Nuclear Skills Strategy Group

Nuclear Workforce Assessment 2017

Summary

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Foreword to the main Nuclear Workforce Assessment

Last year, the Nuclear Skills Strategy Group (NSSG) was delighted to launch its first National Nuclear Skills Strategic Plan.

This confirmed that the much-heralded nuclear renaissance, together with an ageing workforce and continued forecasted high demand across all aspects of the nuclear sector, means we need to take decisive action on skills right now.

This necessitates retaining and nurturing the fantastic skills base we already have, as well as developing a new talent pipeline to meet the requirements of a sector that has a very ambitious programme in the coming decade.

An evidence-based understanding of the skills required, and by when, is fundamentally important to designing a skills pipeline to meet the sectors' skills requirements. The Government needs this Labour Market Information (LMI) to inform policy, the employers to support investment in training and apprenticeships and our education providers to plan and build capacity and capability where it is needed.

This latest NSSG Nuclear Workforce Assessment (NWA) aims to meet these needs. This Assessment is now entirely sponsored by the NSSG member organisations and key partners. They see this clear ownership, alongside their own contribution of refreshed data, as being critical to improving understanding of skills requirements. This will underpin an evidence-based Skills Delivery Plan that will ensure that the skills needed are developed in the right numbers, at the right time and in the right place.

The NWA informs skills planning by providing us with an updated skills timeline for new build, decommissioning and defence activities, as well as a demand picture for the industry over the next two decades. For the first time, our Assessment introduces ground-breaking supply-side planning, using a modelling method that features trainee and industry supply pipelines, that will feed up to 25 different occupations at eight different levels.   This will enable us to develop, in 2017, a number of supply scenarios that will best meet any gap between existing supply and future demand. Again, this is thanks to member and partner investment in new computer simulation capability.

This report, also for the first time, helpfully categorises roles into three distinct groups: subject matter experts (a relatively small number of experts with specialist skills which take a long time to acquire), nuclear skills (specialist skills only required in the nuclear industry) and generic skills (those skills that are most transferable across sectors, particularly relevant to construction activities).

Finally, we are also starting to anticipate skills needs to meet a nuclear future beyond current predictions – including, for example, the introduction of Small Modular Reactors. While these opportunities will take some time to develop, preparation for a new tech skills base needs to start soon, if they are to be fully exploited to benefit of the UK.

We are confident that this Assessment, together with the forthcoming Nuclear Skills Programme Delivery Plan, will address skills risks and allow employers to recruit at the required rate to meet the forward programme and to continue to build a sustainable, world class, nuclear sector.

Dr Fiona Rayment OBE, CChem, FRSC, FNucI
Chair of the Nuclear Skills Strategy Group,
Director, UK National Nuclear Laboratory

Introduction and purpose

This document provides a summary of the 2017 sponsored report to the Nuclear Skills Strategy Group (NSSG) assessing the Nuclear Workforce in 2017 and its forecast requirements over the following two decades.

Key Components, Assumptions and Methodology Overview

The assessment is based on a single scenario for the construction of 16 GWe of new electricity production capacity, together with the ongoing work of the Submarine Enterprise programme. To look beyond the 16 GWe horizon, consideration is also given in the sponsored report to a potential extension to 30 GWe, through the use of other nuclear technologies. For this to be realised, given the long lead times involved, specialist skills need to be developed many years in advance, even though the peak in this phase would occur between 2030 and 2050.

The new nuclear power station build programme has clearly advanced in terms of capital investment and the establishment and growth of project teams. We have now been provided with updated resource figures for the workforce necessary to manage the build programme and operate the facilities. The construction schedule has been reviewed and remains unchanged. Civil and Engineering Construction workforce data for each new build project are based on the Hinkley EPR programme, as in previous assessments. These will be updated when site and technology specific information is made available by each developer.

Primary intelligence has been drawn together from industry sources, but with a greater industry ownership of the data than previously. This has been supplemented with existing Nuclear Industry Association data (NIA) on manufacturing, and with input from CITB and ECITB to help with modelling where required, and to provide overview of the broader context in which the nuclear industry operates.

Most significantly, for the first time, the main report presents initial outputs from the skills supply modelling capability. System Dynamics, a technique that enables the time-dependent response of complex systems to be followed through computer simulation, is being used to model the training pipeline and workforce for the sector. This complements the already established demand side picture, and allows scenarios to be designed that, in turn, inform policy decisions on the level and timing of training and recruitment to meet the nuclear programme.

Although still at the early stages of utilisation, there is a range of valuable potential applications for the analysis it provides. These data could be useful for providers to plan regional delivery programmes or to help flag redeployment opportunities for organisations that are down-turning. The output will also help to model implications of geographic and regional mobility.

Key Developments

Key developments since previous model:

- Improvement to, and completeness of, data including:
    - updated demand forecasts from the decommissioning estate
    - the addition of data from the Defence Infrastructure Organisation (DIO), and their Tier 1 partners, for work they are expected to undertake on behalf of the Submarine Enterprise programme
    - full representation of the Defence Nuclear Safety Regulator (DNSR)
    - improved accuracy of Defence and Engineering Construction data
    - inclusion of specific data for National Nuclear Laboratories

- Development of a single rationalised set of resource codes to be used across the nuclear industry, both civil and defence
- An extension of the role levels utilised from 5 to 8 levels to better model demand at the higher skills levels
- Designation of resource codes as Generic/Nuclear and Subject Matter Experts to help understand nature of skill development required
- Gender diversity data to understand how gender differs between job codes and level and in trainee disciplines
- A break-down of apprentices – numbers and type
- Vulnerability identification- pinch-points plus scarce skill sets and those with a long time to competence
- An improved estimate of the decommissioning supply chain workforce based on a parametric approach to supply chain demand, associated with spend profile converted to typical supply chain resource codes. This data currently only includes supply chain organisation whose main activity is nuclear.
- The web-based technical annex[1] has been updated to provide hyperlinks to
  - Calculations of the recruitment requirement
  - A comprehensive list of nuclear sites, resources codes and role levels used
  - Assumptions and caveats
  - A refined calculation of the Supply Chain calculation

While this forms the most comprehensive picture to date, and a refinement of the analysis presented in 2015, areas remain where assumptions are necessary. All of these will continue to be reviewed, and refined where possible. A detailed list of assumptions and caveats is provided in the Technical Annex[1].

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[1] Technical Annex: http://www.cogentskills.com/about-cogent-skills/research-policy/nuclear-workforce-assessment/

Timeline

The timeline of events on which the data are based is shown in Figure 1. This marks all of the key milestones expected as of April 2017.
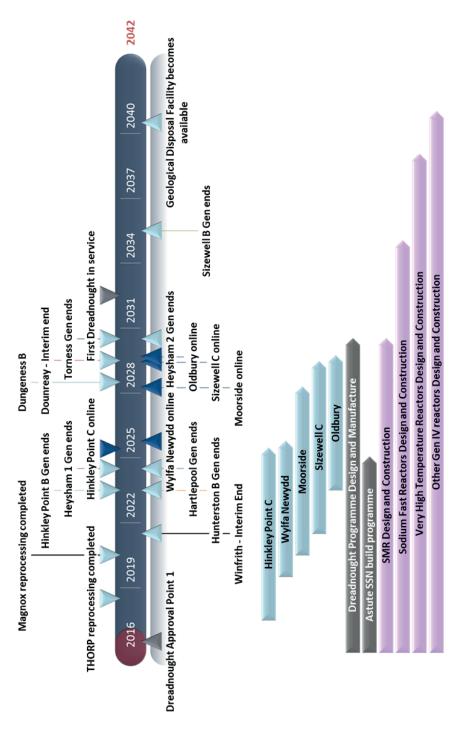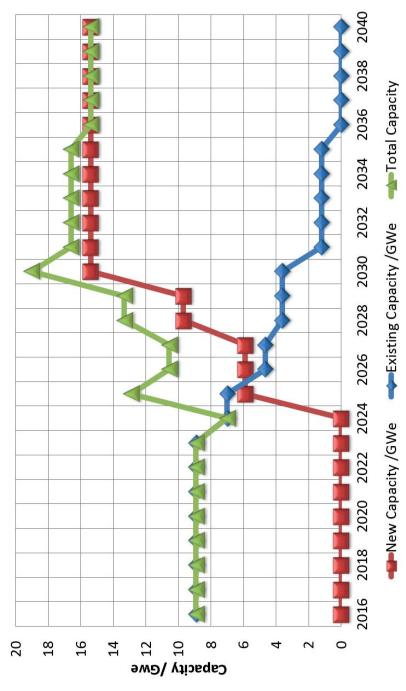

Figure 1 Civil and Defence timeline of expected key events[2]

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[2] At the time of writing, a strategic review of the Moorside programme is being undertaken that may affect the timeline and associated resource demand.

For civil power generation, the planned construction of 16 GWe generating capacity is set to replace the ageing AGR fleet of reactors and, ultimately, the UK's only currently operating PWR. The separate and combined capacities of the retiring fleet, and the development of new plant, is plotted in Figure 2. If the schedule assumed here is adhered to, then the UK capacity for low carbon baseload generation will suffer only a small dip in 2024.
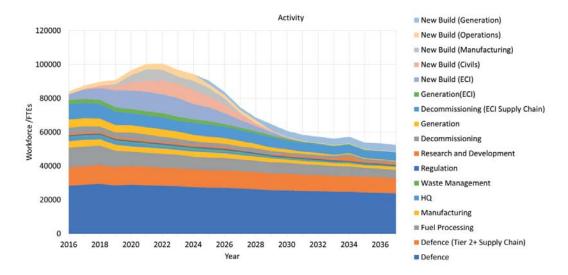
Forecast Nuclear Power Generation

Figure 2 Change in capacity for current schedule based on five new build sites

Key Findings

- Since the forecast civil new build schedule is unchanged from 2015 **the peak** in overall demand remains at **2021.** Changes to the underlying demand data from the existing civil estate have modified the profile leading up to and beyond the maximum

- **The total workforce** programme demand for **2017** is **87560**, although the height of the peak in **2021** is reduced to **100619** by several factors, most significantly a change to the model for the civil Engineering Construction supply chain serving the decommissioning estate

- The existing estate programme demand is now forecast to fall more linearly, with a decrease of around a fifth over the next decade. Nevertheless, **replacement demand averages 1450 per year** over the same period. The overall expected **inflow is c. 7000 FTEs per annum** (not all necessarily long-term appointments)

- Over **80%** of the nuclear workforce uses skills that are shared with other industries

- Occupations where **future pinch points** are considered most likely are
    - Safety Case Preparation
    - Control and Instrumentation
    - Reactor Operation
    - Site Inspectors
    - Project Planning and Control
    - Commissioning Engineers
    - Electrical Engineers
    - Emergency Planners
    - Quality Assurance staff
    - Chemists
    - Given that there have been no changes to the 2015 civils data or analysis at this point, Steel Fixers, Concretors, Civil Engineering Operatives and Scaffolders should also be considered as of concern.

Resource Demand

Summary demand by activity

Figure 3 Overall workforce segmented by industry activity

Figure 3 shows the overall workforce demand based on data for 1 October 2016, segmented by industry activity. The majority of the demand level reflects data collected from the site licence companies, the regulator, new build developers and the defence nuclear enterprise[3].

Fragile Skills

Demand and internal supply analyses are useful methods to quantify skills risks, but they can mask important issues involving small numbers in key areas, or over-estimate risks for larger apparent shortfalls for more readily available personnel. To go some way to mitigate this, data suppliers were asked to risk rate resource codes, in addition to providing quantitative level data. This helps to prioritise areas where action is required. The following table lists the resource codes where the collective response revealed the most significant areas of concern.

Resource Code	Function	Specialism
Nuclear Safety Case Preparation	Engineering	Nuclear
Control and Instrumentation Engineers	Engineering	Generic
Generation	Operations	Nuclear
Regulation Site Inspection	Engineering	Nuclear
Project Planning and Control	Project and Programme Management	Generic
Commissioning Engineers	Engineering	Generic
Electrical Engineers	Engineering	Generic
Emergency Planning	Business Functions	Generic
Quality Assurance	Science Technical Health Safety and Environment	Generic
Chemists	Science Technical Health Safety and Environment	Nuclear
Subject Matter Experts	Range of disciplines	Both

Table 1 Risk areas identified by employers. Given that there have been no changes to the 2015 civils data or analysis at this point, Steel Fixers, Concretors, Civil Engineering Operatives and Scaffolders should also be considered as of concern.
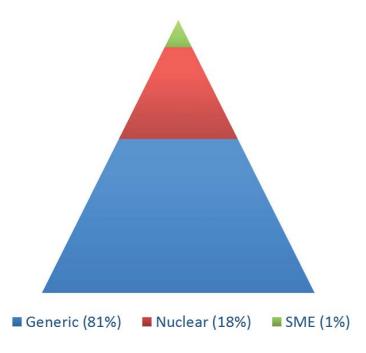
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[3] The Ministry of Defence and industrial partners AWE, BAE, Rolls Royce, Babcock,

Table 1 also includes a label of specialism (Generic skills, Nuclear skills and Subject Matter Experts). Note that only a minority of areas are dominated by skills with a significant nuclear component.

The Skills Pyramid

The Nuclear Skills Strategic Plan used a skills pyramid to classify skills in the nuclear industry into three groups, namely: **subject matter experts** (a relatively small number of experts with specialist skills which take a long time to acquire, including (but not exclusively) high level skills), **nuclear skills** (specialist skills which are only required in the nuclear industry, for example nuclear safety case engineers) and **generic skills** (which may also be at a high level but are equally likely to be found outside of the nuclear industry). These distinctions can be useful in a) identifying those areas where inter-sector transferability might be most straightforward, and therefore the likely impact on 'nuclear context' type development and b) areas where nuclear specificity is important, and might therefore require more specialised training/education.

Definitions can be imprecise at the margins, and the sharp delineation in the pyramid is certainly not realistic, but a generally decreasing number going from Generic to Subject Matter Experts (SME) is accurate. Analysis of workforce data gives the current proportions as Generic 81%, Nuclear 18% and Subject Matter Experts 1%. This emphasises two points: the first is that for a large section of the workforce transfers from outside of the nuclear sector provide a viable supply route; and second, that SMEs represent a challenge of knowledge management rather than volume recruitment.

■ Generic (81%)   ■ Nuclear (18%)   ■ SME (1%)

Figure 4 Skills Pyramid (segment area is proportional to fractional occupancy)

Resource Supply

Gender

As of October 2016, the total workforce is 22% female across all levels and disciplines. However, the civil and defence sectors differ to a statistically significant degree. In the civil industry, around 28% of the workforce is female compared to a corresponding defence figure of 12%.

This overall ratio is broken down by level and by function in the charts of Figure 5. The business functional area has the highest percentage of female workforce at 36%, with the engineering and trades functions being lowest at 15% and 14% respectively. In engineering more generally, the workforce is on average 9% female[4].

In addition to comparisons by functional area, these charts reveal something about the distribution of gender across role levels. Whilst there is some variability, there are a couple of important trends. Firstly there is a general fall in the relative number of women after level 6 in all functional areas, (although it should be noted that the overall populations are also smaller).

Secondly a dip at level 4 exists in the ratio of females to males in several functions. Further investigation would need to be undertaken to explore why this might be the case.
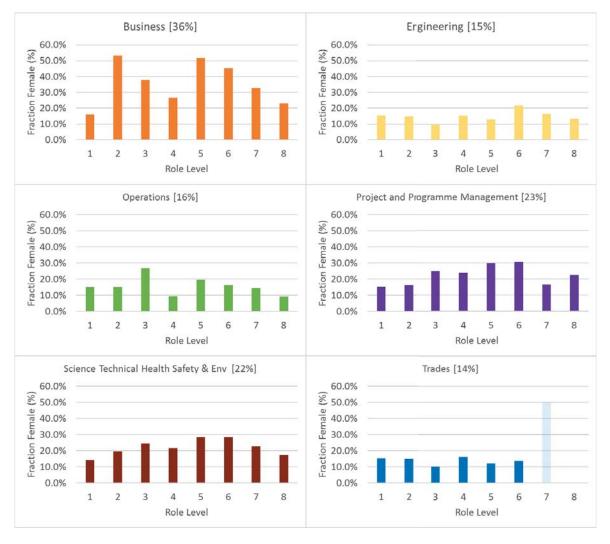

Figure 5 Distribution of female workers by industry function and role level (data for Trades Level 7 is too sparse to be reliable, and for Level 8 zero)

Exploring the gender breakdown of the trainee routes into the industry gives some indication of how

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[4] Women's Engineering Society, revised March 2016, http://www.wes.org.uk/statistics

the balance may be influenced by the latest generation of entrants. The data of Figure 6 compares female trainee occupancy for civil (blue bars) and defence sectors (green bars) and benchmarks both against the current combined civil and defence workforce, (red hatched).
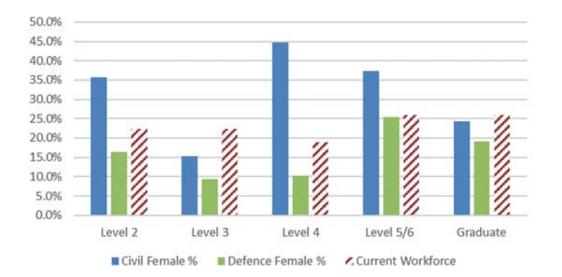
At levels 2, 4 and 5/6, the current trainee population has a greater fraction of females than the existing workforce in the civil industry. At level 4, the female trainee intake (45%) is more than double the proportion of women in the existing workforce (<20%). This will, over time, impact on the total gender distribution, and it is interesting to note that it matches the level 4 dip observed in the overall population data above. At other levels, the female trainee intake is more modest, and will necessarily take longer to impact the trained workforce.

The reassuring intake rate at level 4 nevertheless only represents 16% of the total trainee population, so a difference at this level will still have a limited overall impact. Level 2 intake is 35%, so this is an area where impact could be maximised.

Importantly, even in the best example a 50/50 gender split is not being achieved, making it impossible to achieve a gender balanced workforce by this route alone.

More concerning is that trainee recruitment levels are dropping below the current population at level 3 and at graduate levels, and at all levels in the defence sector.

It is important to consider the context in which this recruitment is occurring. Whilst the gender diversity shown by these data leaves plenty of scope for improvement, it does illustrate that the nuclear industry is doing better than UK engineering as a whole (15% female in the nuclear industry compared to 9% in UK Engineering as a whole).

Figure 6 Comparison of the proportion of females in training and the current workforce

One clear way to influence the balance in the trained workforce would be to increase the proportion of females in the trainee population. The different approaches to influencing this are outside of the scope of this report.
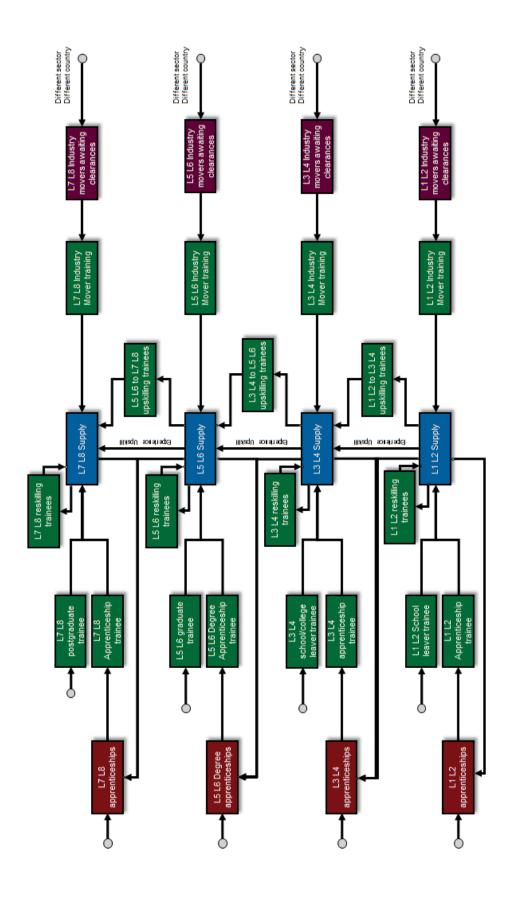
Supply Side Modelling

While the implied recruitment requirement, derived from the programme demand and the projection of the current workforce is useful, a more meaningful gap analysis is only possible when the total supply is considered. Arguably, it is only the gap between demand and supply that is important in developing skill programmes. However, the variety of potential supply routes makes this a complex task. Over a period of 7 months we have collaborated with industry to develop a sophisticated model with the flexibility to represent different training and recruitment scenarios – and to test them. A high priority has been given to ensuring that all reasonable factors affecting supply have been built-in from the outset; attrition routes, delay mechanisms, interactions between different parts of the supply pipeline, and so forth. This is a detailed process but important in making the model robust, flexible and able to grow with increasing understanding of the industry's supply mechanisms.

Employers' HR specialists have helped in verifying the structure and establishing some of the fundamental controlling parameters. The technical testing of the model is now complete, as scheduled, and a programme of full implementation is underway.

Developers such as EDF NNB point to the opportunities in transferring skilled workers between sites with offset construction phases. The model provides the opportunity to determine training scenarios that can use an excess in one area to support rising demand in another. This will be a focus of the modelling in 2017 and beyond.

A simplified schematic of the model is given in Figure 7, showing the principal stocks, flows and relationships. For clarity, attrition routes and delay mechanisms are not shown. More details on the model and initial outputs are available in the sponsored report.

Figure 7 Simplified model of a skills supply side for the nuclear industry

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Industry Context

The nuclear industry renaissance is taking place against the backdrop of both a large, well-developed decommissioning activity, and a significant defence programme. Large parts of the supply chains are distinct, but equally strong overlaps exist.

Whether on different projects within the same sector, or between civil and defence sectors, many of the skills requirements are the same, or similar. It follows that there is great benefit in ensuring that the development and utilisation of skills happens in an efficient and cost-effective manner. Understanding the mobility of skills, and how that knowledge can be applied to the phasing of projects, will be essential in supporting the industry and strengthening those skills currently regarded as fragile.

Future technologies

To date, detailed workforce models have focused on the demand requirement to support the 16 GWe of generation capacity supported by the government's 2011 National Policy Statements and reviewed in Generic Design Assessments. However, options also exist to extend capacity using different nuclear technologies with potential benefits with regard to resilience, the fuel cycle, waste handling and overall efficiency.

This would, to some degree, extend both the type and volume of skills required, but also make the expertise available for international export. Although planning for nascent technologies is at an early stage, many skills will have a long lead time because of the absence of an existing applied skill base from which to build. Consequently, these options are being carefully considered from a skills perspective and will form part of the NSSG delivery programme.

A very positive benefit of extending civil nuclear development is in providing sustained demand for nuclear skills, with the career attraction and more resilient knowledge base that that brings.

Nuclear Skills Strategy Group

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