommissioning sites require a close interaction between operators, consulting and engineering companies, industrial service providers, waste agencies, etc. as well as the independent regulatory bodies. All stakeholders have an interest that the key skills are both developed and matched to demand – scale and time. It is clear that no single organisation can achieve all decommissioning goals.

There is a clear need to share best practice across the European Union to ensure that the organisational costs linked to the knowledge, skill and competence development associated with decommissioning are optimised. Several examples exist at national level. Organisations in the UK, Germany and France are merging efforts for integrated training programmes. ‘Competence clusters’ have been created to merge knowledge and experience. Innovative systems have also been developed and put in place to enable the assessment, recording and demonstration of workforce competence, showing workers have the right skills, knowledge and attributes for the task required [4].

Examples can be also taken from the U.S and Canada, where utilities have accomplished significant projects, whose results would be of interest and benefit to competences in Europe.

International organisations such as the IAEA, the OECD/NEA and the European Commission play a role in the sharing of information on decommissioning practices.

#### Facilitating mobility

Mobility of decommissioning experts is also an important factor to consider. Decommissioning activities are implemented sequentially. For some steps specific competences are required for a

well-defined period, limited in time (which can extend to a few years). There exist opportunities for teams of decommissioning experts to move from project to project thus maximising the cost benefit return to companies that develop the skills-base.

In a European context, mobility faces language and cultural barriers, but the differences of safety and environmental regulations and of on-site requirements appear to be an even more important constraint. There is still work to be done in moving towards a harmonisation of European safety practices on the decommissioning sites.

Clearly, the nuclear decommissioning business is still in an early stage of development. Given the number of facilities that have been shut down and facilities that are anticipated to be closed in the near future, the market for decommissioning is expected to grow and will last at least for many decades, but presently it is not clear how fast these market expectations will be realised. Some contradictory figures exist. The European decommissioning industry and organisations would benefit if a sound assessment is made of the prospects of the market (including human resources needs) over the coming years, based on the nuclear policies and forecasts in the EU member states. Such an in-depth exercise would help organisations to plan over a longer term.

### **3 What are the education and training opportunities?**

A survey of the education and training opportunities in Europe shows that the evolution of nuclear decommissioning activities over the last decades has triggered the development of several programmes, particularly in the three main 'nuclear' EU countries: France, Germany and the UK.

*Higher education* in decommissioning and waste management is currently provided as follows:

- PhD programmes and dedicated Professorships in decommissioning linked to engineering (an example is in Germany the 'Professorship on Decommissioning of Conventional and Nuclear Facilities' at the Karlsruhe Institute of Technology (KIT));
- two to three year or postgraduate taught Masters courses focussed on decommissioning knowledge (examples are in the UK the one year 'MSc in nuclear decommissioning and waste management' at the University of Birmingham or in France the 'ITDD Master – ingénierie, traçabilité et développement durable' at the Université J. Fourier in Grenoble);
- dedicated modules in decommissioning integrated in a more general Master course in nuclear science or nuclear engineering (example are in Belgium the 'Belgian Nuclear higher Education Network or BNEN', in the UK the 'Nuclear Technology Education Consortium or NTEC' modules at various Universities or in France the 'Nuclear Sciences and Technologies engineering' degree sharing courses at CNAM/INSTN (50%) and apprenticeship in industry (50%));
- Bachelor degree with specialisation (about one year) in decommissioning (examples are in France the courses on decommissioning and waste management at the University of Caen and the University of Nîmes).

Some programmes allow students the flexibility to develop managerial skills aimed at running decommissioning projects. It is essential to develop non-technical skills required such as commercial awareness, project organisation, communication, team leadership, example being the 'UK Certificate of Nuclear Professionalism'.

Most of these programmes have been established following the explicit request of industry, while teaching staff are for a large part professionals and those seeking employment in the sector. The programmes also typically include knowledge transfer on specific projects or equipment: indeed it appears that nuclear decommissioning is a privileged area for practical, problem-based in-field learning. Dismantling techniques not only involve the development of the theory but need a close interaction with industry for their practical understanding.

Complementary to those education programmes, which are mainly addressed to students or young professionals at the start of their career, several shorter *vocational training* programmes exist

focussing on professionals having already work experience in the nuclear field but whose job evolution requires new competences linked to decommissioning activities. A few such examples are:

- The JRC ' Summer School on Nuclear Decom-missioning and Waste Management' (one week, on the JRC-Ispra site, Italy);
- the 'Technology and Management of the Decommissioning of Nuclear Facilities' course at the AREVA Nuclear Professional School (one week by the Karlsruhe Institute of Technology (KIT), Germany);
- the Belgian Nuclear Research Centre SCK•CEN courses on 'Decommissioning of Nuclear Installations' (one week open courses and customized courses at the SCK•CEN site, Mol, Belgium);
- the 'European Decommissioning Academy' organised by the Slovak University of Technology (three weeks of courses, on-site training at the Slovak decommissioning sites and technical tours in Austria, Switzerland and Italy);
- the CEA/INSTN international course on 'Dismantling Experience of Nuclear Facilities' (one week, including a tour of dismantling sites);
- the IAEA ad hoc training programmes and possibilities for e-learning.

Decommissioning activities also require specific workers' technical and administrative skills related to decontamination (specific processes), dismantling (operating specific equipment), waste treatment, waste measurement (waste characterisation devices), radiological checks and surveillance, transport, accountancy, etc... All these skills require ad hoc training which are, in general, organised by the industrial organisations or nuclear research and training laboratories.

Various education and training programmes exist; they will probably need to grow to meet a future increased demand. This evolution highlights the need for harmonisation of the outcomes, for cooperation between universities and institutes and for further enhancing the collaboration with all participants involved in decommissioning (industry, safety authorities and associated technical support organisations, waste management and decommissioning agencies, research centres).

#### Harmonisation of the education and training outcomes

Although education and training programmes can differ in their focus, harmonisation of the outcomes would provide more clarity and be beneficial for both students and trainees not to mention companies that rely on such highly skilled staff. Further standardisation would stimulate mobility and the possibility for universities and institutes to attract students from abroad, particularly from smaller countries for which the development of a rather specific education programme in decommissioning is not viable.

Standardisation can be applied at all levels and should be in line with the effective knowledge and skills needs, as identified in the previous section.

For academic education programmes a series of modules exist, spread over one to three years. These academic modules are weighted according to the 'ECTS' credits which importantly creates a high degree of transparency across the EU [5].

For vocational training programmes (aiming e.g. at specific job qualifications), the system 'ECVET' is being introduced for the identification and mutual recognition of the requested learning outcomes [6]. Where applicable, ECVET points are awarded to learning packages; some of them are developed for the nuclear domain. A harmonised definition of the necessary profiles needed in decommissioning combined with mutual recognition schemes across the EU could support the development of the adequate training modules and clarify the learning outcomes.

#### Cooperation for shared education and training programmes

Where a certain degree of uniformity of the outcomes is recognised, a more intensive EU-wide cooperation could be pursued. Given the scale of university programmes in decommissioning will remain relatively modest, synergies could be created by sharing the best courses or e.g. by sharing the possibilities for on-the-job learning in industry.

For vocational training, it appears that the 'summer school' concept of training over one to three weeks offers an attractive opportunity for employers who want to enhance the professionalism of their staff in decommissioning with a focus on practical experience. In order to share resources, a European 'pool of learning initiatives' could be supported offering at different locations a series of courses, visits and practical studies. An EU 'quality label' or 'endorsement' could be issued to those initiatives contributing to qualitative competence building in decommissioning.

#### Collaboration with the nuclear industrial organisations

The education and training programmes should closely interact with industry and other organisations in order to respond to the projected demand. As mentioned above, an example is given in the UK by the 'National Skills Academy for Nuclear', established as a strategic body that represents the industry to stimulate, coordinate and enable excellence in skills to support the nuclear programme. In a similar way the 'EMEIN' initiative in France is an open forum for companies and academic institutions to discuss and identify industrial needs in matters of education and training in the field of maintenance, dismantling, decommissioning and waste management in nuclear facilities. These needs are set out in a core 'Competency Reference Guide' in order to develop new education and training programmes.

The concept of partnerships with a variety of industrial organisations could be further developed in order to align the learning outcomes to the real needs. Partnerships could be embedded in joint EU education and training programmes grouping universities, schools and directly interested industrial actors in nuclear decommissioning, including stages to allow students and trainees to be confronted with the reality on-the-field in nuclear installation.

Collaboration could be also established by setting up joint EU programmes dedicated to some key decommissioning profiles, an example being taken from what is already achieved for other specific competences needed in the nuclear sector (e.g. the Euratom PETRUS III project focusses on the qualification of safety engineers for geological disposal) [7].

#### **4 How can we stimulate interest and future talent?**

Public opinion on nuclear energy is a complex and controversial issue. Views remain so polarized and they differ so much from one Member State to another that it is impossible to identify an "average EU view". But the public perception has obviously an impact on career choices.

Trends in the evolution of the nuclear workforce in Europe have been analysed by the 'European Human Resources Observatory in Nuclear' (EHRO-N) [8]. Related reports are published periodically. EHRO-N statistics show that the number of students graduating in nuclear related disciplines has slightly increased over the last five years. Despite this small positive trend, over many years a shortage of nuclear experts is expected and the situation is generally deteriorating, partially linked to the growing retirements.

The workforce of nuclear educated staff involved in decommissioning and waste management activities represents today only a fraction (< 20%) of the total nuclear employment. Most of the human resources are dedicated to the operation of nuclear facilities, to R&D and to design purposes; decommissioning is still a 'niche' activity in the entire nuclear business.

At a first glance, undertaking a career in decommissioning seems not particularly exciting; at face value it involves mainly clearing, cleaning and demolishing of reactors and facilities. This is often seen as less attractive than constructing something new – a negative rather than positive contribution. However, the finality of decommissioning is material recycling and environmental plus economic valuation, once a site is cleaned and can be released from regulatory control and reused for other

purposes. Decommissioning can be challenge/problem led, due to the variety of issues to be resolved, requiring the mastery of a diverse set of knowledge and skills, with the development of a bespoke set of solutions.

The experience shared by young professionals working in decommissioning showed that the job offers many advantages that make it particularly attractive:

- Decommissioning is in reality much more than clearing, cleaning and demolishing; decommissioning projects are usually complex and present an appealing technological challenge. They require creative solutions in innovative and diverse fields (e.g. in automation, robotics, measurement techniques, ...). Many new processes need to be developed to make the work more efficient. As such there is a significant element of creativity and ingenuity linked to the decommissioning activity.
- Decommissioning offers also tremendous opportunities for people who have developed expertise in reliable technologies or experience in managing projects and who are interested in mobility.
- A job in decommissioning is secure; young engineers and scientists graduating after studies dedicated to decommissioning are almost certain to find a job.
- Decommissioning is an emerging activity involving on the average young people; related jobs offer many possibilities for career development; 'horizontal' evolution by enlarging the experience over diverse decommissioning projects and 'vertical' development by increasing the managerial responsibilities.
- The ethical and societal factors driving the need to progress on decommissioning contribute to the commitment for the job. Actually, decommissioning provides a service to society and can be considered as a 'noble cause': decommissioning is aiming to restore a safe environment and demonstrates that closing the nuclear energy cycle is feasible.

However, the many possibilities offered to study and to start a career in nuclear decommissioning presently appear to be rather 'hidden'. In addition, the on-going decommissioning programmes and the difficulties they face are in general presented too negatively, instead of highlighting the achievements made so far. A way of promoting decommissioning among the young generation should be pursued, starting at secondary school level, through to the universities.

Promotion could start by clarifying the existing education, training and career opportunities in Europe. Advertising the challenge and excitement linked to decommissioning could be stimulated and integrated within existing campaigns for the promotion of education and training. And more generally, promotion of decommissioning could be helped by improving the public understanding on its finality and as such presenting the activity in a more objective way.

#### Clarifying the existing education, training and career opportunities

The earlier section of this document has shown that in some countries there is already a wide spectrum of education and training programmes. A compilation of all possibilities and a clarification of the outcomes and of the later career opportunities could support focussed promotion campaigns.

The suggested harmonisation of the training outcomes will obviously also help to clarify the existing opportunities.

#### Promoting education and training in decommissioning

Several programmes are in place in Europe for stimulating education and training (best known are the Erasmus+ programme [9], and Marie Curie actions). Those programmes attract young students and could be a way for introducing proposals that would advertise the possibilities offered by studies linked to careers in nuclear decommissioning and stimulate interest of young students.

Material explaining the decommissioning challenges could also be presented at universities or even delivered at school level and thus stimulate interest of teachers and students at a very early stage.

In the same way focussed advertising on decommissioning could be introduced at career days and as such better highlight in a positive way the career opportunities.

#### Improving the public understanding of decommissioning endeavours

'A resilient Energy Union with forward-looking climate change policy' is one of the ten key priorities of the new European Commission. It emphasises the need for ensuring a sustainable, competitive and secure energy market in Europe. Nuclear energy presently produces nearly 30% of the EU's electricity and is 'part of the picture' in 14 out of 28 Member States.

Attempts are currently made at various levels to redefine the debate on energy and include social and societal issues, giving people a clear perspective on what is required and on what is obtained. The more the public understands, the more the trade-offs become acceptable. In this context, the place of decommissioning as the last step of the nuclear life-cycle could be highlighted.

On a local scale, attention should be paid to the environment in which decommissioning activities are conducted. Involvement of stakeholders, informing residents in the vicinity of decommissioning sites will stimulate interest and offer local business and employment opportunities.

## **5 Conclusions on a way forward**

The necessity to progress with the decommissioning of obsolete installations and the perspective of a growing market, particularly in Europe, should be interpreted as positive driver as it creates new industrial opportunities. However, progress will only be guaranteed if the right knowledge, skills and competences can be created as required for undertaking this endeavour. Attention should be paid to:

- ensure an efficient management of the cultural change when starting decommissioning
- plan of the required skills/competences over a long term
- collaborate between the stakeholder organisations
- facilitate mobility of a competent decommissioning workforce in Europe
- share best practices and lessons learned.

The EU industry and organizations would be also helped by a more in-depth assessment of the future of the nuclear decommissioning activities and of their impact on the job market.

A wide spectrum of education and training programmes in decommissioning exists, particularly in the three main nuclear EU countries (UK, France and Germany). There would be a benefit from:

- a harmonisation of the learning outcomes referring to the necessary curricula
- cooperating for shared education and training programmes
- further stimulating the collaboration with the industry.

More particularly, a significant step would be the combined efforts of universities and institutes to create a joint modular training programme in decommissioning that could be practiced at different places in Europe, with well-defined training outcomes.

For the young generation a career in nuclear decommissioning presents many positive aspects:

- a reliable work environment, and almost certain assurance of finding a job after having followed dedicated studies in decommissioning;



- offering perspectives of career development, being it horizontally (variety of projects) or vertically (possibility for growing in responsibilities)
- facing many interesting and always changing technological challenges, mixing competences in various disciplines
- offering possibilities for mobility,
- with finality a 'noble cause', as it aims at restoring a safe environment.

However, these activities and possibilities of careers in nuclear decommissioning are probably currently often 'hidden' or are considered too negatively. Different ways of promotion of decommissioning among the younger generation should be pursued, starting at secondary school level through to the universities.

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