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RENAISSANCE NUCLEAR SKILLS SERIES: 3

Assurance

Skills for Nuclear Defence

The Renaissance series:

Renaissance 1 *– Power People: The Civil Nuclear Workforce*
Renaissance 2 *– Next Generation: Skills for New Build Nuclear*
Renaissance 3 *– Assurance: Skills for Nuclear Defence*
Renaissance 4 *– Illuminations: Future Skills for Nuclear*

cogent
The National Skills Academy NUCLEAR
The strategic skills alliance for the Nuclear Industry

Rear Admiral Simon Lister OBE

Director Submarines

Over the past ten years, and more, there has been significant scrutiny of the policy and strategy underpinning the UK's Defence Nuclear Programme. Emerging from this scrutiny is a programme that endures over and beyond the period considered by this report. A programme which, as the earlier reports in Cogent's Renaissance Nuclear Skills Series show, will need to be delivered alongside anticipated growth in the UK's civil nuclear sector as the older power generating stations are decommissioned and new stations are built and brought into service.

Safe and successful delivery of these programmes in both the civil and defence nuclear sectors will raise the UK nuclear industry's overall demand for appropriately skilled and qualified people to levels not experienced by the industry for over 30 years. Meeting this increased demand and sustaining the skilled workforce at the required levels will be extremely challenging.

The nature of these challenges and the responses to them will vary across the industry. In particular, it is to be anticipated that the demands and constraints specific to the civil and defence nuclear sectors will promote differences. However, there is much common ground and this is sufficient for the UK nuclear industry, across both civil and defence sectors, to develop and apply strategies and processes for workforce assessment, planning, management and development. This will ensure that the UK nuclear industry not only meets the workforce challenge that it faces, but does so effectively and efficiently.

It is important for the Ministry of Defence and its industrial partners to work closely with Cogent, the National Skills Academy Nuclear and other bodies to develop the right solutions for delivering and sustaining the UK's nuclear industry workforce. Solutions that address and promote the recruitment and training of graduates and apprentices, the development and up-skilling of mature recruits, or established members of the workforce, and the mobility of staff within the industry.

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Downloadable report:
www.cogent-ssc.com/research/nuclearresearch.php

Executive Summary

Assurance: Skills for Nuclear Defence

After more than 60 years of exploitation in both civil and defence sectors, nuclear energy production remains a critical technology; and the skills to support it a strategic resource. At a time when the demand for low carbon baseload electricity generation has resulted in plans for the largest civil nuclear building programme for several decades, the UK Submarine Enterprise Programme is engaged in supporting the current fleet of nuclear submarines, constructing one replacement class, and planning for the eventual replacement of another. This report, the third in a series of four covering the nuclear industry in the UK, identifies the level of defence nuclear skills demand in terms of the nuclear Job Contexts already reported for the civil sector.

The military use of nuclear technology resides wholly within the submarine fleet, which itself is divided into two submarine designations; the nuclear deterrent platform (Ship Submersible Ballistic Nuclear - SSBN), and hunter killer attack submarines (Ship Submersible Nuclear - SSN). While both use compact pressurised water reactors, the former also carries nuclear warheads that, together with the Trident missile delivery system, form the UK nuclear deterrent.

The 2006 defence white paper, *The Future of the United Kingdom's Nuclear Deterrent*, concluded that by 2024 there would be insufficient SSBNs in operation to continue the posture known as Continuous At Sea Deterrence. It also judged that for a replacement the interval from detailed concept work to first patrol would be about 17 years.

The coalition government formed in May 2010 initiated a new strategic review, which reported on 19 October 2010. Defined more widely than the preceding 1998 assessment, the Strategic Defence and Security Review (SDSR) crossed departmental boarders and was carried out under the auspices of a new National Security Council. The most significant change to the submarine building programme, which arose as a consequence, was a delay to the replacement of the Vanguard class of around four years. In contrast, the programme for the construction of seven Astute class SSN submarines, to replace the Trafalgar and Swiftsure flotilla, was left unchanged. At the time of writing, the first two Astute vessels have been launched, with the remainder at various stages of construction. Completion is expected by 2022.

The data presented within this report were collated by Deloitte in 2009 from AWE, Babcock Marine, BAE Systems, the Ministry of Defence, Rolls Royce and the Royal Navy, on behalf of the Ministry of Defence. To make the data consistent with those collected from the civil sector, Deloitte continued the use of the Job Context taxonomy devised by Cogent and first reported in *Power People: The Civil Nuclear Workforce 2009 - 2025*.

Underpinning the work was the assumption that the following key activities would need to be supported:

- the continuation of existing long and short term overhaul programmes of the operational submarine fleet
- decommissioning of submarines coming out of service
- construction of the Astute 'Hunter Killer' SSN class
- conception, design and construction of a successor SSBN launch platform for the nuclear deterrent missile

Excluding any changes arising from the SDSR, projected workforce levels to 2025 remain comparatively constant. This reflects the policy of operating a steady 'drumbeat' of submarine construction which, among other things, stabilises skill demands. **The total workforce level in 2010/11 is predicted to be around 15,000, of which the Royal Navy forms some 29%**.

The chief determinant in the demand for defence nuclear skills is the shape and size of the Submarine Enterprise Programme. Although this has been consolidated over the last few years into a clear ambition of seven Astute hulls and 3 or 4 Vanguard replacement boats, the 2010 SDSR and the political and financial context in which it has taken place, makes the final outcome uncertain. Variations from the assumed building profile will not only affect the skills demand for construction, it will also have an indirect impact on areas such as decommissioning and maintenance, especially inspection and re-validation activities, as the existing fleet is pressed into longer service. Nevertheless, as it stands, the completion of the Astute fleet seems to be on track.

The supply of nuclear skills is further complicated, at least in some areas, by the likelihood of a major civil nuclear generation programme over the same 15 year period. Nevertheless, here too, investment and planning decisions make the magnitude of the demand difficult to determine. The experience of the submarine building programme in the early years of the century suggests that a substantial break in submarine construction will interrupt the skills pipeline. Although demand will initially decrease, later reinstatement of the programme will be limited by a lack of immediately usable skills, increasing the training demand.

Long term waste disposal is an issue for both the civil and defence sectors. Spent fuel from submarine reactors is currently stored at Sellafield alongside that produced from reprocessed fuel from electricity generation. This is a medium term solution. A skill demand exists now for longer term solutions to high and intermediate level waste management, although this is likely to continue to be shared with the civil sector.

A substantial fraction of the total skill supply is formed from Royal Navy personnel. The RN recruitment system applies a sophisticated model to take account of long term future demand, promotion requirements and wastage rates. This vertical training structure leads to a long tenure and a large time lag between recruitment and attainment of the highest skill level (Expert).

While the Defence Nuclear Programme forms a critical 25% of the total current UK demand for nuclear and nuclear related skills, there are a number of significant differences with respect to the civil sector. Nevertheless, the benchmark this analysis provides is valuable in recording the current state of the industry in terms which can be cross-referenced to its civil counterpart.

Whatever changes to the exiting submarine building plan are implemented, the near term will still generate, as a minimum, demand based on operations, decommissioning and the execution of existing contracts. Moreover, the safety and technology requirements of operating a nuclear fleet represent a substantial fixed staff overhead and make the support numbers reasonably insensitive to minor changes in hull numbers.

Chapter 1:
Assurance

Submarine Enterprise Programme

- *Overhauling the operational fleet*
- *Decommissioning*
- *Construction of 7 Astute Class submarines*
- *Conception, design, construction of Vanguard replacement*

Policy

- *On-going Continuous At Sea Deterrence*
- *Strategic Defence and Security Review 2010*
- *Vanguard replacement Main Gate decision 2016*
- *Strategic skills and operational independence*
- *Improving commercial relationships*

1. Assurance

1.1 Introduction

Nuclear technology is a potent energy source, and unique in being common to both civil electricity generation and defence nuclear weapons and submarine propulsion. While there are, naturally, significant differences between the defence and civil sectors, there also remains a high degree of overlap in terms of the nuclear skills required. The beginning of the second decade of the century is a pivotal time for nuclear skills in the UK. Within the civil sector, there is very high aspiration from the utilities and vendors to construct new capacity, set against a rapidly increasing demand for low carbon electricity. Defence nuclear capability, similarly, has a large programme of planned construction and on-going operations. This confluence of nuclear activity has nevertheless formed at a time of considerable financial uncertainty. If the highest aspirations of the two sectors are realised, there will be a major increase in demand for nuclear skills. In the most conservative scenario there remains an on-going demand for decommissioning and operational skills in both arenas. Here, we seek to provide a benchmark based on government nuclear defence plans developed between 1998 and 2010, and against which new plans may be calibrated.

The report is the third in a series of four, working with industry and government to help ensure that the projected demand for nuclear skills in the UK can be met. The first, *Power People: The Civil Nuclear Workforce 2009 - 2025*[1] assessed the macro skills picture of the existing estate, and its likely development in the light of an ageing workforce. The central finding of the study, even within the most modest plan for replacement of nuclear generating provision, was that the rate of attrition will require an active skills development policy in order to avoid a critical deficit. In bringing together skills data from a number of different industrial sources, hundreds of job functions were mapped to a matrix of 13 Job contexts and 5 skill levels. This made tractable the comparison of different specific jobs and functions.

The mapping was continued in the second report, *Next Generation: Skills for New Build Nuclear*[2], for which the Nuclear Energy Skills Alliance[3] was formed to identify the skills demand for new build, the capability and capacity issues that will arise, and to initiate a risk register of the most at risk skills.

This third report moves the focus to the defence sector where many of the nuclear skills overlap. In common with its civil counterpart, the strongest determining factor as to the overall shape of the defence nuclear programmes is government policy. Beyond current operations, there is a need to define future military requirements and to manage the supply of nuclear skills accordingly.

The data presented were collated by Deloitte in 2009 on behalf of the Ministry of Defence. Underpinning the work was the assumption that the following key activities would need to be supported:

- the continuation of existing long and short term overhaul programmes of the operational submarine fleet
- decommissioning of submarines coming out of service
- construction of the Astute 'Hunter Killer' SSN class
- conception, design and construction of a successor SSBN launch platform for the nuclear deterrent missile

This combined suite of activities, including its oversight by the Ministry of Defence and its support through the first tier supply chain, forms the Submarine Enterprise Programme.

1.2 Policy Review

The current UK nuclear defence arrangements derive ultimately from the 1958 *UK-US Agreement for Cooperation on the Uses of Atomic Energy for Mutual Defence Purposes*, which details the circumstances under which materials, information and equipment related to nuclear weapons and propulsion can be exchanged. The maintenance of a UK independent nuclear deterrent, and the tactical advantages of nuclear propulsion, have engaged the UK in nuclear operations in both weapons and propulsion over five decades, now reflected in the latest version of the agreement, signed in 2007[4].

1.2.1 The UK Independent Nuclear Deterrent

In 1963, the Polaris Sales Agreement (PSA) provided a specific shared, but independent, submarine based nuclear missile system. Following the replacement of Polaris by Trident, the agreement was amended in 1982 to set up a mingled ownership protocol, whereby missiles are selected at random from the US stockpile at Kings Bay, Georgia. Warheads, designed and manufactured at AWE Aldermaston are fitted to the missiles at the Royal Naval Armaments depot at Coulport.

The UK nuclear deterrent operates according to a philosophy of minimum assured deterrence, which makes use of submarines to make the launch point extremely difficult to track. The strategy uses the principle of Continuous At Sea Deterrence (CASD) and has operated since the introduction of the Polaris system in 1968. By having an operational nuclear launch platform constantly available, it is also judged that the escalatory risk of sailing a submarine as a response to an increased

1 *Power People: The Civil Nuclear Workforce 2009 – 2025, Cogent 2009*
2 *Next Generation: Skills for New Build Nuclear, Cogent 2010*
3 *The Nuclear Energy Skills Alliance comprises: Cogent Sector Skills Council, National Skills Academy for Nuclear, Department of Energy and Climate Change, Department for Business Innovation and Skills, Engineering Construction Industry Training Board, ConstructionSkills, Nuclear Decommissioning Authority and SEMTA*
4 *Treaty between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the United States of America concerning defense trade cooperation: London and Washington, 21 June and 26 June 2007, Cm 7213, September 2007*

threat is avoided. In practice the policy is executed by a flotilla of four vessels arranged such that one submarine is on operational patrol while the remainder are in different states of pre- and post- patrol preparation and maintenance. In NATO nomenclature, the combination of nuclear propulsion and ballistic weapons results in the designation Ship Submersible Ballistic Nuclear – SSBN. Since 1998, the SSBN vessels providing continuous patrols have been the four boats of the Vanguard class, launched between 1992 and 1998: Vanguard, Victorious, Vigilant and Vengeance.

Following the withdrawal from service of the RAF's WE177 free-fall nuclear weapon in 1998, all UK nuclear weapon capability has been concentrated in the submarine based Trident system, whose effectiveness is predicated on combining a long range ballistic missile with the ability to patrol any part of the globe, undetected. HMS Vengeance, the fourth and last of the Vanguard class SSBN submarines, was launched in the same year. The 2006 defence white paper, *The Future of the United Kingdom's Nuclear Deterrent*, concluded that by 2024 there would be insufficient SSBNs in operation to continue the posture of CASD.[5] It also judged that for a replacement the interval from detailed SSBN concept work to first patrol would be about 17 years, based on the experience of designing, manufacturing and deploying the existing submarine based deterrent.

1.2.2 The Hunter Killer Fleet

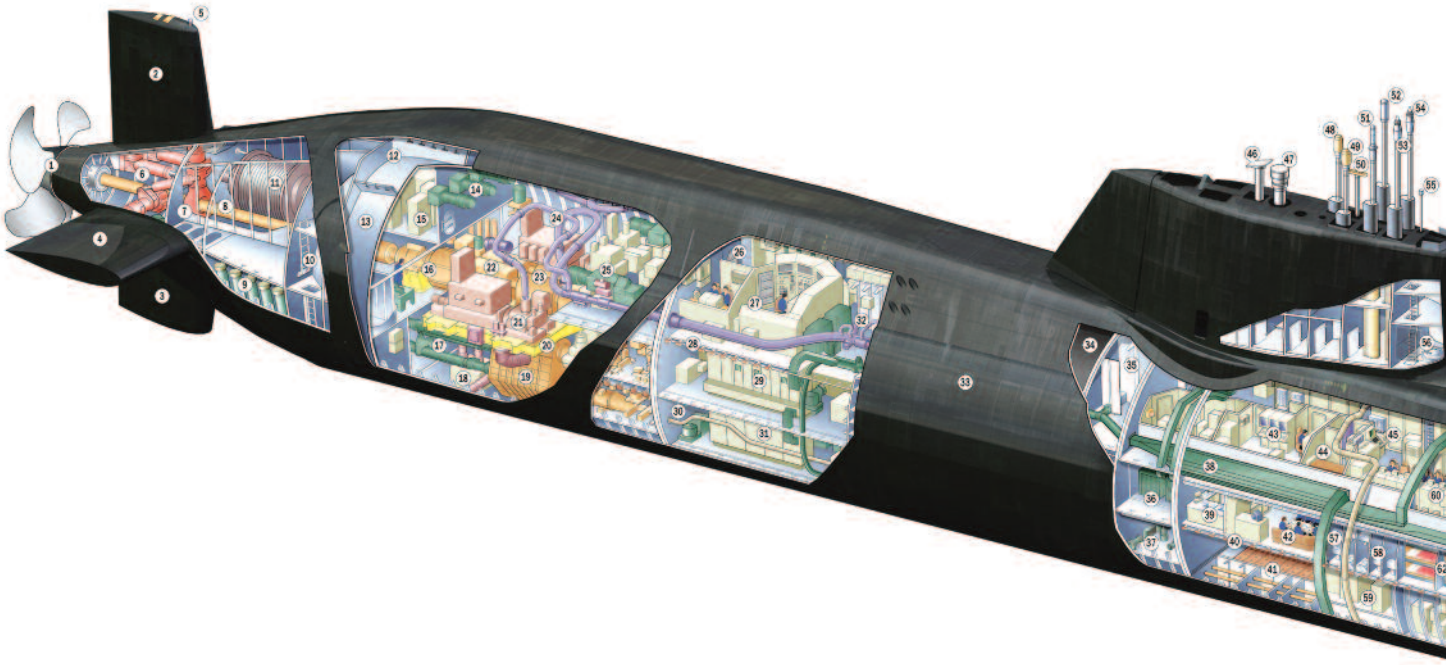
The second nuclear strand of Royal Navy operations is the role played by Hunter Killer submarines – Ship Submersible Nuclear, or SSN – of which the Astute class (figure 1.1) is the latest to be produced in the UK, designed as the replacement for the Swiftsure and Trafalgar classes. In contrast to the singular Trident launch platform function of the Vanguard class, the Astute fleet and its predecessors are designed for a range of operations from surveillance, to surface warfare and anti-submarine operations. Nuclear propulsion again allows for wide geographical deployment with minimal risk of detection. The boats carry conventional weapons, but represent the state-of-the-art in terms of instrumentation and crew facilities.

The last of the Swiftsure fleet was taken out of service in 2010. A phased withdrawal of the Trafalgar class has also begun, with the first of class vessel having ceased operations in late 2009. The remainder of the Trafalgar fleet will be progressively decommissioned over the period to 2022.

HMS Astute, was launched in November 2009, followed by Ambush in January 2011. The third and fourth boats are now under construction, and the fifth has been ordered (table 1.1). Long lead time components for a sixth Astute class submarine were ordered in March 2010. The Strategic Defence and Security Review provides confidence that seven hulls will be constructed, consistent with the original plan.

[5] Defence White Paper – The Future of the United Kingdom's Nuclear Deterrent, Cm 6994, December 2006

Figure 1.1
Astute cut-away



1. Shrouded Propulsar
2. Upper Rudder Segment
3. Lower Rudder Segment
4. Starboard Hydroplane
5. Aft Anchor Light
6. Rudder and Hydroplane Hydraulic Actuators
7. No.4 Main Baliast Tank
8. Propeller Shaft
9. High Pressure Bottles
10. No.3 Main Baliast Tank
11. Towed Array Cable Drum and Winch
12. Main Ballast Vent System
13. Aft Pressure Dome
14. Air Treatment Units
15. Naval Stores
16. Propeller Shaft Thrust Block and Bearing
17. Circulating Water Transfer Pipes
18. Lubricating Oil Tank
19. Starboard Condenser
20. Main Machinery Mounting Raft
21. Turbo Generators, Port & Starboard
22. Combining Gearbox
23. Main Turbines
24. Steam Delivery Ducting
25. Aft Equipment Compartment
26. Watertight Bulkhead
27. Manoeuvring Room Citadel
28. Manoeuvring Room Isolated Deck Mounting
29. Switchboard Room
30. Diesel Generator Room
31. Static Converters
32. Main Steam Valve
33. Reactor Section
34. Part of Pressure Hull
35. Forward Airlock
36. Air Handling Compartment
37. Waste Management Equipment
38. Conditioned Air Ducting
39. Galley
40. Fwd Section Isolated Deck Mountings
41. Batteries
42. Junior Ratings' Mess
43. RESM Office
44. Commanding Officer's Cabin
45. Port Side Communications Office
46. Diesel Exhaust Mast
47. Snort Induction Mast
48. SHF/EHF (NEST) Mast
49. CESM Mast
50. AZL Radar Mast
51. Satcom Mast
52. Integrated Comms Mast
53. Visual Mast - Stbd
54. Visual Mast - Port
55. Navigation Mast
56. Bridge Fin Access
57. Junior Ratings' Bathroom
58. Senior Ratings' Bathroom

Table 1.1
Astute Class build status - June 2011

Boat	SSN	Status June 2011[6]
1	Astute	Sea Trials
2	Ambush	Launched 6 January 2011
3	Artful	Outfitting
4	Audacious	Under Construction
5	Tbc	Initial build
6	Tbc	Long lead time items ordered
7	Tbc	Planned[7]

59. Battery Switchroom
60. Control Room Consoles
61. Sonar Operators' Consoles
62. Senior Ratings Bunks
63. Medical Berth
64. Weapons Stowage and Handling Compartment
65. Sonar Array
66. Maintenance Workshop
67. Sonar Equipment Room
68. Forward Hydroplane
69. Hydroplane Hydraulic Actuator
70. Hydroplane Hinge Mounting
71. Ship's Office
72. Junior Ratings' Berths
73. Torpedo Tubes
74. Water Transfer Tank
75. Torpedo Tube Bow Caps
76. Air Turbine Pump
77. No.2 Main Ballast Tank
78. High Pressure Air Bottles
79. Forward Pressure Dome
80. Weapons Embarkation Hatch
81. Gemini Craft Stowage
82. Hinged Fairlead
83. Anchor Windlass
84. No.1 Main Ballast Tank
85. Anchor Cable Locker
86. Bow Sonar

[6] Ministry of Defence communication, June 2011
[7] No change to the original proposal for seven hulls has been proposed

1.2.3 The evolution of government policy

A number of papers have been published by government since 1998 updating policy, fundamentally based on a continuation of the existing approach, but developing some strategic aspects. The first of the series was a 2003 defence white paper[8] that recognised the finite lifetime of the Trident system but deferred a decision on its replacement until the following parliament. This was followed in 2005 by the publication of a Defence Industrial Strategy[9], which made the case for retaining

"sovereignty over industrial skills to ensure operational independence".

In drafting an overarching defence white paper in 2006, the government took the view that, while the end of the cold war has made a reduction in the nuclear arsenal both justified and desirable, the overall geopolitical environment still made an independent UK nuclear deterrent system necessary into the 2020s.[5]

Four options were considered:

- cruise missile equipped aircraft
- silo-based ballistic missiles
- surface ship based ballistic missiles
- submarine based ballistic missiles

The first two options were judged to be both costly and vulnerable, while ballistic missiles launched from a surface ship would provide no significant cost advantages over a submarine platform.

The paper went on to conclude that a decision on the replacement, or refurbishment, of the Trident warhead was required in the 2010-2015 parliament, and earlier rather than later since the expectation was that contracts would be placed in the period 2012 to 2014. Nevertheless, the number of replacement submarines remained a question to be determined only once detailed design information was available. In terms of the missile system, the paper argued that the decision on participating in any US programme to develop a successor to the current design (designated D5) was not necessary until the 2020s. Subsequently, a House of Commons motion to retain a strategic nuclear deterrent beyond the life of the current system was carried.

Each of the four Vanguard class SSBNs has a service life of 25 years. The first of the fleet, HMS Vanguard, began its service life in 1992, with HMS Victorious following in 1994. Given a permitted five year extension, these two vessels are due to end their active duty in 2022 and 2024 respectively. While there is on-going consideration as to whether CASD can be effectively maintained with as few as three boats, some level of replacement was considered necessary for the policy to continue in its present form.

Since the early stages of the Astute programme, it has been acknowledged that the recruitment and retention of skills greatly benefits from a steady 'production line' of submarines. This point was made explicit in the 2006 white paper[5]

"There are also risks that, in the event of a significant gap between the end of design work on the Astute-class conventional role nuclear submarines and the start of detailed design work on new SSBNs, some of the difficulties experienced on the Astute programme would be repeated because of the loss of key design skills."

Future skills planning has since been strongly influenced by this recognition; a feature clearly visible in the projections presented here.

It remains the case, however, that the form and timing of any replacement programme remains a high profile political decision, and one heightened by strong pressure to reduce the total spent on defence, including the Trident programme.

In February 2010, the government published a consultative Green Paper[10], *Defence, Adaptability and Partnership: Issues for the Strategic Defence Review*. The paper does not refer to Trident explicitly although the role of a nuclear deterrent is still regarded as critical. It makes no comment on personnel numbers, or equipment, but acknowledges that resource constraints require a comprehensive review of the defence programme. The Vanguard based deterrent system costs around 5-6% of the overall defence budget.

Table 1.2
Chronology of government policy development 1958 to 2010

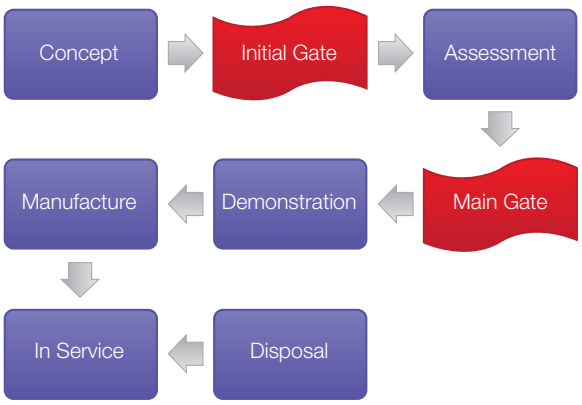
Date	
1958	UK-US Agreement for co-operation on the uses of Atomic Energy for mutual defence
1963	Polaris sales agreement with the USA
1968	Continuous At Sea Deterrent begins
1998	Beginning of submarine only launch platform
1998	Strategic Defence Review
2003	White Paper *Delivering Security in a Changing World*
2005	White Paper *Defence Industrial Strategy*
2006	White paper *The Future of the United Kingdom's Nuclear Deterrent*
2010	Green Paper *Adaptability and Partnership: Issues for a Strategic Defence Review*
2010	Strategic Defence and Security Review

The coalition government formed in May 2010 initiated a new strategic review, which reported on 19 October 2010. Defined more widely than the 1998 review, the Strategic Defence and Security Review (SDSR) crossed departmental boarders and was carried out under the auspices of a new National Security Council[11].

8 *Defence White Paper - Delivering Security in a Changing World, Cm 6041, December 2003*
9 *Defence White Paper – Defence Industrial Strategy, Cm 6697, December 2005*
10 *Ministry of Defence, Adaptability and Partnership: Issues for the Strategic Defence Review, Cm7794, Session 2009-2010*
11 *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review*

Procurement of a replacement submarine class is required to follow the so called CADMID cycle (figure 1.2) for large government projects: Concept, Assessment, Demonstration, Manufacture, In-service and Disposal. Within this sequence are 'gates' where the viability of the project is re-assessed before further resources are committed and the project allowed to continue. An initial gate is positioned between Concept and Assessment, and a main gate between Assessment and Demonstration.

Figure 1.2
CADMID procurement cycle



The initial gate was first scheduled for September 2009, however in January 2010 this milestone was still reported to be 'several months away'[12] Expectation of the ultimate approval of the initial gate improved within the SDSR process. A number of other measures were also outlined with a view to reshaping the spending profile for the replacement programme, although some were, simultaneously, responses to broader political drivers. In the review, the following policy changes were announced with respect to the Vanguard replacement

- deferral of a decision on replacing the Trident warhead until after 2015
- reduction of the warhead stockpile to a maximum of 180, with no more than 120 being operationally available
- reduction of the number of warheads on each submarine from 48 to 40
- reduction of the number of missile tubes on each boat from 16 to 8
- main gate decision to be made around 2016
- further lifetime extensions to be granted to the Vanguard boats to allow them to operate to the late 2020s or early 2030s with a first replacement scheduled to be available in 2028.

The Strategic Defence and Security Review calculates overall savings of 1.3 billion GBP and a deferral of a further 2 billion GBP, with the most significant change to the submarine building programme being a delay of around four years with respect to the previous SSBN timetable. Importantly, the government also refers to saving up to 900 million GBP through,

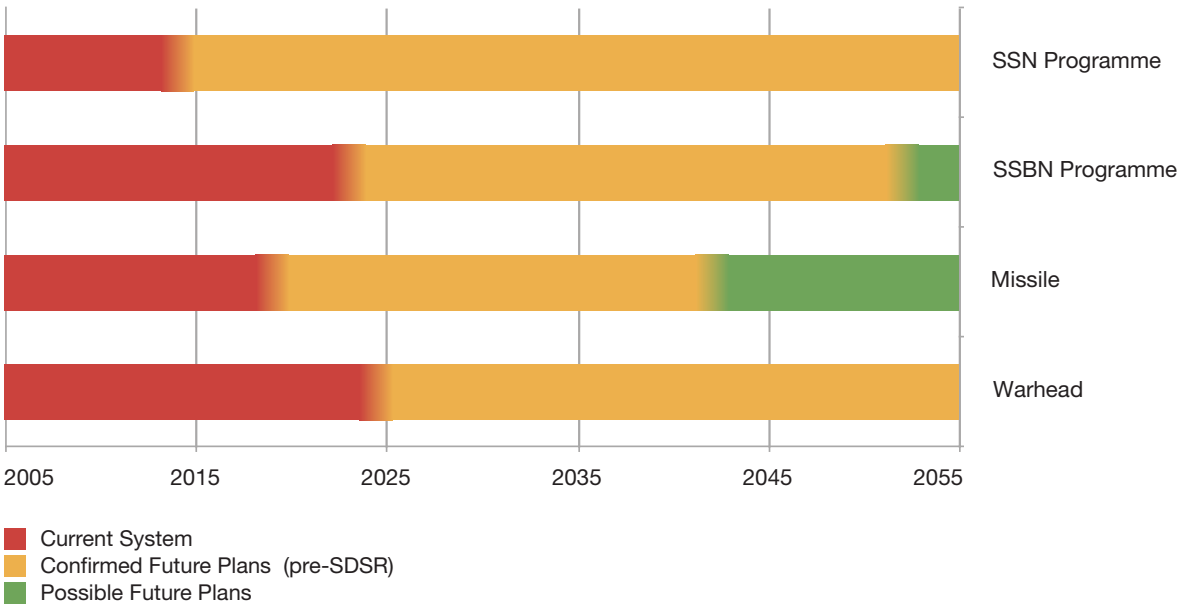
"…working closely with our industrial suppliers to improve commercial arrangements and efficiency."

In contrast to delays to SSBN replacement, the review still refers to seven Astute vessels, with no changes proposed to the construction schedule.

Clearly, the re-profiling described in the SDSR will have an effect on the skills demand for the Submarine Enterprise Programme, but the details have yet to be determined. The timeline for the programme, on which the data that follows is based, is shown in figure 1.3.

Figure 1.3
A base-line indicative timeline - not including changes arising from the SDSR.

Indicative Timeline for Future UK Submarine Enterprise Programme



[12] Quentin Davies: Hansard T7 309597 11 January 2010

1.2.4 International context

Some gauge of the positioning of the UK fleet within the NATO alliance can be made by comparison with the French and US nuclear fleets. All three nations operate both SSN attack submarines and SSBN deterrent platforms.

France

In late 2006, the French Defence Ministry awarded initial contracts with the intention of procuring six Barracuda class SSN submarines, a similar number to the Astute fleet. The first of the class will be delivered in 2017 and the remainder at 2 year intervals (a rate comparable with that intended for the Astute fleet). These will replace the four existing Rubis, and two Amethyst, boats.

Unlike the UK, the French nuclear deterrent is distributed across both air and marine launch platforms, although SSBN submarines account for around 80% of the arsenal. Le Triomphant, the most recent boat procured, was received by the French Navy in September 2010. It is estimated that the French nuclear defence budget is 9.5 to 10% of the national total, compared to 5 – 6% in the UK.

USA

The United States submarine fleet is considerably larger than those of the French and UK. Fifty-three SSN boats[13] operate from three classes: Los Angeles – 43, Seawolf – 3, Virginia -7. Five further Virginia class submarines are in construction.

The total US deterrence programme also employs air and land launched systems, although the submarine fleet forms the largest single component hosted by fourteen boats of the Ohio class[14]. Each submarine can carry 24 Trident II D5 missiles.

1.2.5 Support of the existing fleet

Both SSN and SSBN submarines are powered by pressurised water reactors (PWR) designed by Rolls Royce. Two designs, PWR1 and PWR2 have been implemented, with a total of five core developments to date. The latest, core H, for PWR2 is fitted to the Vanguard and Astute submarines and has sufficient fuel to obviate the need for time consuming refuelling operations.

Nevertheless, continued operational effectiveness and reliability requires, in addition to in-service maintenance and Operational Docking Periods, a schedule for planned large-scale replacement of key components, the inspection and re-validation of safety critical items and the upgrading of systems to reflect on-going technological advances.

At the end of life, the submarine is prepared for storage afloat, whilst a long term disposal option is resolved. This process is known as Defuel, De-equip and Lay-up Preparation and is conducted by Babcock Marine.

1.3 Scope

This report considers the data collated by Deloitte, against Job Contexts previously defined by Cogent, to quantify the current and predicted skill demand in the defence nuclear industry. Against a background of an active nuclear submarine building and maintenance programme, this analysis regards the first tier civil supply companies, along with the Ministry of Defence and the Royal Navy, as the direct UK defence nuclear work force. Although not exact, this is a reasonable parallel with the operators, utilities and vendors involved in civil electricity generation discussed in the other reports in the Cogent Renaissance series.

The workforce and skill levels reported have been informed by the nuclear defence policy, as it has developed over the last decade or so. The effects of the policy decisions outlined in the SDSR have yet to become clear, but these data form the baseline from which they can be judged.

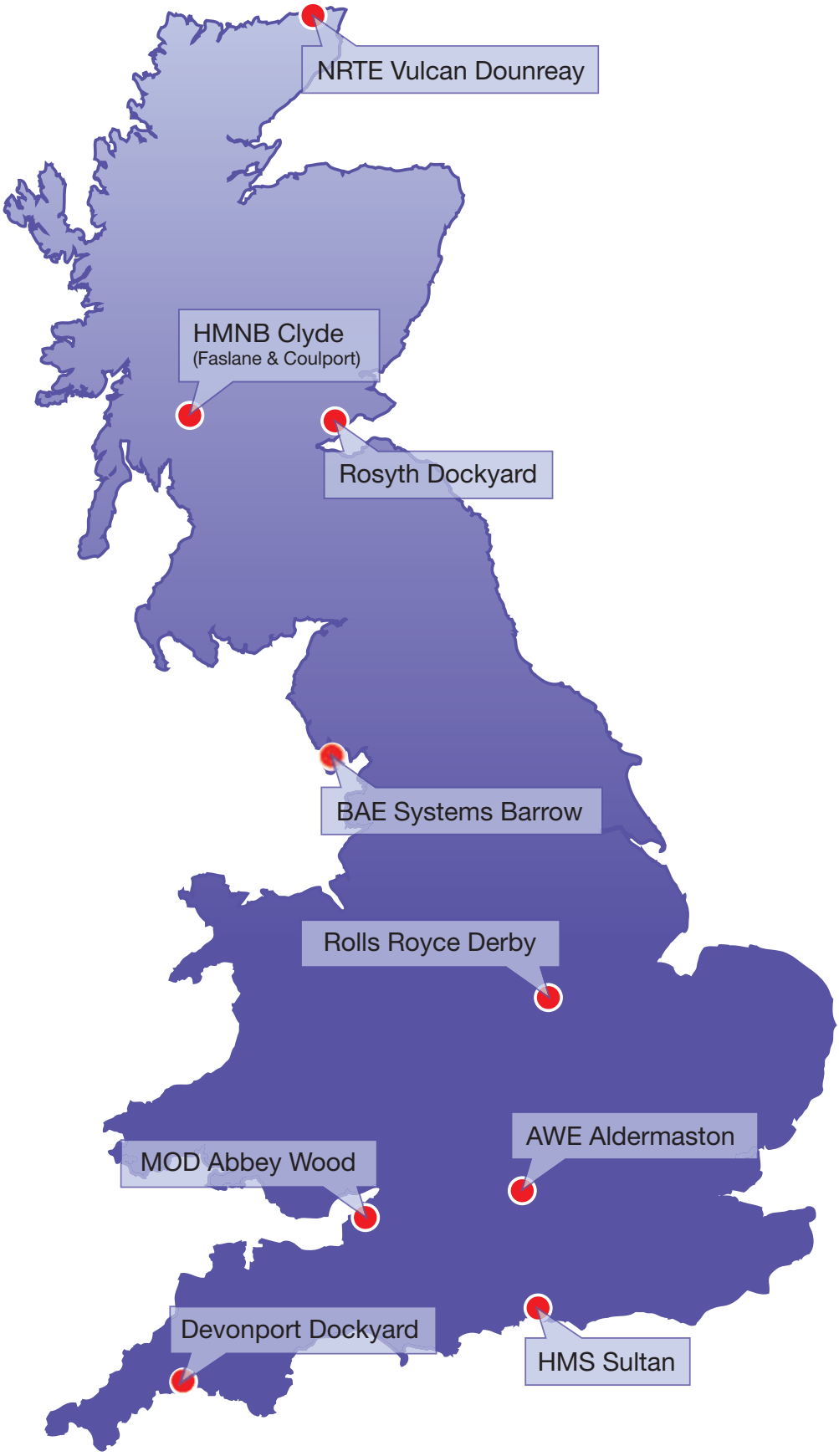
As collected, the data represent demand and supply at the level of individual employer, functional work area, job context and skill level. Future predicted levels have been calculated on the basis of recruitment and attrition rates supplied by the employers. The input of individual employers has been aggregated in the analysis developed here.

1.4 The Supply Chain

The defence nuclear programme is supported by a number of commercial enterprises, equipment testing facilities and personnel training centres located in England and Scotland (figure 1.4). In principle, the civil companies providing nuclear components, vessel fabrication, support systems and system integration can be regarded as the first line supply chain for the Ministry of Defence.

13 *United States Navy Fact File, Attack Submarine - SSN*
14 *United States Navy Fact File Fleet Ballistic Missile Submarines - SSBN*

Figure 1.4
Key nuclear defence operations in England and Scotland



1.4.1 Atomic Weapons Establishment (AWE) plc

AWE plc is managed on behalf of the Ministry of Defence by a private company, AWE Management Limited, formed from three equal shareholders – Serco, Lockheed Martin and Jacobs Engineering Group.

The company is responsible for the day to day operations, and in particular the maintenance, of Britain's nuclear stockpile, while the sites and facilities themselves remain in government ownership.

Overview of performance is maintained by the Ministry of Defence, in conjunction with defence and civil nuclear regulators, to ensure high safety, environmental and security standards. Originally awarded in 2000, the contract is now set to run until 2025.

AWE's contract covers the entire life cycle of nuclear warheads; from initial concept, assessment and design, through to component manufacture and assembly, in-service support, and finally decommissioning and disposal. These activities are carried out under nuclear site operating licenses and discharge authorizations maintained by the company.

The work programme is executed by over 6,500 scientists, engineers, technicians, crafts-people, safety specialists and business support staff. Around 4500 are directly employed, the remainder being contract workers.

AWE plc has two major sites, both in Berkshire: AWE Aldermaston and AWE Burghfield.

The headquarters is located at the 750 acre site at Aldermaston, which also hosts research, design and manufacturing facilities. A second 225 acre site at Burghfield is used for final assembly and maintenance of the warheads while in service, as well as their decommissioning.

1.4.2 Babcock Marine

Babcock Marine provides operational support for the Royal Navy's submarine fleet at Devonport, Clyde and Rosyth.

Devonport Royal Dockyard is used for refitting, refuelling and decommissioning operations including Long Overhaul Period (Refuel) – LOP(R) and defueling, decommissioning and lay-up preparation.

LOP(R) is a significant operation where the critical path is defined by the reactor refuelling process. The fitting of Core H will remove this element. The overhaul period includes the replacement of key components, for example main coolant pumps and instrumentation. Weapon systems are also upgraded and accommodation refurbished during this work.

Babcock Marine also supports the operational submarines at HM Naval Bases at Devonport and Clyde.

Rosyth Dockyard was previously a refit dockyard for nuclear submarines and now operates primarily as a support dock for surface ships, in addition to storage for decommissioned submarine hulls (lay-up). No further submarines are due to be decommissioned or stored at Rosyth.

1.4.3 BAE Systems Submarine Solutions

As well as being responsible for the design, build and initial in-service support of the Astutes, Submarine Solutions is also home to the Future Submarine Programme office, where a collaboration made up of BAE Systems, Ministry of Defence, Rolls Royce and Babcock Marine personnel are working on a concept design for a successor to the Vanguard class. The company is the only UK builder of nuclear submarines.

Submarine Solutions employs approximately 5,100 people across the UK in:

- Barrow-in-Furness
- Devonport
- Filton
- Faslane
- Farnborough
- Ash Vale (Farnborough)
- Waterlooville
- Derby
- Weymouth

1.4.4 Ministry of Defence / Defence Equipment & Support

Responsibility for the procurement of defence equipment including SSN and SSBN submarines resides with the Defence Equipment and Support (DE&S) executive of the Ministry of Defence. The organisation was formed in 2007 with the merger of procurement and logistics operations and the focus of operations at Abbey Wood, Bristol. By 2012, on pre-SDSR assumptions, DE&S will employ around 20,000 staff covering all aspects of defence procurement from personal equipment to the contract and programme management of the Submarine Enterprise Programme. Half of these will be accommodated at Abbey Wood.

1.4.5 NRTE Vulcan

The Nuclear Reactor Test Establishment Vulcan has been used to test the operation of submarine reactor cores since 1965. Core H, now being fitted to the Astute class submarines and being back-fitted to Vanguard Class, currently occupies the Shore Test Facility. Owned by the Ministry of Defence, and operated and managed by Rolls Royce with a workforce of more than 250, the facility is used for safety and evolving technology testing, and for proving operational equipment.

1.4.6 Rolls Royce Submarines

Rolls Royce has a history of collaboration with the UK nuclear submarine programme dating from 1959 when, under the 1958 US-UK Mutual Defence Agreement, the company used a Westinghouse design as the basis of the PWR1 pressurised water reactor. By the mid 1960s Rolls Royce was self-sufficient in design capability. The company has been the sole supplier of submarine reactors (PWR1, PWR2 and incremental variants) to the Royal Navy since that point.

Employing over 1,000 engineers in nuclear propulsion activities, Rolls Royce maintains capability in:

- Design
- Stress analysis
- Structural integrity assessment
- Safety case development
- Non-destructive examination
- Thermo-hydraulic analysis
- Materials
- Chemistry

1.5 Royal Navy Facilities

1.5.1 HM Naval Bases

The Submarine Enterprise Programme currently uses two naval bases for its range of operations; Devonport and Clyde; both provide operational support. (Devonport Dockyard is the location for long overhaul period maintenance and final decommissioning within the Submarine Enterprise. Rosyth Dockyard is now used solely for the lay-up of decommissioned hulls).

Table 1.3

HM Naval Base	Function
Devonport (Plymouth)	Operations and Operational Maintenance Base port for Trafalgar class
Clyde (Faslane + Coulport)	Operations and Operational Maintenance. Future Base port for all SSNs and SSBNs (from 2015). Storing, processing, maintenance and issue of Trident weapon system

1.5.2 HMS Sultan

HMS Sultan is a shore based training facility in Gosport, Hampshire that hosts the Nuclear Department of the Defence Academy, and the Nuclear Systems Group of the Royal Navy School of Marine Engineering. Together these schools provide nuclear education and training for military and civilian personnel engaged in the Naval Nuclear Propulsion programme (NNPP) on shore and on submarines. Courses include reactor physics, nuclear engineering, radiation protection, nuclear safety and systems training. Levels range from basic awareness to MSc. The facilities also include basic and high fidelity simulators, and laboratories to provide practical experience. Some education and training is also provided to personnel from the civilian nuclear industry.

Chapter 2:

Skills Today and Tomorrow

- *15,000 personnel in defence nuclear workforce*
- *⅔ of the level of the directly employed civil sector*
- *¼ of the total current UK nuclear workforce*
- *Royal Navy forms ~30% of the defence nuclear workforce*
- *Large project management skills demand*
- *Submarine Training and Education Programme covers MOD and major suppliers*
- *Contemporaneous civil and defence construction expected*

2. Skills Today and Tomorrow

2.1 Roles and Skills

The data that form the core of this report were collated from across the Defence Nuclear Programmes by Deloitte as part of the Submarine Enterprise Skills Mapping model. It is intended that this will identify the skills requirement until 2025, a time scale that potentially includes a successor to the Vanguard fleet, the delivery of Astute class together with the maintenance of the existing Vanguard and Trafalgar fleet and care of the decommissioned submarines.

Power People: The Civil Nuclear Workforce 2009 – 2025 analysed the existing nuclear estate using a set of 13 job contexts, acting as a repository for hundreds of individual job descriptions used by nuclear companies. In this report, the taxonomy is largely preserved to allow comparison between the civil and defence sectors. However some minor modifications have been applied. For example, the tenth category (Business) has not been used and the fifth category (Safety and Security) is only used by some companies (the remainder including the safety and security function within other Job Contexts). Necessarily, this introduces some distortion and compromise which affects both the numerical precision of the Defence sector data and the fidelity of the comparison of these data with those from the Civil sector.

The job contexts are:

- Energy Production Operations
- Decommissioning Operations
- Process Operations
- Maintenance Operations
- *Safety & Security*
- Radiation Protection
- Project Management
- Engineering Design
- Scientific & Technical Support
- *[Business]*
- Construction
- Waste & Repository Operations
- Commissioning

A full description of the skills supply and demand requires the Job Contexts to be placed against a set of skill levels. In the case of the civil sector reported in Power People, this used five levels (Semi-skilled, Skilled, Technician, Professional, Senior Manager) defined with respect to Standard Occupational Codes. Within the Ministry of Defence a different, three level, classification is used, namely: Awareness, Practitioner and Expert (APE). This was used by Deloitte as the unified classification across the organisations surveyed, although within their own operations and Human Resource systems other levels are normally used. Broadly, the correspondence is:

Awareness:	NVQ Levels 1/2
Practioner:	NVQ Levels 2/3
Expert:	NVQ levels 4/5

2.2 Segmentation

The Submarine Enterprise Programme recognises functional workforce groupings associated with major systems, equipment and major capital assets, as follows:

- Nuclear Propulsion
- Nuclear Weapons
- Strategic Weapons
- Combat Systems
- Platform Systems
- Facilities

A further, operations-based functional group is:

- Royal Navy

Each functional group contains one or more of the nuclear job contexts. Naturally, the populations of the job contexts within the workforce groupings varies between organisations, depending on the core business.

2.2.1 Nuclear Propulsion

The power source for nuclear submarines is a unique application of a complex and safety critical technology. Space is severely constrained, safety systems need to respond to the operational status of the vessel and refuelling needs to be minimised.

The Rolls Royce PWR1 reactor was fitted to Valiant and Resolution. A final PWR1 core design fitted to the Swiftsure and Trafalgar fleets provides improved reliability and time between refuelling. A successor design, PWR2, has been designed for larger Vanguard boats, and provides six times the power output of the original PWR1 core and four times the service life. Core H, is now fitted to the existing Astute SSNs, it will be standard fit in the future[15] and is being back fitted to the Vanguard Class. The longevity of this reactor provides a significant change in the operational cycle in that no refuelling is required during standard service life.

2.2.2 Nuclear Weapons

Each of the Vanguard class submarines can carry up to 16 Trident II D5 missiles with a variable number of warheads to allow some degree of control over the size of a nuclear strike. The stockpile of warheads under UK control is around 200, reduced from 300. Following the Strategic Defence and Security Review, and assuming that a successor class is procured, the number of missiles will be reduced to 8 and the stockpile of warheads to 180.

2.2.3 Strategic Weapon Systems

These are the systems supporting the delivery of the nuclear warheads. They include the missiles and their integration with the submarine and its systems; providing for safe onboard storage, targeting and launch.

[15] Rolls Royce: http://www.rolls-royce.com

2.2.4 Combat Systems

These are the systems which provide the submarine with its capability to "fight" both offensively and defensively. They allow the submarine to detect and classify threats and targets, and to launch weapons and countermeasures. They include systems for communication, sensing, navigation, data processing and display, and weapon launch. The Combat System function also provides for the integration of the individual combat systems with each other, with the submarine platform and with its weapons and countermeasures. Combat systems may also, on a wider definition, include conventional tactical weapons. Trafalgar, Vanguard and Astute classes carry Spearfish wire guided torpedoes. Trafalgar and Astute classes are further armed with Tomahawk Cruise missiles with conventional warheads. The Astute class weapons load is 50% greater than the preceding Trafalgar class[16]

2.2.5 Platform Systems

These systems deliver the float, propulsion and manoeuvring functions of the vessel and provide for crew habitability and platform safety. Many are unique, in the maritime domain, to submarines. All pose particular challenges through the levels of integrity, safety and quality demanded.

2.2.6 Facilities

Facilities include shore supporting infrastructure such as shiplifts, graving (dry) docks, jetties and berths, along with their cranage and electrical and mechanical services to support nuclear submarines where the demands on their integrity and performance are high.

2.2.7 Royal Navy

Operation and first-level maintenance of the UK's nuclear submarine flotilla is performed by service personnel from the Submarine Branch of the Royal Navy. Naval personnel are also engaged across the MoD in a non-operational capacity, undertaking a range of managerial, technical and advisory roles alongside their civilian colleagues.

2.3 The Workforce Today

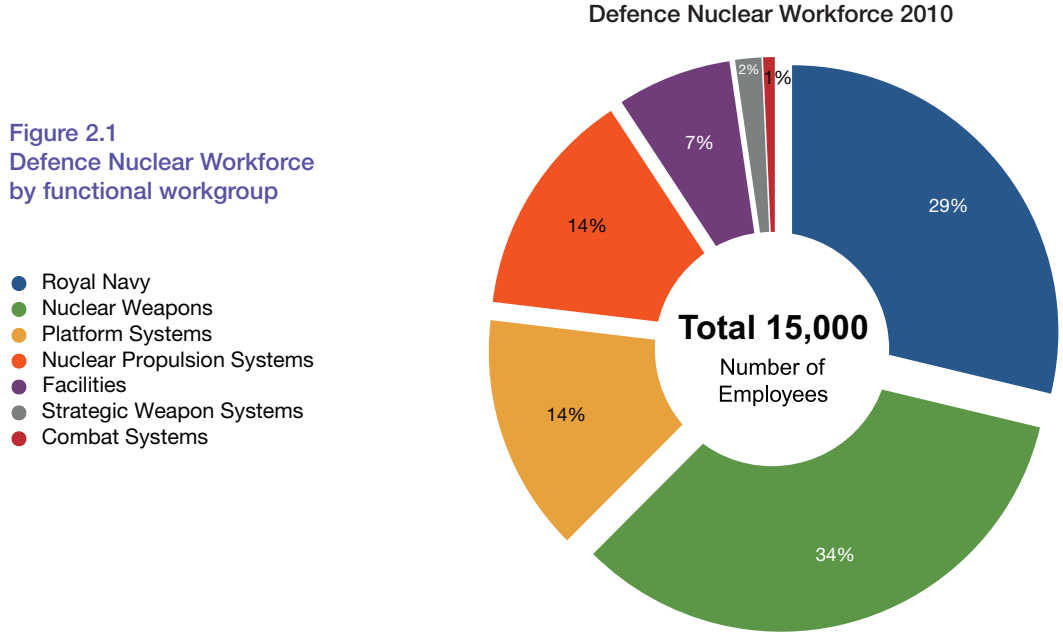
In 2011 the total Defence nuclear workforce comprises, at the Tier 1 level, over 15,000 personnel supporting a range of functions, over a combination of SSN (nuclear propelled, but conventionally armed) and SSBN (nuclear propelled nuclear deterrent) vessels. The equivalent civil workforce is around 23,500 but the upper tiers of both civil and defence sectors are supported by a broad supplier-base some of which is common but larger overall for the civil sector. Although smaller, the demand for nuclear skills in defence forms a very significant fraction of the UK total. This is not to say that a direct correspondence exists all areas, but the level, broad competences required and job appeal put many aspects on the same footing, at least outside of the Royal Navy where the military bottom-fed entry and progression routes apply.

Figure 2.1 shows the breakdown of the current defence nuclear workforce (construction and operations) by functional workgroup. Platform and Weapons form nearly half (45%) of the total, with the Navy constituting 29%.

Some RN personnel are employed in the predominantly civilian sectors of the MoD; in some cases interchangeably with their civilian equivalents. In the data presented, the overwhelming majority of RN personnel are accounted for in the Royal Navy functional group. Some, however, are included in the employee totals for other functional workgroups. The numbers involved are relatively small and any distortion of the analysis is correspondingly low.

The data collected also relates only to those employed at Tier 1 level in the Submarine Enterprise. In some functional workgroups, more of the work is undertaken further along the supply chain where the numbers of those employed do not contribute to the numerical analysis. Hence workgroups, such as Combat Systems, present as a proportion of the Enterprise workforce that may seem, intuitively, too small.

Figure 2.1
Defence Nuclear Workforce by functional workgroup



[16] BAE Systems Astute Leaflet

Figure 2.2 segregates the same total workforce against job contexts, which allows a comparison with the civil sector. Energy production (for nuclear propulsion), Maintenance and Scientific and Technical support form the largest specialisms and collectively amount to over half of the total complement.

It is notable that the data collected show more people are employed in the energy production in the defence sector than the civil. For the defence sector, numbers in this Job Context are dominated by the inclusion of those RN personnel serving in operational submarines; the majority of whom are categorised as Awareness level as each member of the submarine crew requires a degree of knowledge of the nuclear propulsion systems. A civil sector new build programme on the scale assumed by the industry and described in the second Cogent nuclear report, *Next Generation: Skills for New Build Nuclear* would double the operational demand.[2]

The role of the defence nuclear industry in on-going construction of the Astute class is represented in the large project management cohort, which is at an equivalent level to the civil sector, but a larger proportion of the defence total. A further defence job context which is notably high, in both absolute and percentage terms, is Scientific and Technical support. This is associated particularly with weapons maintenance and development, and also reactor production. Skill levels in these areas are weighted towards Practitioner and Expert levels.

It should be recalled that data on the defence business function are not available and also that Safety and Security data workforce data have only been provided in selected areas.

Figure 2.2
Nuclear Workforce – Job Contexts Civil and Defence

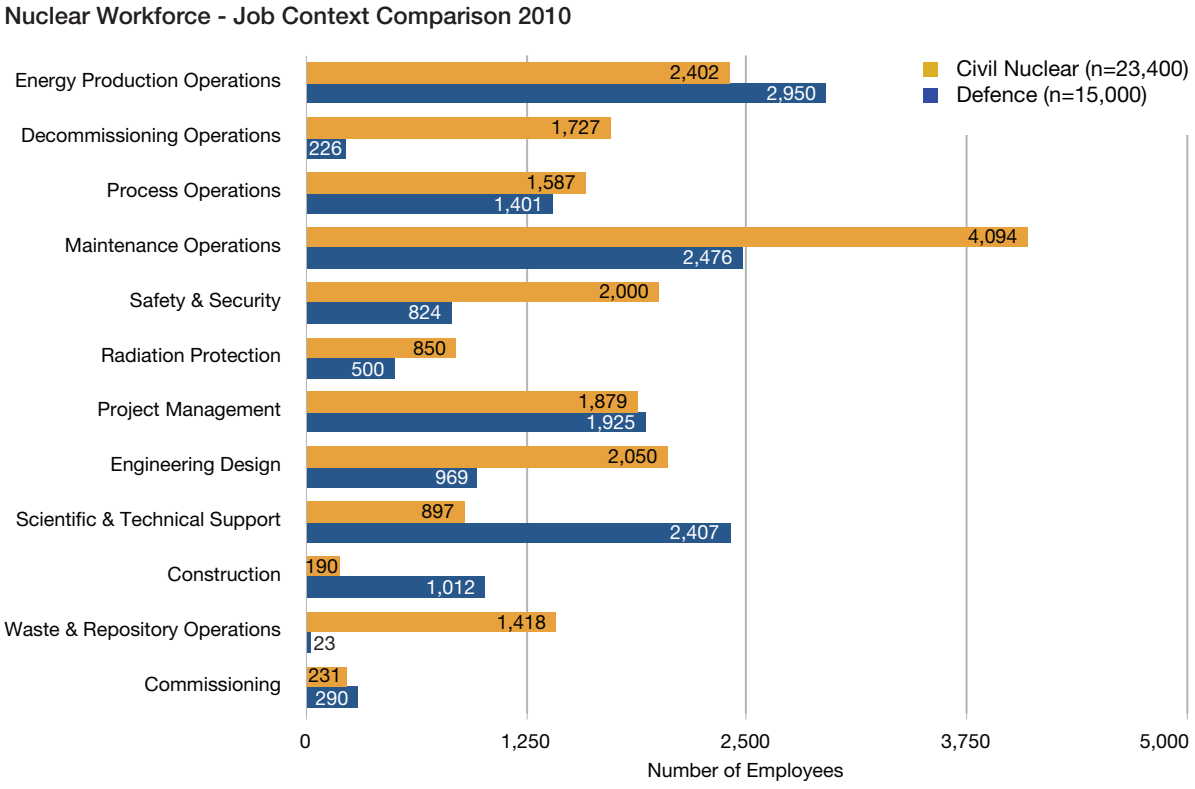


Figure 2.3

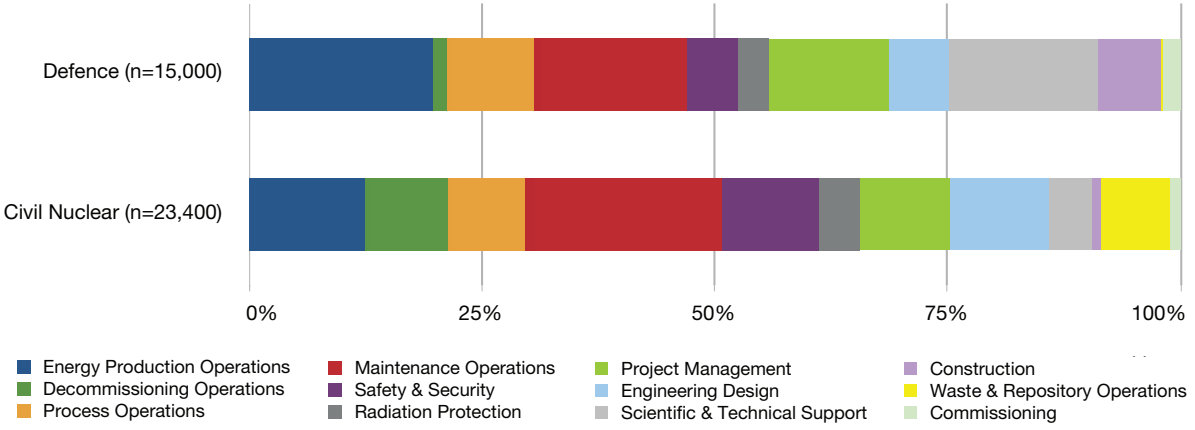


Figure 2.3 shows the proportionate distribution of the job contexts in the two sectors. This reflects the particularly strong roles for Energy production, Project Management and Scientific and Technical support.

2.4 The Workforce into the Future

Project and workforce planning in submarine construction has been very heavily influenced by the experience of restarting a submarine building programme in 2002 after a number of years with no construction. With no fundamental change to the government's position on the UK's independent deterrent, and required global reach still implying a role for an advanced hunter-killer fleet, planning has for some time assumed a steady drumbeat to retain a constantly renewed, but maintained skill supply level. This is manifest in the evolution of the functional workforce levels illustrated in figure 2.4. It should be emphasised that for all companies the data were a fair representation of the expectation at the time they were supplied, but long term planning in particular should be seen as being most exposed to impact from changes to funding and priorities.

With the exception of the Nuclear Weapons team, and to a much lesser extent Facilities, demand is essentially constant. The dominant change is downwards and results in a predicted decrease in the total of around 1,000 or 7%. Over 900 of these are related to the decrease in nuclear weapons staff as envisaged in 2009. One consequence of the financial challenges posed by the SDSR is likely to be a need to reduce further the workforce employed by the Defence Nuclear Enterprise. The net change in the predicted workforce from 2010 to 2025 is shown in figure 2.5

Figure 2.4
Workforce demand forecast

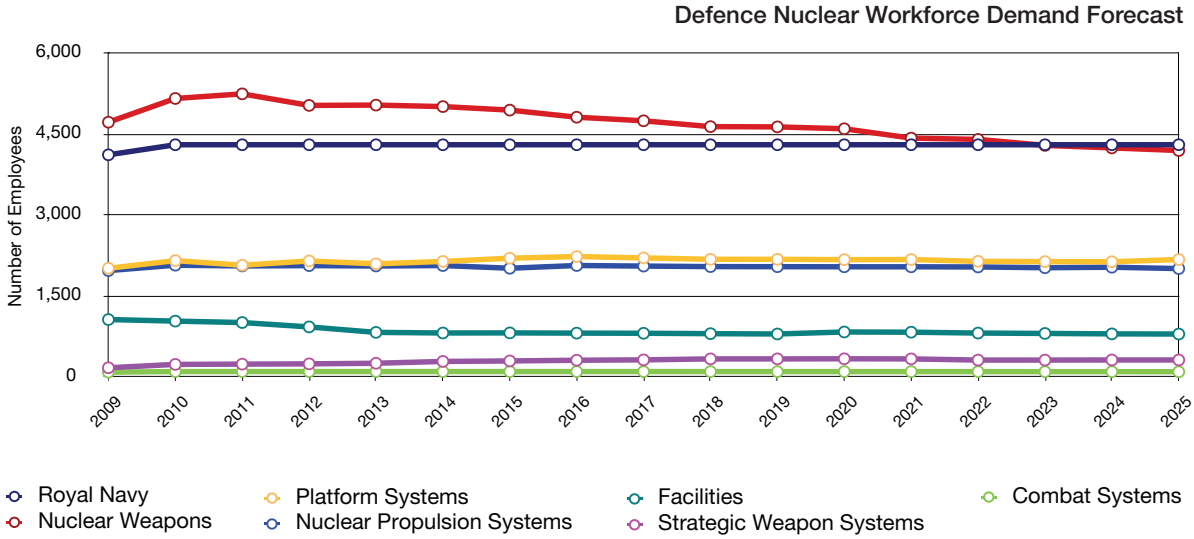
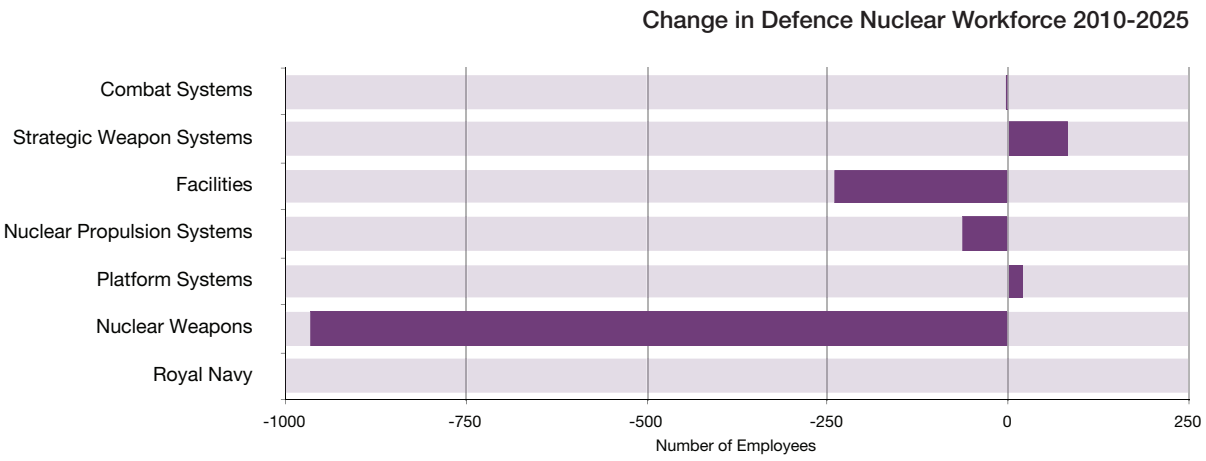
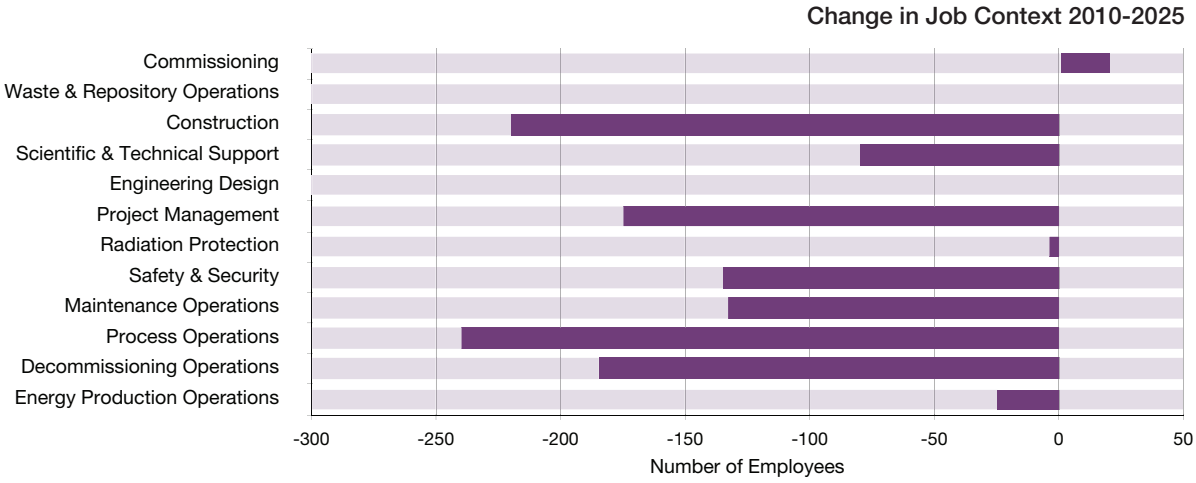


Figure 2.5
Forecast changes in Functional Workgroups



The equivalent change mapped against Job Contexts is shown in figure 2.6, revealing a decrease in most job contexts.

Figure 2.6
Forecast changes in Job Context populations



The decrease in workforce numbers is reproduced at all three skill levels as shown in figures 2.7, 2.8 and 2.9. These plot both the actual and required numbers over the next fifteen years; recognising that the nuclear baseline is being reassessed and hence some uncertainty exists over absolute numbers. The gross reduction portrayed is dominated by reductions in the nuclear weapons area but the general conclusions apply across most nuclear functional areas and are consistent with the need and intent to upskill the Defence Nuclear Enterprise workforce. At the lowest of the three skill levels the supplied, actual, workforce is predicted to slightly exceed demand through out the period. However, the situation is reversed at practitioner and expert level, with the later revealing a constant shortfall from 2013 onwards.

Figure 2.7

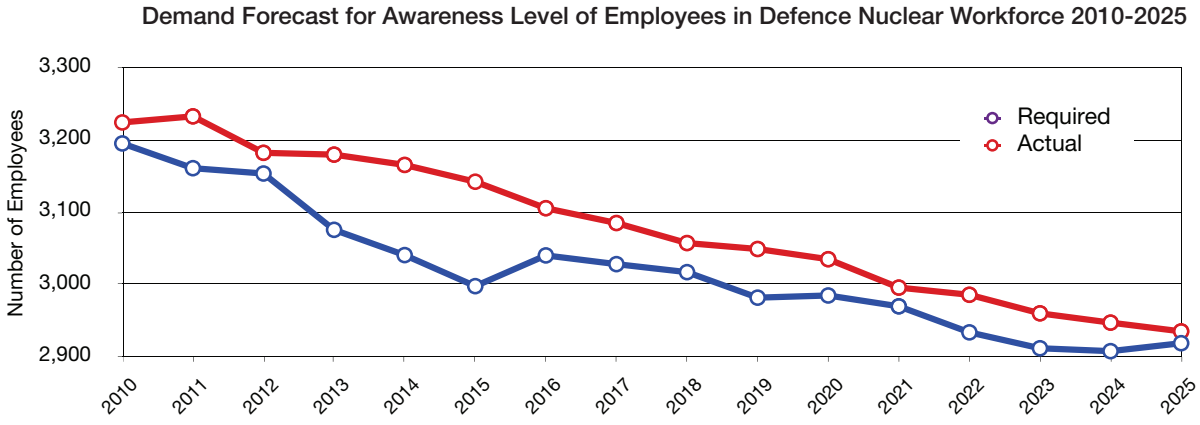


Figure 2.8

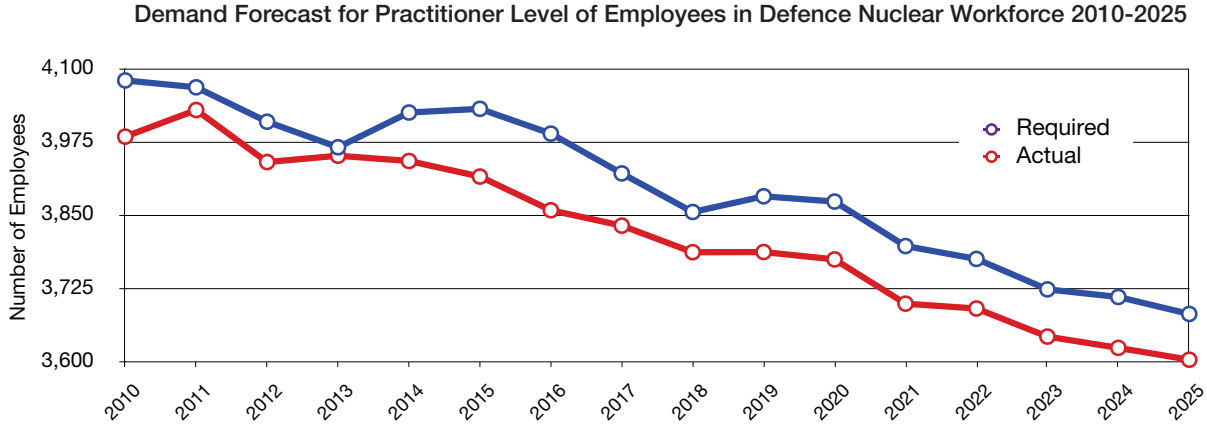


Figure 2.9

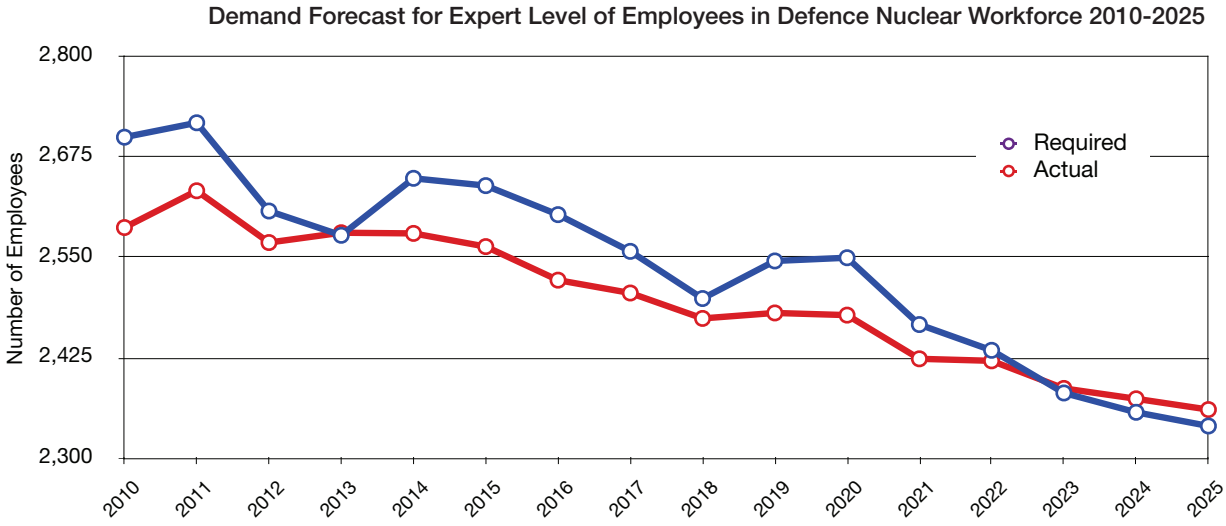


Table 2.1 Forecast skill level shortages and surpluses

Skill Shortages and Surpluses

Skill Level	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Awareness Skill Level 1/2	29	72	29	104	125	144	65	57	40	67	50	26	52	48	39	16
Practitioner Skill Level 3/4	-96	-39	-69	-14	-83	-116	-131	-89	-69	-95	-99	-98	-85	-81	-87	-78
Expert Skill Level 4/5	-112	-84	-39	3	-68	-76	-81	-52	-25	-65	-71	-43	-13	6	17	20

- **Potential for Large Shortage:** Variance greater than 60
- **Potential for Shortage:** Variance -11 to -60
- **Fair Match:** Variance -10 to 10
- **Potential for Surplus:** Variance 11 to 60
- **Potential for Large Surplus:** Variance greater than 60

The evidence supporting these data suggests that, in common with the civil nuclear workforce, retirement is a major cause of staff loss which, combined with recruitment predominantly of junior staff, aggravates the decline in corporate skill and expertise.

Table 2.1 highlights areas of shortfall or surplus in the three defined skill levels for each year to 2025, against the current programme requirements. The absolute levels are not high, although this area will need to be reviewed once the impact of the SDSR has been assessed and as the civil new build programme emerges, with its potential for predation of the defence workforce.

2.5 Training and Accreditation

The training and accreditation landscape for the nuclear component of the Submarine Enterprise Programme, across civil and military employers, is a complex one. While commercial organisations operate Ministry of Defence Sites (for example Babcock at Devonport and Rolls Royce at NRTE), security and regulatory arrangements differ between the civil and military sectors. Nevertheless core nuclear skills are required throughout and exist within the Nuclear Job Contexts, organised into four skills areas associated with training and qualifications:

- Technical
- Business Improvement
- Compliance
- Functional and Behavioural

STEP (the Submarine Training and Education Programme) is the Defence Equipment and Support's current programme for optimisation of training and education solutions across the Defence Nuclear Enterprise to sustain the Enterprise's technical capability and capacity consistent with successful delivery of the integrated submarine programme. In pursuit of its objectives, STEP is working with those organisations, at Tier 1 in the Enterprise, that plan and manage the technical workforce; matching the skills needs and demands for the Submarine Enterprise as a whole. The activity encompasses design, production, operations, maintenance and decommissioning throughout the Ministry of Defence and first tier supply chain companies.

Chapter 3:

The Skills Compass

- *Retaining skills through well paced construction*
- *Maintenance of enhanced technician and graduate training required*
- *SDSR and civil nuclear new build - key factors*

3. The Skills Compass

3.1 Drivers For Skills

The chief determinant in the demand for defence nuclear skills is the shape and size of the Submarine Enterprise Programme. Although this has been consolidated over the last few years into a clear ambition of seven Astute hulls and 3 or 4 Vanguard replacement boats, the 2010 SDSR and the political and financial context in which it has taken place, makes the final outcome uncertain, although the completion of the Astute fleet seems to be on track. Variations from the assumed building profile will not only affect the skills demand for construction, it will also have an indirect impact on areas such as decommissioning and maintenance, especially inspection and re-validation activities, as the existing fleet is pressed into longer service.

The supply of nuclear skills is further complicated, at least in some areas, by the likelihood of a major civil nuclear generation programme over the same 15 year period. However, here too, investment and planning decisions make the magnitude of the demand difficult to determine.

The experience of the submarine building programme in the early years of the century suggests that a substantial break in submarine construction will interrupt the skills pipeline. Although demand will initially decrease, later reinstatement of the programme will be limited by a lack of immediately usable skills, increasing the training demand.

Long term waste disposal is an issue for both the civil and defence sectors. Spent fuel from submarine reactors is currently stored at Sellafield alongside that produced from reprocessed fuel from electricity generation. This is a medium term solution. A skill demand exists now for longer term solutions to high and intermediate level waste management, although this is likely to continue to be shared with the civil sector.

A substantial fraction of the total skill supply is formed from Royal Navy personnel. The RN recruitment system applies a sophisticated model to take account of long term future demand, promotion requirements and wastage rates. This vertical training structure leads to a long tenure and a large time lag between recruitment and Expert status.

3.2 Critical Issues

Demand forecasts from the Submarine Enterprise Programme employers show a modest decrease over the period to 2025 principally in the Nuclear Weapons functional workgroup. This however is predicated on a seamless transition from Astute build to a Vanguard successor. Two factors make this uncertain. Firstly, the SDSR has now built in a (minimum of) four years delay, from 2024 to 2028 for the in-service date of the first Vanguard replacement boat, following a positive main gate decision in 2016. The second issue is the point at which the Astute programme will be completed. At an early point, construction was 47 months behind schedule. Subsequently the project was re-baselined. Nevertheless, there is no clear published timetable to allow a gap, overlap or seamless transition to be identified. The highest impact risk is that there is a substantial loss of submarine building skills arising from a gap between Astute and the Vanguard successor, mirroring that at the beginning of the Astute build.

Awareness Skills remain in surplus over the period out to 2025 in the existing profile, however there is a shortfall in the Practitioner and Expert areas, which requires the recently enhanced Technician and Graduate level nuclear and submarine training schemes to be maintained and special attention to be placed on knowledge transfer from those retiring from the enterprise to the new joiners.

While the impact of the SDSR will affect this pattern, with further reductions in numbers likely to result, in general the size of the technical Suitably Qualified and Experienced Person (SQEP) cohort required to sustain the integrated submarine programme are reasonably insensitive to the number of submarine hulls due to the high safety and technology requirements associated with operation of a nuclear fleet.

3.3 Concluding Remarks

This report provides an important benchmark for a sizable section of the UK demand for nuclear skills, at a time of potential resurgence for the civil nuclear programme. The data on which it is based were collected from the government and commercial organisations at the heart of delivering on-going submarine operations and planning future projects. Underlying the forecasts was the assumption that all of the Astute class submarines would be constructed, and that the policy of Continuous At Sea Deterrent would require a replacement fleet for the existing Vanguard class. This is in addition to the operational support of the fleet. While the starting point is based on a national position developed over a number of years, the political and financial context in 2010/11 leaves this potentially open to large change.

The Submarine Enterprise Programme to 2025 will need to develop in the context of a rejuvenated civil sector supporting electricity supply, decommissioning and, crucially, new build. An analysis of the current and projected state of the civil sector has been developed in the first two reports in this series, based on the management of the existing AGR and Magnox reactors and the construction of a new fleet of Pressurised Water Reactors[2]

Job Contexts, developed by Cogent for the civil sector, have been used to provide comparability across the nuclear industry. This is important because of the shared skill pool from which much, but not all, of the workforces are drawn. Furthermore, the commencement of a civil build programme could result in greater mobility of skilled personnel between the defence and civil sectors. By extending the Job Contexts developed initially for the civil nuclear sector, it has been possible to make some

comparisons between the sectors and enable a total UK nuclear picture to be established for the final report in this Renaissance series – Illuminations[17]. However, since the full extent of the Job Contexts remains to be defined, some variability in their interpretation can be expected.

While the Defence Nuclear Programme forms a critical 25% of the total UK demand for nuclear skills there are a number of significant differences from the civil sector. Nevertheless, the benchmark this analysis provides is valuable in recording the current state of the industry in terms which can be cross referenced to its civil counterpart. Whatever changes to the exiting submarine building plan are implemented, the near term will still generate demand based on operations, decommissioning and the execution of existing contracts as a minimum. Moreover, the safety and technology requirements of operating a nuclear fleet represent a substantial fixed, staff overhead and makes the support numbers reasonably insensitive to minor changes in hull numbers.

This benchmark can also be used by the Submarine Enterprise to assist in the estimation of training and education provision needed to support the Defence Nuclear Programmes into the future.

[17] Illuminations, Cogent, to be published 2012

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