Renewing Skills in Nuclear R&D - opportunities arising from the UK's formation of a National Nuclear Laboratory - 8126

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ABSTRACT

This paper summarises challenges to maintenance of scientific and engineering skills relevant to the nuclear industry in the UK. A number of new initiatives are discussed, included the contribution to be made by the recently announced National Nuclear Laboratory (NNL). Working with both the university sector and major stakeholders in the UK nuclear industry, the National Nuclear Laboratory will bring valuable contributions to the overall skills maintenance approach. It is well suited to the provision of industrially-relevant training and occupies facilities for experimental study of radioactive materials which are unique in the UK. A strong contribution to skills maintenance from the National Nuclear Laboratory will produce benefits across the UK's nuclear industry at an important stage in the country's management of nuclear energy.

INTRODUCTION

It is widely recognised in the UK that a viable nuclear industry is dependent upon a strong technical skill base of scientists and engineers conversant with the particular challenges and constraints of the industry. Since the 1980's there has been a progressive decline in the skill-base, Figure 1, such that in the last 2-3 years there has been a need for new initiatives to remedy the predicted shortfall between supply and demand. This paper describes the need for technical skills in the UK nuclear industry and shows how these are being addressed by various initiatives. Particular attention is given to the formation of a National Nuclear Laboratory and to the role that it will play in renewing the technical skill-base for nuclear in the UK.

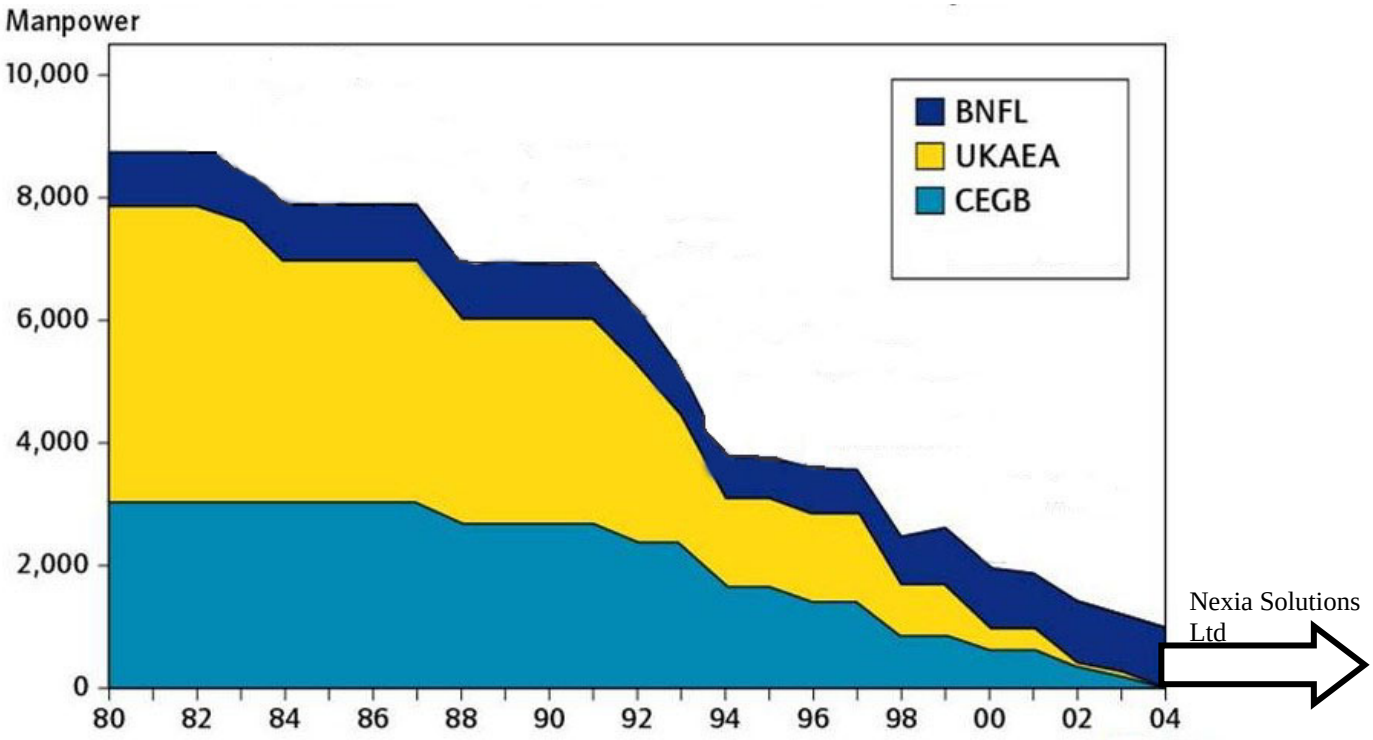

Figure 1 Decline in UK R&D skill base for nuclear

BACKGROUND TO TECHNICAL SKILLS NEEDS IN THE UK

Within the UK, the recent emphasis on clean-up and decommissioning of our nuclear legacy together with the possibility of new nuclear generating stations has underlined the need for action to replenish the skill-base of scientists and engineers. Analysis by the Nuclear Decommissioning Authority (NDA) has summarised the skills challenges to be[1]:

- To fill the gap left by an ageing workforce
- To create a consistent understanding of the long term skills needs
- To ensure competition and the increased use of contractors is not hampered by lack of suitably trained people
- To ensure that the focus of university courses, skills initiatives and standards meets the industry's needs

These challenges apply to all the skills needs of NDA but they are particularly appropriate to the provision of suitably skilled scientists and engineers. Analyses of the needs of new nuclear generation have reached similar conclusions.

The traditional source of supply of scientists and engineers used to be through the grounding provided by R&D programmes. These supplied valuable experience of the context and challenges of the industry and trained young graduates to develop solutions capable of being deployed in the industrial situation. In the UK many technologists were equipped to follow a

variety of career paths on the basis of the training they received in the industry's R&D programmes.

This route remains viable but there has been a significant reduction in the UK's nuclear R&D programmes over the past 15 years. It is therefore no longer sufficient to rely on an informal 'market-led' approach; positive steps are needed to ensure that there will be the required number and quality of trained scientists and engineers.

The challenge of skills provision is one of the reasons why the UK government has been seeking to establish a National Nuclear Laboratory; it will have a role in running strategic R&D programmes and in safeguarding and enhancing key skills.

PROPOSED UK NATIONAL NUCLEAR LABORATORY

The intention was set out in October 2006 to establish a National Nuclear Laboratory based around Nexia Solutions and its 'state of the art' facility at Sellafield in Cumbria[2]. The initial phase of the work to examine the viability of the laboratory is now complete and the NNL will be formally established.

A National Nuclear Laboratory will be able to create opportunities for skills development in ways that would be difficult for companies without such a broad and long term remit. As a government-owned organisation it will take a medium to long term perspective and be able to build relationships between academic institutions and commercial companies in the nuclear industry. Thus it will be able to provide a bridge by which scientists and engineers undergoing academic training will enhance their skills through industrially-relevant research and problem-solving.

THE NATIONAL NUCLEAR LABORATORY'S ROLE IN RENEWING SKILLS

The NNL will have a strong heritage of nuclear-related skills and expertise from its formation out of Nexia Solutions Ltd. This unique skill base was assembled when Nexia Solutions was established out of the former Research & Technology division of British Nuclear Fuels (BNFL). It encompasses the nuclear fuel and waste management expertise of BNFL, the reactor R&T activities of the former Magnox Electric and the nuclear science skills from AEA(T), which was acquired by BNFL in 2003. The result is that Nexia Solutions constitutes the bulk of the UK's remaining civil nuclear fission research capability and all of the significantly active research facilities. An important point is that the NNL will contain the knowledge and experience from more than 30 years of delivering practical solutions which are suitable for deployment in the industrial context.

It is essential to use this experience to enhance the training of new scientists and engineers entering the industry and the NNL is appropriately constituted to allow this to be done. To complement the skills initiatives described above the NNL will bring 2 key elements to the training:-

- Skills development in an industrial context
- Facilities for study of radioactive materials

Skills Development in an Industrial Context

The NNL will operate as a customer-facing organisation and will have a prime aim to deliver solutions that operate in an industrial context. Evidently, such skills are an essential part of developing scientist and engineers for the future and the NNL will respond in 2 ways:-

- Formal training
- Provision of 'hands-on' training & experience

Formal training will deliver the benefit of the NNL's experience through packages and modules as part of university courses, both modules in undergraduate courses and Master degree courses.

Provision of 'hands-on' training & experience

The more valuable aspect of complementing the training of scientists and engineers is through provision of 'hands-on' training. The NNL will provide students with the means to participate in industrial projects while still undertaking academic study. Such experience enhances the learning gained within the academic institution and the NNL's customer-facing programmes are an ideal vehicle to gain relevant experience.

Addressing technical challenges in co-operation with the NNL's experienced researchers will provide an unparalleled learning experience, unlikely to be obtained in either the university or customer environment. Secondments from customer organisations are being explored, by which young technical managers can be involved in a short R&D project so that they can gain insights into the intricacies of delivering solutions for the industrial context. Other opportunities will be developed as the NNL becomes established in its skills programme.

Active facilities

The second contribution that the NNL will make is the capability it can offer to undertake research with radioactive material. The NNL's technology centre in Cumbria has extensive facilities to undertake studies with radioactive material, notably a suite of 5 highly active cells and a suite of gloveboxes for work with high inventories of plutonium and other actinides[3]. Such facilities are both modern and unique within the UK; they offer researchers the opportunity to undertake studies not possible elsewhere.

The trace active laboratories are the largest single suite of active fumehood and glovebox facilities in the UK and they have the ability to handle relatively large quantities of radioactive material. Advantage has been taken of location on the Sellafield site to use the site's effluent treatment infrastructure and low level waste treatment facilities. The result is that the Technology Centre has the ability to undertake a larger number of trace active experiments, with fewer effluent and waste constraints than is possible in any other UK laboratory.

The Technology Centre also houses a uranium active rig hall, including a 25m tower, which is capable of housing large experimental rigs. Programmes in the U-active rig hall are expected to

support fuel manufacturing and certain aspects of reprocessing and waste treatment, where uranium compounds form the major chemical component of the system to be studied. The alpha active facilities, Figure 2, are unique to the UK in terms of the number and size of gloveboxes and the quantities of radioactive material that can be handled.

These laboratories are able to undertake a wide variety of work relevant to advanced fuel cycles and to the recovery and treatment of wastes. Advanced fuel cycle work would be able to include studies on actinide separations by solvent extraction and on molten salt systems for electro-refining of irradiated fuels.

Figure 2 Part of the Alpha-active Facilities in the NNL's Technology Centre

The HA cells, Figure 3, are capable of supporting experiments with a wide range of highly active materials, including irradiated fuel and reactor components. They are well suited to examination of components removed from service, following shutdowns and in-plant inspection. The highly active cells also provide opportunities to make advances in the characterisation and treatment of legacy wastes from Sellafield and other nuclear sites in the UK.
It is clear that the ability to work with actual radioactive materials, such as irradiated fuel, samples of radioactive sludges, plutonium residues, enables the NNL to undertake programmes that can deliver viable solutions to customers.

Figure 3 One of the highly active cells in the Technology Centre

As well as its own programmes of research, which will provide opportunities for skills development, the NNL will also provide access to its technology centre for other researchers. Already the Dalton Nuclear Institute and NDA have an agreement for provision of access to the Technology Centre in order to support its research at the Dalton Cumbria Facility[4].

Consequently, by providing 'hands-on' experience to young researchers in experimental study of radioactive materials the NNL can significantly enhance the training provided. By working within the NNL's own programmes or with R&D programmes of one of our associates, such as the Dalton Nuclear Institute, the training will go beyond merely mechanical learning of procedures and precautions. The researcher will gain insights into the planning and undertaking of experiments that will encompass the scientific goals as well as the safety needs. The experience of addressing the many issues associated with successful experiments using radioactive materials should prove invaluable.

SKILLS INITIATIVES IN THE UK

The NNL will not undertake a role in safeguarding skills on its own but will work in the context of other major training and skills initiatives, which are also part of the UK's response to the need to replenish the technical skill-base. A useful overview of technical training provision is given by the skills pyramid, Figure 4. This defines 4 layers of training of increasing technical depth, from school curricula all the way up to higher degrees. While there is a sound foundation in the national infrastructure, eg. schools, training institutes and universities, a need has been identified to provide nuclear-specific education at key points in the pyramid.

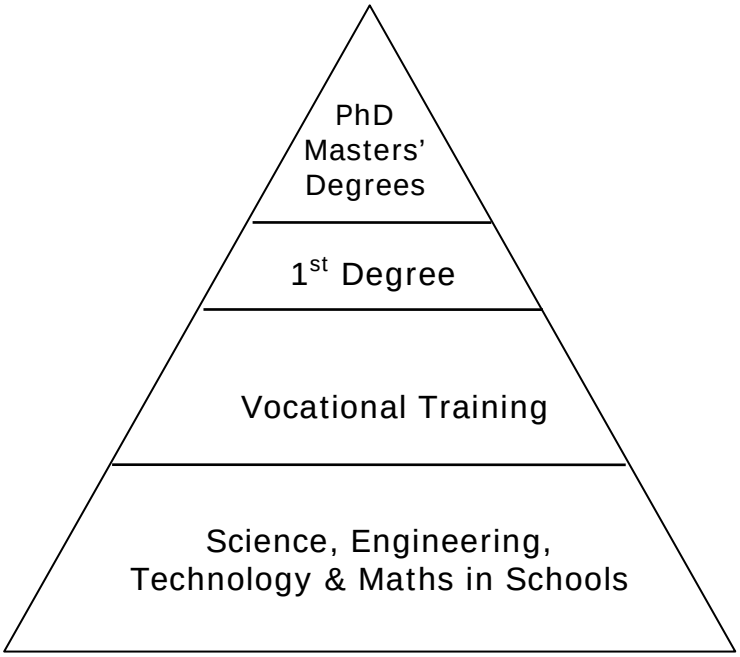

Figure 4 – The Skills Pyramid

Energy Foresight

The NDA has been working with an initiative to improve science education in schools (Energy Foresight)[5]. The aim is to bring an exciting new perspective to the teaching of the Radioactive Materials area of the Physics curriculum. During 2007/8 the programme has been rolled out to over 300 schools. As well as addressing the physics behind radioactivity, the course highlights the employment opportunities in the nuclear industry in health, power, decommissioning, and waste management.

In 2007, Nexia Solutions contributed to a national initiative to raise awareness in engineering among 14-15 year olds. This was part of a series of events run by the Smallpeice Trust and comprised a 3-day long team activity based on a design exercise to devise ways to retrieve sludge from a typical nuclear waste facility. The NNL recognises the value of capturing the interest of young people and will plan to continue this type of involvement along with other companies in the nuclear industry.

National Skills Academy for Nuclear

For vocational skills and training up to just short of first degree level there is a newly launched National Skills Academy for Nuclear[6]. This will provide training across a wide range of skills needed by the nuclear industry, not only technical training, up to foundation degree level.

The National Skills Academy for Nuclear will be based on a hub and spoke model. A small centre at the hub will provide leadership and accreditation and a network of regional specialist nuclear training centres around nuclear sites will deliver the training. The largest centre, 'The Nuclear Academy', will be close to Sellafield, which because of its major decommissioning challenges is expected to be a large skills user

1st Degree Courses

The essential foundation in the training of most professional scientists and engineers is the 1st degree course since it provides the academic discipline on which nuclear-specific training can be built. There has been a decline in nuclear-related degree courses, or indeed degree course with any nuclear component at all. However, Imperial College, in London, is set to reverse this trend by launching a new undergraduate course in Nuclear Engineering. This will be the first nuclear engineering course at degree level in the UK for many years. It will be based upon a combination of teaching in mechanical/chemical engineering and materials science, complemented by nuclear-specific modules occupying the latter half of the course. Nexia Solutions, as the precursor to the NNL, has begun to work with Imperial College to support the course and is a member of the steering group for the course.

Higher Degrees

The provision of nuclear-related training is much stronger in the field of higher degrees with Masters courses in Physics & Technology of Nuclear Reactors, Medical and Radiation Physics, Nuclear Engineering, Radiometrics, Radiation and Environmental Protection, and International and Comparative Nuclear Law. The nuclear industry itself funds PhDs at a number of universities and in recent years there has been funding from the UK government via programmes such a 'Keeping the Nuclear Option Open'. For the latter, a role is being prepared for the NNL through Nexia Solutions' membership of the KNOO board.

The National Nuclear Laboratory will continue to run a series of partnerships with UK universities - known as University Research Alliances. The present 4 alliances have been built by the NNL's predecessor (Nexia Solutions) with input from NDA, to strengthen the academic research base in ways relevant to the nuclear industry. The Alliances are proving to be fruitful centres of research and are responsible post-graduate training through significant numbers of PhD projects.

In addition to the above, there are 3 new initiatives which will strengthen skills provision in the field of higher degrees and these are being led by the Dalton Nuclear Institute.

Nuclear Technology Education Consortium (NTEC)

This is a new concept in postgraduate-level training for the nuclear sector which has been developed by a strong consortium of UK universities and HE institutions[7]. The breadth and format of the training is designed to meet the UK's projected nuclear skills requirements in decommissioning and clean-up, reactor technology, fusion and nuclear medicine.

Together the institutions involved represent more than 90% of the nuclear postgraduate teaching expertise residing in the UK's universities and research institutes. NTEC thus provides a one-stop shop for a range of postgraduate training in Nuclear Science & Technology, which is unparalleled in the UK. The structure and content of the programme leads to qualifications up to Master's level in Nuclear Science & Technology.

Key features of the NTEC programme are:

- It offers an ideal format for employees within the industry
- Leads to a Postgraduate Diploma or Postgraduate Certificate
- Provides great flexibility: part-time or full time
- Direct teaching minimises the time away from the workplace
- Distance Learning option being developed
- It is ideal for employee development

Nexia Solutions is part of the NTEC board and this is a role the NNL will expect to continue. It is clear that the NNL's particular contribution to training will match the style and content of the NTEC course and opportunities to utilise that contribution will be pursued vigorously.

Nuclear Engineering Doctorate

A partnership between Imperial College and the University of Manchester's Dalton Nuclear Institute, has established an Engineering Doctorate (EngDoc) qualification in nuclear engineering[8]. This new initiative is a four-year postgraduate qualification aimed at the UK's best young research engineers. Its aim is to equip them with the skills needed to take on senior roles within the nuclear industry. A key aspect is that up to seventy-five percent of the EngD will be made up of industrial placements, through partnerships with the National Nuclear Laboratory and companies including British Energy, and Rolls Royce. The programme will also be supported by the universities of Bristol, Leeds, Sheffield and Strathclyde, who will provide expertise in specialist areas such as risk management and process engineering. In a similar manner to the NTEC course, the NNL will be able to offer a contribution to high quality R&D training by providing industrially-relevant experience and ability to work with radioactive materials.

Dalton Cumbria Facility

The 3rd initiative with an important skills component is the Dalton Cumbria Facility[4], which is a centre jointly funded by the NDA and Dalton Nuclear Institute. Its aim is to bring world class scientific research to West Cumbria and to establish a link to facilities operated by the National Nuclear Laboratory. The Dalton Cumbria Facility is based at the Westlakes Science and Technology Park, also in Cumbria, and it will complement the well-established work of Westlakes Research Institute in environmental science, health and epidemiology

Research at the Dalton Cumbria Facility will focus on radiation science and engineering decommissioning. The new laboratory will include accelerators and experimental equipment to study irradiation damage and effects on materials and chemical systems used in nuclear environments, as well as cutting-edge computational modelling and simulation tools. Access to the facilities offered by the National Nuclear Laboratory are clearly an important aspect of the Dalton Cumbria Facility and development of this working arrangement underlines the value of the NNL.

SUMMARY

In summary, the UK's National Nuclear Laboratory will have an important role in skills development. It will complement a number of other initiatives and bring 2 essential aspects to successful training and skills development. The strength of this contribution promises to deliver a significant improvement in the nuclear R&D skills base for the UK.

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