BASIC Trident Commission

Options for
the United Kingdom's
Nuclear Weapons Programme

# Defence-Industrial Issues: Employment, Skills, Technology and Regional Impacts

Keith Hartley

Discussion Paper 2 of the
BASIC Trident Commission

*An independent, cross-party commission to examine UK nuclear weapons policy*

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BASIC

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# Foreword from the Commission Co-Chairs

The last Labour Government reaffirmed its commitment to Britain's independent nuclear deterrent, based on Trident, at the end of 2006. The current coalition government, in its October 2010 Strategic Defence and Security Review (SDSR), maintained a commitment to this decision in principle but also announced some changes to UK nuclear doctrine, a reduction in the number of warheads and missiles possessed by the United Kingdom, and a delay to the timetable for the construction of the replacement submarines on which the Trident system depends.

The decision to delay the final judgment on replacing the submarines until after the next election has created a window of opportunity for further deliberation on UK nuclear weapons policy. The starting point for the BASIC Trident Commission is a belief that it is important to make the most of this opportunity.

We are living through a period of enormous change in international affairs with new powers and security threats emerging, increased nuclear proliferation risks, and growing pressure on economies and defence budgets in the West. Since the original 2006-07 decision on Trident renewal modest arms control progress has also been made by the United States and Russia and President Obama has set out a vision of a world free of nuclear weapons. The current government, more recently, has also initiated a further review of possible alternatives to Trident.

In our view, there is a strong case in this context for a fundamental, independent, review of UK nuclear weapons policy.

There is also a case, in the national interest, for lifting the issue of the United Kingdom's possession of nuclear weapons out of the day to day party political context and for thinking about it in a cross party forum. The BASIC Trident Commission is doing this by facilitating, hosting, and delivering a credible cross-party expert Commission to examine the issue in depth.

The Commission is focusing on three questions in particular, namely:

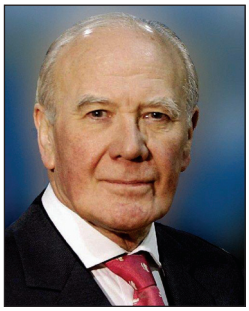
- Should the United Kingdom continue to be a nuclear weapons state?
- If so, is Trident the only or best option for delivering the deterrent?
- What more can and should the United Kingdom do to facilitate faster progress on global nuclear disarmament?

This discussion paper addresses part of the context of relevance to all three of these questions. It is the second in a series and makes an important contribution to our understanding of the economic implications of the decisions that the government have to make about Trident. The paper outlines the industrial factors that are relevant to the UK's Trident system, considers the potential impact of government decisions on jobs and local economies and estimates the cost of both the renewal and the operation of the system over time. Of course, economic factors should not be the determinant factors in the decision whether to renew Trident.

However, if for no other reason than that the manufacture and maintenance of Trident is concentrated within a small number of highly dependent communities, the Government will need to take account of economic factors when considering alternatives.

The report is published in the name of the author, rather than in the name of the Commission as a whole, but it will feed into the Commission's deliberations and we hope it will stimulate wider discussions and further submissions of evidence for the Commission's consideration.

**Malcolm Rifkind**



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BASIC Trident Commission

# Executive Summary

1. This study reports on the employment, skills, regional and industrial impacts of the Trident replacement decision (the Successor Deterrent Programme). It is not claimed that the replacement decision should be dominated by these impacts. However, in making choices, policy-makers need to be aware of the impacts of their decisions.

2. The UK submarine industry is a unique industry with a single customer, monopoly suppliers and small production numbers. Gaps in design and construction work present major problems in retaining the specialist design and construction worker skills, especially the skills needed for nuclear work. However, more analysis and evidence is needed on the costs and benefits of production gaps of different magnitudes, including their cost and employment implications.

3. A Trident replacement will be costly with total costs of some £87 billion over the period 2007 to 2062, equivalent to annual average costs of £1.6 billion. A replacement will possibly support some 26,000 jobs some of which are located in high unemployment areas (e.g. Barrow-in-Furness). However, it must be recognised that a Trident replacement is designed to contribute to UK defence by providing peace, protection and security: it is not designed to support UK jobs. Often, there are alternative and more cost-effective methods of creating UK jobs.

4. Cancellation will produce substantial cost savings of up to £83.5 billion over the period 2016 to 2062, equivalent to an annual average saving of £1.86 billion. It should be emphasised that the total cost savings will not be available immediately on cancellation in 2016: they occur over the period 2016 to 2062. Cancellation also means job losses with some high unemployment areas at risk. The worst case scenario for submarine-related jobs assumes that after 2052, the United Kingdom will withdraw completely from the operation of nuclear-powered submarines. The result would be the loss of 9,200 jobs after 2037 followed by the loss of a further 21,700 jobs after 2052: a total of almost 31,000 jobs being lost.

5. Any possible cancellation will not occur before 2016. Some of the high unemployment areas at risk have submarine work which will continue to about 2025. This means that there is a substantial adjustment period allowing Government to decide on the future of the UK submarine industry and to introduce appropriate public policies to allow a smooth adjustment to cancellation.

# Part 1
# Background:
# The Industry and Policy Issues

## Chapter 1. Introduction: Terms of Reference [1]

1. This study presents an analysis and supporting evidence on the defence-industrial issues connected to options for the UK's current nuclear weapons programme. It provides detailed analysis of the consequences of different options. The following issues are examined:

i) Who are the likely main contractors and their suppliers?

ii) Employment: how many jobs are involved; over what time-period; what are their skills; and where are the jobs located?

iii) Defence industrial base issues: what is the position of the Trident replacement in the wider UK defence industrial base?

iv) Options: consider alternatives including cancellation of any replacement programme and the impacts on jobs and regions.

2. It must be stressed that this study of industrial and employment impacts of the Trident Replacement decision and its alternatives does not address the major issue of whether the Trident system should be replaced. Instead, it provides a partial economic evaluation identifying the ***industrial and employment aspects*** of any replacement decision. Policy-makers need to be aware of the consequences of their choices and this study identifies some of the industry and employment consequences.

***...this study of industrial and employment impacts of the Trident Replacement decision and its alternatives does not address the major issue of whether the Trident system should be replaced. Instead, it provides a partial economic evaluation identifying the industrial and employment aspects of any replacement decision.***

1 The author is grateful for assistance and advice from Stuart Klosinski and Furness Enterprise Ltd; Dr. N. Ritchie; Paul Ingram; and Dr. Ian Kearns. Mr. Peter Whitehouse, Director, Babcock International Group kindly provided employment data on Devonport Dockyard. The author is responsible for interpretations and the results of this study; the usual disclaimers apply.

# Chapter 2. The Major Contractors

3. Even before any replacement decision is made, it is possible to identify the likely major contractors involved in building a replacement. It is assumed that the replacement will be a submarine-based nuclear deterrent. This will require a new generation of nuclear-powered submarines to replace the existing fleet of Vanguard class SSBNs. All of the United Kingdom's submarines are nuclear-powered vessels. There are two types, namely, the deterrent force (SSBNs: currently the Vanguard class) and nuclear-powered attack submarines (SSNs: Astute and Trafalgar class).

4. Nuclear-powered submarines have a three stage life-cycle comprising construction, operations and disposal. The replacement submarines will involve design, development, testing and construction of the vessels and their nuclear reactor power plants as well as suppliers providing specialist equipment and materials, including the Trident missiles and their warheads. Their in-service life involves an onshore naval infrastructure for operations and routine maintenance as well as privately-owned facilities for refuelling, refit and maintenance, followed by disposal (decommissioning).

## Construction

5. BAE Systems at Barrow-in-Furness, Cumbria, is the United Kingdom's sole supplier of nuclear-powered submarines. It is the only nuclear-licensed site for the construction, testing and commissioning of nuclear-powered submarines. A variety of suppliers are involved in the contract for a nuclear-powered submarine. Fifty per cent of the value of the prime contract for a nuclear-powered submarine is subcontracted to the supply chain (HCP 59, 2006).

6. The nuclear power reactor (nuclear steam raising plant: NSRP) for the submarines is supplied by Rolls-Royce at Raynesway on the outskirts of Derby. Rolls-Royce is involved in design, development and manufacture of the NSRP, in-service support, design improvements and safety reviews. It also manages the Navy's Vulcan Shore Test Facility at Thurso in Scotland.

7. Nuclear warheads for the Trident missiles are manufactured by the Atomic Weapons Establishment (AWE) at Aldermaston and Burghfield (Berkshire). AWE is operated under a Government-owned and contractor-operated arrangement comprising three equal shareholders, namely, Serco, Lockheed Martin and Jacobs Engineering Group (contracted to 2015). Lockheed Martin (USA) supplies the Trident missiles with nuclear warheads fitted to the missiles at the Royal Naval Armaments Depot at Coulport (which together with Faslane forms HM Naval Base Clyde).

## Operations: in-service life

8. Operation of the submarines involves an on-shore naval infrastructure with naval bases at Faslane, Scotland and Devonport, Plymouth. The current Vanguard submarine fleet (SSBNs: Trident) and the new Astute-class SSNs are based at HM Naval Base Clyde at Faslane. In 2009, the United Kingdom's Maritime Change Programme announced plans for HMNB Clyde to become the main operating base for the UK submarine fleet. Refit and maintenance of nuclear powered submarines is undertaken by Babcock International Group at Devonport in Plymouth (Babcock acquired Devonport Management Ltd (DML) in 2007). Babcock is a major employer in the Plymouth region (and in Devon/Cornwall).

## Disposal: Decommissioning nuclear-powered submarines

9. Disposal of nuclear-powered submarines is a costly and complex process. Decommissioned submarines are stored at HM Naval bases Devonport, Plymouth and Rosyth Royal Dockyard, Fife, Scotland. Current costs for de-commissioning past and current UK submarines are estimated at some £1.75 billion (HCP 59, 2006, GR). However, the Ministry of Defence (MoD) has created the 'Submarine Dismantling Project' (SDP) to find a solution to the Navy's redundant submarines. The SDP has a 60 year life. The submarines have to be dismantled, the radioactive waste has to be stored and disposed of in a national waste facility and where possible, the remaining materials have to be recycled. Work on removing the nuclear fuel from redundant submarines is planned to start in 2014 and will be managed as part of Devonport Naval Base operations; but this work will not be part of the SDP (EA, 2011). In 2011, the two candidate sites for removing reactor contaminated parts from some 27 submarines as part of the SDP were Devonport and Rosyth.

# Chapter 3. The Economics of the UK Submarine Industry

10. The UK submarine industrial base (SIB) has some distinctive economic features which make it a unique UK defence industry:

i) *A single product.* It produces a single product, namely, nuclear-powered submarines.

ii) *A technically complex and costly product.* Nuclear-powered submarines are high technology products: they have to operate under water at great depths and quietly for long periods offering a safe environment for their crews living alongside a nuclear reactor. The attack versions or hunter-killers (SSNs) perform a variety of missions including fleet protection from other submarines, attacking surface warships, launching cruise missiles and landing special forces. In contrast, the nuclear deterrent submarines perform a single specialised mission, namely, providing a strategic nuclear capability (they are mission-specific systems). Technical complexity comes at a cost: for example, the unit production cost of the new Astute class submarines (SSNs) is some £1.4 billion (2011 prices: HCP 489, 2010; HCP1520, 2011). Also, substantial gaps arise between new designs leading to major challenges for firms to retain essential skills and resources (e.g. an 11 year gap between last of the Vanguard class and the first Astute class submarines).

iii) *A single buyer.* The industry has one customer, namely, the UK MoD (the Royal Navy), where a single buyer is known as a monopsony.

iv) *A single supplier.* The industry has one major prime contractor capable of designing and constructing nuclear-powered submarines, namely, BAE Systems at Barrow-in-Furness which forms a domestic monopoly.

v) *Other UK monopolies*, namely, Rolls-Royce which supplies the Nuclear Steam Raising Plant, and Babcock International Group which is a monopoly supplier of repair, refit and decommissioning services. An industry with monopoly suppliers creates an imperfect market environment, where value for money is hard to achieve (HCP 250, 2009). As a result, there are monopoly supplier risks (HCP1115, 2008, p29). The Submarine Enterprise Performance Programme aims to improve efficiency in the UK submarine industry.

vi) *Entry barriers.* Entry into the nuclear sector of the industry is restricted by the need for a nuclear site licence (for construction of the NSRP and the submarine and for refit, repair and decommissioning). This imposes major barriers to new entry and competition. Further restrictions on competition and international collaboration arise from the U.S.-UK nuclear agreement and the UK commitment to buy nuclear-specific items from the United Kingdom only. These entry barriers are reinforced by the need for large capital investments, specialised skilled labour and physical capital resources, uncertainty of future orders, low production numbers and the need for high standards of production and quality assurance (HCP 59, 2006, Ev60).

vii) *Small numbers of submarines are purchased and there are no exports.* For example, the United Kingdom has a requirement for seven of the new Astute class submarines (SSNs) with planned delivery over the period 2006 to mid-2024 (originally at a planned rate of about one boat every two years). The Trident replacement will be for three to four submarines (SSBNs). Small numbers production limits the opportunities for economies of scale and learning, which require long production runs.

viii) *Incentives to reduce costs.* MoD claims that there remain opportunities for reducing costs in the UK SIB: inefficiencies are predicted in an industry dominated by domestic monopolies. Inefficiency is reflected in entry barriers, excess capacity, duplication of competencies, spread of best practice and supply chain management (HCP 59, 2006, p28). Nonetheless, UK submarines appear to be cost competitive being some 40% cheaper than their U.S. equivalents (HCP 59, 2006, Ev8 and 65). Also, labour productivity has increased between successive generations of submarines. The number of people required to build a nuclear-powered submarine in an acceptable timescale has reduced from between 8,000 and 12,000 in the early 1990s (Vanguard class) to under 4,000 in 2006 (Astute class: HCP 59, 2006, Ev56). Furthermore, there have been labour productivity improvements within the Astute class where there was a 22% reduction in man hours over the construction of the first three boats (Cmnd 6994, 2006, Ev56). Also, there are expected to be savings in life-cycle costs on the Astute class (at least 10% cost savings compared with the Trafalgar class SSNs: HCP 59, 2006, GR).

ix) *Wider spin-offs.* Unlike other UK defence industries (e.g. aerospace), the UK SIB provides no obvious wider economic benefits in the form of exports and extensive technology spin-offs to other products and to the rest of the economy (c.f. military and civil aircraft).

x) *Need for specialised resources.* Nuclear-powered submarines require specialised skills and facilities for their design, construction, maintenance and decommissioning. Some of these skills and facilities are specific to nuclear-powered submarines, with no alternative-use value. For example, there are no nuclear-powered civilian submarines and some specialist components and equipment are only required by the nuclear submarine industry.

# Chapter 4. UK Defence Industrial Policy and the Submarine Industry

11. The distinctive features of the UK submarine industry are reflected in industrial policy. The United Kingdom's Defence Industrial Strategy outlined policy on the UK submarine industrial base, specifying which capabilities had to be retained in the United Kingdom for the foreseeable future.[2] It stated that:

> *"The UK's fleet of nuclear powered submarines requires a specialist subset of skills within the maritime industry. We have duties of nuclear ownership and commitments to the USA which can only be fulfilled by close control of an onshore submarine business. Therefore, it is essential that the UK retains the capability safely to deliver, operate and maintain these platforms, without significant reliance on unpredictable offshore expertise. This delivery spans from conceptual design through to disposal, and includes the management of submarine and nuclear safety; all underpinned by appropriate science and technology. Some submarine sub-system elements may be sourced from abroad, but only under appropriate arrangements that guarantee supply or from a sufficiently broad supplier base to assure access and availability"* (Cmnd 6697, 2005, p71; HCDC, 2006; HCDC, 2006, GR).

12. UK defence industrial policy also identified the ability to manage the Nuclear Steam Raising Plant throughout its life cycle as a strategic capability that must be retained in the United Kingdom (Cmnd 6697, 2005, p71). This capability embraces design, development, test and evaluation, manufacture and disposal (decommissioning). A guarantee of UK control and safe ownership requires "An irreducible minimum level of associated facilities, intellectual resource and supporting technologies" (Cmnd 6697, 2005, p71).

13. The UK commitment to retaining its nuclear-powered submarine industrial base involves a commitment to retaining the industry's specific skills, especially those skills which are not available from the broader market place and which have to be maintained within the specialist submarine industry. These submarine-specific skills include structural acoustic design, together with specialist welding and fabrication skills. Retaining this industry also requires the retention of specialised industrial facilities and supporting technologies (Cmnd 6697, 2005, p71).

14. UK policy also recognises that submarine design capability is at risk if long gaps emerge between major designs. For example, the eleven year gap between the design of the Vanguard and Astute classes led to a loss of capability. As a result, the United Kingdom aims to sustain design capability by maintaining a gap of eight years between new designs. Similarly, to retain the industry requires regular production orders with industry's preference for one submarine every two years; but the industry's preference is subject to UK defence budget constraints which can result in longer production gaps.[3] Furthermore, there is a focus on sustaining 'significant capabilities' in the submarine supply chain. These include limited sources of supply in second or third tier suppliers which are at risk of exit; and which, if they do leave the market, it will be difficult to regain their specialist capabilities in the future (Cmnd 6697, 2005, p76).

15. Overall, the United Kingdom aims to retain a sovereign capability in the design, construction, operation, maintenance and decommissioning of nuclear-powered submarines. This reflects the United Kingdom's "...duties of ownership and commitments to the USA which can only be fulfilled by close control of an onshore submarine business. Therefore, it is essential that the UK retains the capability safely to deliver, operate and maintain these platforms without significant reliance on unpredictable offshore expertise" ( HCP59, 2006; GR, p2). The United Kingdom intends to build the Trident replacement submarines "...in the UK, for reasons of national sovereignty, nuclear regulation, operational effectiveness and safety, and the maintenance of key skills" (HCP 59, 2006, GR, p3). Even if it is decided not to replace Trident, "... a specialist skills base will have to be retained in order to build SSNs and maintain and finally decommission the UKs existing fleet of nuclear powered submarines" (HCP 59, 2006, p16). However, without a Trident replacement, it is possible that there will be insufficient demand for nuclear submarines to sustain the industry. "It is important to recognise that there is an interrelationship between SSN and SSBN construction" (HCP 59, 2006, p19).

2 The 2005 Defence Industrial Strategy was replaced by a new policy named National Security Through Technology (Cmnd 8278, 2012). This new UK defence industrial policy will not affect policy on the procurement of the Astute and of the submarine-based Trident replacement. Any future policy changes will be long-term affecting any future replacements for these submarines.

3 The 2010 Strategic Defence and Security Review delayed the in-service date for the Successor deterrent submarine to 2028. To avoid a production gap in the submarine construction industry, the Astute programme was slowed so further delaying the introduction of the Astute submarines (HCP 1520-II, 2011).

# Part 2
# Employment and Industrial Impacts

## Introduction

16. This section outlines the current (2011/12) position on the Trident replacement costs and the assumptions used in this study to assess the impacts of the replacement.[4] Strictly, Trident replacement is used as a shorthand for the work outlined in the 2006 White Paper (Cmnd 6994, 2006) which is all about Trident renewal comprising new submarines, refurbishing or replacing the warhead and infrastructure work. It does not include replacing the Trident missile system which is planned to be operational until around 2042. It is expected that the decision to proceed with a replacement will be made in 2016 (the Main Gate decision). The Trident replacement submarines are planned to enter service from 2028 and with a service life of 25 to 30 years, they will remain in service into the 2060s. Originally, the Main Gate decision was expected to be in 2014 with delivery of the first submarine in 2024 (HCP 1115, 2008).

17. The acquisition costs of the replacement are estimated at £20 billion to £25 billion for a four boat fleet (2011 prices: Fox, 2011; MoD, 2011).[5] These cost estimates comprise:[6]

i) The submarines at a cost of £14.6 billion to £17.5 billion;

ii) Warheads at a cost of £2.7 billion to £3.75 billion;

iii) Infrastructure at a cost of £2.7 billion to £3.75 billion.

18. In addition to acquisition costs, there are running costs for the replacement. The in-service costs of the Trident replacement are estimated at some 5-6% of the 2006 defence budget (including AWE costs at some 2.5% to 3% of the defence budget: Cmnd 6994, 2006, p27), resulting in annual running costs of about £2.1 billion (2010/11 prices: DASA, 2011).[7] These annual running costs apply to a four boat fleet over its 25-30 year service life and they include AWE costs.

It should be recognised that these cost estimates are initial estimates only, especially for whole life costs (HCP1115, 2008, p6). Further costs arise from the cost of maintaining and extending the existing Trident fleet until the replacement submarines are in service with these costs estimated at some £2.2 billion (2010/11 prices: HCP1115, 2008, p25; Ritchie, 2010). Also, it is likely that there will be 'hidden costs' of the Trident replacement which will only emerge at some future date. For example, there are the costs of replacing the Trident missiles after 2042: these costs are not included in this study.

19. Costs for the Trident replacement have already been incurred in the form of Concept and Assessment phases. The Concept phase started in 2007 and cost £900 million (2011 prices). Initial Gate followed, starting in 2011 with the Main Gate decision expected in 2016. The Initial Gate decision involves the Assessment phase of the programme and is expected to cost a further £3 billion resulting in a total cost of some £3.9 billion equivalent to some 15% of total programme costs over the period 2007 to 2016 (2011 prices: MoD, 2011, p8). The Initial Gate point announced that the submarines will be powered by a new generation of nuclear propulsion system (PWR3). Costs for the Initial Gate include the purchase of long lead items valued at £530 million (2011 prices: MoD 2011). These items for the first three boats comprise specialist steels and the main boat systems including the computer systems, hydraulic systems, steam generators and communications systems (Fox, 2011).[8]

4 Trident replacement is officially known as the Successor Deterrent programme.

5 Unless stated otherwise, all cost estimates are in constant 2011 prices.

6 Estimates based on the original 2006 cost estimates of £15 billion to £20 billion at 2006/07 prices adjusted by the author to 2011 prices (Fox, 2011).

7 Annual running costs were estimated by applying the average of the 5-6 percentages to the average of the 2005/06 and 2006/07 defence budgets expressed in constant 2010/2011 prices. Allowing for build-up and run-down of the four boat fleet results in a service life for all four boats from 2034 to 2058 or 24 years (the original first boat retiring after 30 years service starting in 2028). On this basis, the annual running costs for all four boats apply to the period 2034 to 2058 with lower annual costs during build-up and run-down.

8 There are some published cost figures for the AWE. Over the period 2005-2015, spending at the AWE is expected to total £570 million. Over the period 2016-2020, planned spending at the AWE is £1368 million (on warhead assembly and uranium manufacturing: Hansard, November, 2011, Col 272W). The aggregate total of spending at the AWE for 2005 to 2020 is almost £2 billion.

20. As a starting point for the study, two broad assumptions will be used to assess the economic impacts of the Trident replacement, namely, a replacement and no replacement:

i) First, it is assumed that there will be a replacement of a nuclear-powered submarine deterrent to replace the current Vanguard fleet of four submarines. Two options will be considered, namely, a like-for-like replacement of four submarines (Option 1A) or the alternative of a three boat fleet starting in 2016 (Option 1B) with the first submarine delivered in 2028 and the remaining submarines delivered at the rate of one boat every 36 months.

ii) Second, there is no replacement: the cancellation option. Without a replacement, the following options will be considered:

a) Option 2. Immediate scrapping of the existing Vanguard and Trident fleet; or

b) Option 3. Retaining the existing fleet to 2024 after which the whole fleet will be scrapped. Options 2 or 3 involve further options which are not considered in this study. These include spending all the savings from cancellation on conventional equipment and forces; or spending on civil public expenditures; or allocating the savings to tax reductions.

***In evaluating the options, care is needed to identify myths, emotions and special pleading...the key question is which of the alternative public spending projects will make the greatest contribution to national output?***

## Conclusion

21. In evaluating the options, care is needed to identify myths, emotions and special pleading. For example, industry will often claim that a decision not to replace the Vanguard fleet would have 'devastating and catastrophic impact' on the United Kingdom's submarine industrial base and its continued capability to design and build nuclear-powered submarines. Claims have been made that a decision to abandon a future submarine programme and focus solely on in-service support and decommissioning would impact on the availability of the entire nuclear-powered submarine fleet. Fears have also been expressed about the future of Barrow-in-Furness and other local communities dependent on the Trident replacement (Cmnd 6697, 2005, p25). Such claims, emotive language and special pleading need to be subject to critical analysis and evaluation of the supporting empirical evidence. For example, the employment and skills impacts of a Trident replacement are not the main policy objectives of defence equipment procurement: such procurements are about the contributions of various equipment programmes to UK security, protection and peace. Also, alternative public spending will create and support jobs, skills and provide wider economic benefits. Here, the key question is which of the alternative public spending projects will make the greatest contribution to national output?

The next task is to estimate the employment, skills, regional and industrial impacts of the Trident replacement decision.

# Chapter 5. Employment Impacts

22. Employment in the UK submarine industry comprises personnel employed at BAE Systems as prime contractor (direct employment) plus employment amongst all its suppliers at the various levels of the supply chain (indirect employment). Typically, some 50% of the value of the prime contract for a nuclear-powered submarine is subcontracted to the supply chain where 10 companies accounted for 80% of the contract value (including BAE Systems: HCP 59, 2006, p10). Inevitably, access to accurate data creates problems so that the estimates presented in this study should be regarded as broad orders of magnitude, especially for the estimates relating to the Trident replacement. This Chapter proceeds by estimating the **total employment** resulting from the UK submarine fleet, followed by the likely employment impact of a Trident replacement.[9]

23. BAE Systems at Barrow-in-Furness employed 5,045 personnel in 2011 (FE, 2011).[10] BAE Systems is the major employer in Barrow-in-Furness (it is effectively a monopsony buyer in the Barrow labour market) and the town is one of the most defence-dependent and geographically isolated in the United Kingdom. It has experienced major changes in local employment. Employment at the Barrow shipyard fell from 14,250 in 1990 to 5,800 in 1995 and fell below 3,000 in 2004 (HCP59, 2006, Ev72). BAE Systems contributes significantly to spending in the local economy. In 2006, the total annual wage bill for BAE Systems at Barrow was some £77 million with annual average wages for managers of £45,000, for skilled labour of £20,000 and an annual average for all workers of £23,263 (2006 prices: HCP59, 2006, Ev72). The annual average wages for all BAE Systems workers at Barrow was higher than the equivalent figure for Great Britain in 2005/6 (some 3.4% higher at BAE Systems: NOMIS, 2011), suggesting a net contribution to national output (i.e. wages higher than the next-best alternative shown by average wages for Great Britain).

9 All employment numbers and estimates as well as other evidence have been obtained from available published sources. A more complete and accurate analysis would require considerably more resources and time.

10 BAE Systems at Barrow employed 480 personnel in Land Systems and these numbers are included in the total employment at BAE Systems at Barrow. Since the focus of this study is on broad aggregates, Land Systems employment is not deducted from the BAE total employment at Barrow.

24. Within the supply chain, the major suppliers are:

i) Rolls-Royce supplying the nuclear reactors (NSRP) and other equipment based at Raynesway, Derby. Employment on nuclear-powered submarines is estimated at some 1,000 personnel (including about 100 personnel working on Heavy Pressure Vessels (Rolls-Royce owned: HCP 59, 2006, Ev61).

ii) McTaggart Scott supplying non-hull-penetrating masts based at Edinburgh. Employment on nuclear submarines estimated at some 100 personnel.

iii) Weir, Strachan and Henshaw supplying weapons handling and launch systems based at Bristol (it is also a supplier to AWE and is now owned by Babcock International Group). Employment on submarine work estimated at 300 personnel.

iv) Alstom Power Steam Turbine Retrofits UK (Rugby) designs, manufactures and supplies steam turbines for nuclear-powered submarines. Steam turbines for submarines is not the company's core business. However, the specifications for submarines are significantly different from those for normal civil power plants (e.g. different materials; safety concerns; long life: HCP59, 2006, Ev13).

v) L-3 Communications supplies Command, Control, Communications, Intelligence, Surveillance and Reconnaissance systems (C3ISR: U.S. company).

vi) Sheffield Forgemasters based in Sheffield supplies valves and specialist steels for submarines and the NSRP.

vii) Thales (UK) Underwater Systems is the design authority for sonar systems (Templecombe, Somerset) and Thales Optronics (Barr and Stroud: Glasgow) is the design authority for periscopes.

viii) Wellman Defence supplies submarine air purification systems based at Portsmouth;

ix) York supplies shipboard air conditioning and refrigeration equipment (part of Johnson Controls group: US company);

25. Total employment in the UK submarine manufacturing industry can be estimated by applying the ratio of direct to indirect employment for UK submarines: in 1995, this ratio was 1:0.83 meaning that for every person employed directly, there were 0.83 persons employed in the supply chain (Schofield, 2007).[11] On this basis, BAE System's employment at Barrow of 5,045 personnel results in **total estimated employment in the UK submarine *manufacturing* industry of some 9,200 personnel in 2011** (all BAE Systems staff at Barrow are defined as direct since BAE is the prime contractor).

26. In addition to employment in the UK submarine manufacturing industry, there is employment in the following areas:

i) Repair, maintenance and decommissioning of nuclear-powered submarines. This work is undertaken at Devonport Dockyard by Babcock International Group. Employment on submarine work at Babcock Devonport Dockyard is about **3,000** ***personnel in 2011***. Adjusting for the ratio of direct to indirect employment of 1:1 (based on MoD equipment spending) results in total estimated employment for repair, maintenance and decommissioning in Devonport and its suppliers of ***some 6,000 personnel in 2011.***

ii) The nuclear warhead element of the UK strategic deterrent. The AWE undertakes work on the nuclear warheads with employment of some ***4,500 personnel in 2011.*** The AWE has some 2,000 contractors. It is assumed that the typical ratio of direct to indirect employment is 1:1 based on the figures for MoD equipment spending (DASA, 2008). This gives a ***total estimated UK employment of some 9,000 personnel*** (direct and indirect) involved in the nuclear warhead design, development and manufacture of the nuclear weapon component of the strategic deterrent.[12]

iii) Operational and support work: Navy personnel. The in-life operation and support for nuclear-powered submarines involves the employment of both Royal Navy personnel and civilians employed by MoD and contractors. Each of the Vanguard fleet (4 SSBNs) requires a crew of 135 Navy personnel; the Trafalgar class (6 SSNs) require a crew of 130 Navy personnel; and the new Astute class (currently 1 SSN) require a crew of 98 Navy personnel. In 2011, the United Kingdom deployed 11 SSBN and SSN submarines requiring a total crew of 1,418 Navy personnel. Continuous deployment of submarines requires a multiple of these crew numbers, say, about 1.6 crews per submarine: hence, an estimated total of ***some 2,300 Navy personnel to provide crews for the United Kingdom's nuclear-powered submarine fleet.*** Further Navy personnel are required to support the submarine fleet. Applying the average ratio of shore to sea Navy personnel (0.53 on-shore Navy personnel for every one at sea) gives an estimate of total Navy personnel providing crews and on-shore support for the UK submarine fleet of ***some 3,500 Navy personnel*** in 2011 (mostly at HMNB Clyde: Faslane).

iv) Operation and support work: Civilians. Two groups of civilians are involved, namely, those employed by MoD (MoD civilians) and those employed by private contractors (mainly by the Babcock Group). It is estimated that HMNB Clyde employed ***some 3,200 civilian personnel on submarine work in 2011***.[13]

27. Table 1 presents an estimate of total employment in 2011 associated with the UK submarine fleet (both SSBN and SSN boats). These numbers provide a baseline for estimating the employment impacts of the Trident replacement decision.

**Table 1**

**Total Employment on UK Submarine Fleet, 2011**

| Activity | Estimated Employment (numbers of direct and indirect personnel) |
|---|---|
| **BAE Systems and suppliers:** | **9,200** |
| Including: | |
| RR Derby | 1,000 |
| WSH | 300 |
| McTaggart Scott | 100 |
| **AWE** | **9,000** |
| **Operations and Support:** | **6,700** |
| Comprising: | |
| RN personnel | 3,500 |
| Civilians | 3,200 |
| **Devonport and suppliers** | **6,000** |
| **Total** | **30,900** |

**Notes:**

i) WSH is Weir Strachan and Henshaw.

ii) Operations and support is mainly at HMNB Clyde.

11 This ratio was based on the 1995 data for the Trident programme which are the only available data for the ratio of direct to indirect employment for UK submarines: all other data are for UK aggregate MoD spending. For example, in comparison, the ratio of direct to indirect employment for all MoD equipment expenditure in 2008 was 1:1 (DASA, 2008: this was the final year of publication of these data). Applying this ratio gives a total UK submarine manufacturing industry employment of some 10,000 personnel in 2011.

12 This is probably an upper-bound figure since AWE's nuclear-related activities are likely to mean less sub-contracting than shown by the average ratio of 1:1 for direct to indirect labour.

13 Estimates show that HMNB Clyde employed a total of over 6,500 military and civilian personnel in 2011. These numbers have been divided as 3,000 Navy personnel and 4,000 civilian workers. Assume that work on surface ships accounts for 20% of the civilian labour force: hence, an estimated 3,200 civilians employed on submarine work (MoD, 2009).

## The Trident replacement

28. Overall, the ***UK submarine fleet*** supported some 31,000 jobs in 2011 comprising military personnel, industrial and civilian jobs. Within this total, the UK submarine construction industry employed some 5,000 personnel directly and about 4,000 personnel in the supply chain (indirect). The next step is to estimate the employment impacts of the Trident replacement decision (either three or four boats: Options 1A and 1B). It is estimated that a Trident replacement submarine will require an additional 1,000 workers at BAE Systems Barrow resulting in total employment at Barrow of 6,045 personnel (FE, 2011). This results in an overall total in the UK submarine manufacturing industry of some 11,000 personnel over the production period for three or four boats (both direct and indirect employment using a 1:0.83 ratio). It is assumed that a replacement submarine will require a seven year design phase and a seven year build phase plus time for sea trials before service entry (say, one year for sea trials for the first boat). Assuming major design work starts in 2016, the first boat will be delivered around 2028 with the remaining boats delivered at a rate of one every three years: hence the final boats will be delivered in either 2034 (for three boats: Option 1B) or 2037 (four boats: Option 1A). On this basis, the employment impacts for the UK submarine manufacturing industry of a three or four boat option will end in either 2034 or 2037. It is highly likely that these estimated delivery dates will be subject to slippages (possibly by up to two-three years). It is assumed that a three boat fleet means a potential loss of some 9,600 to 11,000 industry personnel after 2034 compared with a four boat fleet (at BAE Barrow and its suppliers).[14] After the completion of construction work on the Trident replacement, it is assumed that there will be follow-on work on a new SSN to replace the Astute class. Initial design work on such a follow-on SSN is expected to start around 2025 with delivery of the first boat around the period 2034 to 2040.

***Overall, the UK submarine fleet supported some 31,000 jobs in 2011 comprising military personnel, industrial and civilian jobs.***

29. A Trident replacement will require other labour inputs embracing the nuclear warheads, operations and support and employment at Devonport. It is assumed that the numbers employed at AWE and its suppliers remain unchanged at 9,000 personnel. The remaining inputs are assumed to be proportional to the Trident replacement submarines in the total fleet. Allowances have to be made for the larger size of the Trident replacement boats.[15] For operations and support, a three boat Trident replacement requires some 2,240 personnel whilst a four boat fleet requires about 2,700 Navy and civilian personnel. Similarly, for Devonport, a three boat fleet requires some 2,760 personnel and a four boat fleet requires about 3,180 personnel. The numbers stated in this section will remain constant over the planned service life of the Trident replacement submarines (say, to the early 2060s). However, the assumption of constant employment at the AWE and Devonport is unlikely since the PWR3 nuclear reactor will not need in-life refuelling and there will be future employment efficiencies: hence, the employment estimates are upper-bound figures. The employment estimates for the Trident replacement are summarised in Table 2.

14 The lower figure was estimated as follows. Production of Astute class submarines require less than 4,000 personnel, say, 3,500 personnel (HCP 59, 2006, Ev56). Assume that a Vanguard replacement is 1.5 times the labour required for Astute, giving a total of 5,250 personnel at BAE Systems for building one Vanguard replacement submarine. The overall industry total is 9,600 personnel as the difference between 3 and 4 boats (this total is for direct and indirect employment). Emphasis is on potential loss of jobs reflecting the possibility that most direct employment will be lost and a significant but unquantifiable proportion of indirect employment will be at risk.

15 It is assumed that each Trident replacement boat is equivalent to two Astute class submarines. On this basis, a 3 boat Trident replacement requires 46% of total Navy and civilian operations and support personnel required for the total UK submarine fleet; whilst a 4 boat fleet requires 53% of these personnel. The estimates were adjusted to allow for technical progress leading to smaller crews on the Successor deterrent (crews of 102 personnel per boat, based on the ratio of Astute to Trafalgar class crew size). The employment totals need to recognise that numbers will build-up to reflect the phased introduction into service of the boats.

**Table 2**

**Employment on the Trident Replacement, 2016 to early 2060s**

| Activity | Estimated employment: 3 boats (Option 1B) From 2016 to 2020: | Estimated employment: 4 boats (Option 1A) From 2016 to 2020: |
|---|---|---|
| BAE Systems and suppliers | 200-600 designers, etc. | 200-600 designers, etc. |
| | From 2020 to 2034: Total of 11,000 personnel | From 2020 to 2037: Total of 11,000 personnel. |
| AWE | 9,000 | 9,000 |
| Operations and support | From 2034: 2,240 personnel | From 2037: 2,700 personnel |
| Devonport and suppliers | From 2034: 2,760 personnel | From 2037: 3,180 personnel |

**Notes:**

i) All employment numbers are annual numbers for the stated periods and are for both direct and indirect employment. They should be regarded as upper-bound estimates (e.g. no allowances for productivity improvements).

ii) Designers, etc., comprise designers, engineers and draughtsmen.

iii) For construction, operations/support and Devonport, employment numbers will build-up to the totals shown in Table 2. Also, the employment numbers for each of these groups will continue as annual employment numbers until the first of the Trident replacement submarines exits from service (say, 2058).

iv) AWE numbers are assumed to apply so long as the United Kingdom retains a nuclear deterrent.

v) The estimated employment at Devonport is 50% of the total shown in Table 2 (namely, 1,380 and 1,590 personnel for the three and four boat fleets, respectively).

# Chapter 6. Skills Impacts

30. The new SSBNs will be built in the United Kingdom "... for reasons of national security, nuclear regulation, operational effectiveness, safety and maintenance of key skills" (Cmnd 6694, 2006, p28). In engineering terms, nuclear-powered submarines with ballistic missiles are one of the most complex and technically demanding systems in existence. They require a nuclear power plant, ballistic missiles, communications and combat systems, all fitted into a confined space capable of safe and continuous underwater operations for long periods. The United Kingdom has developed a high level of expertise in the design, manufacture and maintenance of nuclear-powered submarines.

31. The UK submarine industry requires a uniquely skilled specialist labour force with skills which are specific to the submarine industry. Specificity means that some of the skills are not used or supported by any other shipbuilding work (e.g. surface warships), nor are they generally available elsewhere in the UK labour market. These skills embrace design, construction and maintenance of submarines and the nuclear propulsion system. Some of the skills needed are nuclear skills embracing the Nuclear Steam Raising Plant (NSRP), its integration into the submarine and the safe operation of the nuclear reactor plant at sea and in port. Often the numbers involved in each specialist area are relatively small (e.g. four radiation physicists: HCP 59, 2006, Ev5).

32. Submarine construction requires designers and engineers in such areas as computer-aided design, electrical mechanical systems, systems integration, structured hydrodynamics, noise and vibration. Necessary skills also include life support and safety for both the hull and nuclear propulsion system. Submarine hull construction requires specialist techniques such as specialist welding and fabrication processes. Similar skills are needed for the maintenance and refit process but with less demand for design engineers and more demand for skills in nuclear safety and environmental impacts.

33. Further specific skills, especially nuclear skills, are needed for the design and manufacture of the NSRP. Design of the NSRP requires nuclear engineers and safety case skills whilst construction of the NSRP requires specialist manufacturing skills which are unique to the United Kingdom (here skill specificity applies to both the industry and to the United Kingdom). The 1958 UK-U.S. Mutual Defence Agreement limits the non-UK provision of components so that the NSRP industrial base is mostly within the United Kingdom (HCP 59, 2006, p14; Ev57).

34. Parts of the supply chain also require specialist and submarine-specific skills. Weapons handling, steam turbines and masts require design skills in systems engineering, structural design and control systems and specialist manufacturing skills in specialist welding, assembly, fitting and testing (Cmnd 6994, 2006, p14).

35. There is a further dimension to the nuclear skills dimension, reflected in the AWE which designs, develops and manufactures the nuclear warheads for the submarine deterrent. This is another high-skill activity employing scientists, engineers, technicians, crafts-people and safety specialists. Examples include staff in plasma and design physics, supercomputing and hydrodynamics and specialist supercomputing facilities (e.g. simulations instead of the actual testing of nuclear warheads: AWE, 2011). The need for a nuclear site licence creates an entry barrier.

36. Without a Trident replacement, all the specialist skills required for the UK submarine industry are needed to build and maintain any further SSNs and eventually to decommission the United Kingdom's remaining nuclear-powered submarines. However, gaps in submarine design and construction work can lead to the loss of key skills as occurred between the end of the construction of the Vanguard class and the start of the Astute class (an 11 year gap). The award of other shipbuilding work to the Barrow shipyard was not sufficient to maintain those skills specific to submarine design and construction (HCP 1115, 2008, p11). The loss of key skills contributed to delays and cost overruns on the Astute class submarines (HCP 489, 2010).[16] The key point is that gaps in submarine work lead to the loss of skilled labour to other industries and the loss of skill competence through continued failure to apply these skills to submarine work. Furthermore, highly specialised and nuclear-specific skills are needed to integrate the weapons system into the ballistic missile submarines (SSBNs). But, most of the claims about gaps in submarine work emanate from industry which has an incentive to exaggerate the problem.

More work is needed to estimate the costs and benefits of design and production gaps of different duration. Slowing the build programme for the Astute class will avoid production gaps in the submarine construction industry; but such gaps were at a cost of almost £1 billion for the Astute programme and can involve a smaller workforce (HCP 1520, 2011, p29).

37. In addition to the skills required for the UK submarine industry, there are also requirements for specialist industrial facilities (physical capital). Some of these are highly specialised and specific to the nuclear-powered submarine industry. They include all the physical capital associated with the nuclear site licences required for construction of the submarine, its NSRP, maintenance and decommissioning facilities (Barrow; Derby; Devonport). The strategic nuclear deterrent requires additional specialist industrial and nuclear facilities at the AWE.

## Conclusion

38. Gaps in design and construction work for nuclear-powered submarines can lead to the loss of skilled labour and the exit of suppliers from the submarine industry. To avoid these losses of skilled labour and specialist industrial facilities requires various solutions, including a regular submarine work-load, or other non-submarine work. For example, naval architects specialising in submarine design can be transferred temporarily to design work on complex and large naval surface warships. Or, some of the specialist nuclear skills needed at Barrow might be retained by allowing some staff to retain their expertise by working on nuclear submarines at Devonport or working at the nuclear power station at Heysham or at the nuclear establishment at Sellafield. Or, resources can be allowed to leave the submarine industry and re-constituted at a future date; but the re-constitution option takes time and involves both costs and risks (e.g. the gap between Vanguard and Astute class submarines: HCP 59, 2006, Ev69).

16 Faced with skill shortages, MoD has resorted to buying outside consultancy services. On Astute, technical difficulties with computer-aided design led to the employment of an engineering team from General Dynamics Electric Boat Company to assist BAE Systems. Broadly, some skills can be 'out-sourced' or 'bought-in'.

# Chapter 7. Regional Impacts

39. A number of UK towns and regions are dependent on the manufacture and operation of nuclear-powered submarines and especially on a Trident replacement (SSBN). Towns, areas and companies which are particularly dependent on a Trident replacement include:

i) Barrow–in-Furness and the BAE System's submarine facility in Cumbria.

ii) The AWE at Aldermaston and Burghfield, Berkshire.

iii) The Rolls-Royce NSRP at Raynesway on the outskirts of Derby.

iv) HMNB Clyde.

v) Devonport Dockyard at Plymouth (Babcock International Group).

40. A town or region's dependence is related to total employment on Trident replacement submarines in relation to total employment in the area and the local unemployment rate signalling whether alternative employment opportunities are readily available. Much also depends on whether the labour and physical capital are transferable between submarine and other work or whether submarine human skills and physical capital are specific to submarines with no alternative uses. In some cases, skills and facilities are transferable within one firm so that resources do not need to change firms and employers. For example, a manufacturer of track for tanks might have a large civil business in providing track for cranes and bulldozers. Similarly, firms like Boeing and EADS have large civil aircraft businesses so that labour and facilities manufacturing military aircraft can be transferred to the manufacture of civil airliners (also with aircraft engines where there are opportunities for shifting labour and physical capital within the same plant from military to civil production).

41. Proponents of conversion often argue that, say, tank firms might shift from the manufacture of tanks to tractors (cf. swords to ploughshares). But such shifts are not costless and costs arise in searching for new profitable market opportunities and in entering new markets: search and entry are not costless, nor are they risk-free. Further costs arise in adjusting the firm's labour force and its capital from military to new civil markets and in changing a firm's culture from dependency on military contracts to a culture of enterprise dependent on earning profits in a world of uncertainty (UNIDIR, 1993).[17]

42. For towns dependent on the Trident replacement, a decision not to proceed with a replacement is equivalent to disarmament, involving both costs and benefits. On the costs side, there is a need for a fundamental reallocation of resources from military to civilian production which will involve potential problems of unemployment and under-employment of labour, capital and other resources. However, disarmament can be viewed as an investment process with short-term costs offset by long-term benefits as resources released from the military-industrial sector are reallocated to the production of civil goods and services. But adjustment and resource reallocation can be costly and might take considerable time, especially where resources are highly specific to the defence sector and are non-transferable to alternative civilian uses. These raise the greatest adjustment problems, especially for labour where there is potential for hardship associated with the loss of income from redundancy and unemployment. Here, there is a role for public policy to assist change and resource reallocation through such manpower policies as labour retraining, mobility assistance and information on job opportunities together with other policies to assist resource reallocation. Adjustment depends on the transferability of skills and other resources and on how well and how quickly labour markets operate as 'clearing mechanisms' (UNIDIR, 1993).

43. Some guidelines can be suggested for adjustment policies designed to minimise the costs and time involved in reallocating resources released from the defence sector to the civilian economy. Ideally, long-term gradual reductions in defence spending under conditions of an expanding economy associated with supportive public policies for new investment and for retraining military personnel and defence workers for the civilian economy offers the potential for a high return from reduced defence spending: hence, ensuring prospects of a high rate of return from disarmament (where disarmament is viewed as an investment process: UNIDIR, 1993). Alternatively large-scale unexpected disarmament in a declining economy without supportive adjustment policies will result in high costs and much fewer benefits, offering a poor return from disarmament.

17 Interestingly, under previous ownership as VSEL, the Barrow yard had substantial business outside warship building, especially in General Engineering. However, post-privatisation, VSEL shifted its core business to submarines (Mort, 2002, p87).

A decision not to replace Trident announced in, say, 2016, but to continue with the construction of the remaining Astute submarines with the last one delivered around 2024/25 allows ample time for governments to introduce appropriate adjustment policies for those towns and areas likely to be the losers from such a decision. In some cases, towns have considerable experience of major shocks and changes. For example, Barrow-in-Furness had to adjust to major job losses following the end of the Cold War and after the Trident contract. Between 1990 and 1995, employment at the Barrow shipyard fell from 14,250 to 5,800 which was much greater than the possible job losses from a cancellation of the Trident replacement. For the future, questions arise as to whether cancellation of the Successor deterrent programme will lead to closure of the yard or to more warship building (for a study of shipyard closure, see Hess, *et al,* 2001). Much also depends on the state of the UK economy and labour market, including local labour markets, at the time of any cancellation of a Trident replacement.

## Barrow-in-Furness

44. BAE System's submarine facility at Barrow-in-Furness has three distinctive features. First, submarine construction requires skills and industrial facilities which are specific to submarines (see Chapter 6). Second, BAE Systems is the largest employer in Barrow which is a defence-dependent and submarine-dependent town (a single defence product town). In 2008, BAE Systems employed some 13% of the total employed workforce of Barrow and accounted for 55% of all manufacturing employment in the town (Nomis, 2011). Third, Barrow has a unique location in being the only major town in a geographically-remote region where there are few alternative sources of employment.

45. Unemployment rates for Barrow and other submarine-dependent areas are shown in Table 3. In 2011, Barrow had higher unemployment rates than its nearest towns of Carlisle and Lancaster and higher than for the North West Region. Manufacturing accounted for 23% of the town's jobs compared with 11.6% for the North West and 10.2% for Great Britain: hence, Barrow is a more manufacturing-intensive town. Also, gross weekly pay for all workers employed in Barrow was higher than for the North West Region suggesting that they made a net contribution to Regional output (weekly pay in Barrow was some 5% higher compared with the NW Region in 2011; NOMIS, 2011). The relatively higher pay in Barrow reflects the contribution of BAE Systems as a high skill employer.

**Table 3**

**Local Unemployment Rates, 2011**

| Town / area | Unemployment Rate (%) |
|---|---|
| **Barrow-in-Furness** | 8.7 |
| Carlisle | 6.2 |
| Lancaster | 5.6 |
| North West Region | 7.8 |
| **AWE: Basingstoke** | 5.4 |
| South East Region | 5.8 |
| **Rolls-Royce: Derby** | 8.8 |
| East Midlands Region | 7.4 |
| **HMNB Clyde: Glasgow** | 11.2 |
| Scotland | 7.8 |
| **Devonport: Plymouth** | 7.4 |
| South West Region | 6.0 |
| **Great Britain** | **7.6** |

**Notes:**

i) Unemployment rates are shown for the nearest town and each town is placed in its Region.

ii) Unemployment rates are for April 2010 to March 2011.

**Source:** NOMIS (2011).

## AWE: Aldermaston and Burghfield

46. The AWE specialises in the design and manufacture of the United Kingdom's nuclear weapons and most of its activities are dependent on a submarine replacement for Trident. There are, though, alternative possibilities that the AWE would be involved in lengthy decommissioning activities and there may be opportunities to expand into related work around verification. Unemployment rates in Basingstoke (taken as the nearest town) and in the South East Region are relatively low and considerably lower than the rates for Barrow and the North West Region. This suggests that there are alternative employment opportunities available if the AWE were to be contracted or closed. In addition, the AWE employs highly-skilled labour with transferable skills who are likely to find alternative jobs easily and quickly (e.g. scientists and technologists; computing skills). It is also possible that the AWE will find alternative markets for some of its highly-skilled labour and supercomputing facilities.

## Rolls-Royce: Derby.

47. Unemployment rates in Derby were slightly higher than in Barrow in 2011 but the East Midlands Region's unemployment rate was lower than the North West and lower than the national average. Derby is similar to Barrow in having a major manufacturing employer, namely, Rolls-Royce, although the company has a dominant civil business and is not so defence-dependent. Also, Derby is not geographically isolated and there are alternative employment prospects within the East Midlands Region.

48. One study estimated that about 80% of the staff required for the nuclear reactor at the Rolls-Royce Derby site had transferable skills. Staff used for submarine work could be transferred to other work at Rolls-Royce, such as naval surface ship design and support, commercial marine power (e.g. cruise liners) and manpower support for non-marine customers (e.g. aero-engine work). However, some staff could only be used for submarine work such as nuclear design specialists; and some facilities in the form of the core factory in Derby and the shore test facility in Thurso Scotland are highly specialised and can be used only for submarine work (Hartley, 1999).

49. Cancellation of a Trident replacement occurring in 2016 would mean the end of design and development work on its planned PWR3 design. However, there would still be a requirement for nuclear reactors for the Astute class of SSNs until around 2025 after which there might be further design work on a new reactor plant for a replacement attack submarine (see Chapter 8).

## HMNB Clyde

50. Glasgow is a city with a high unemployment rate suggesting limited prospects for alternative employment. Without a Trident replacement, there will be job losses affecting both military personnel and civilian staffs. The military employment contract means that Royal Navy personnel employed on SSBNs are more easily reallocated to alternative Navy jobs (e.g. surface ships; other shore duties). Their contract requires that they obey orders and the Navy will provide appropriate re-training.

51. The cancellation of a Trident replacement will mean the loss of some civilian jobs at HMNB Clyde; but Glasgow is part of the wider Clyde economy where there are alternative job prospects and the unemployment rate for Scotland is similar to that for Great Britain (see also CND, 2010).

## Devonport Dockyard: Plymouth

52. Devonport Dockyard is an important employer in Plymouth and the South West Region. About 400 local and regional firms supply Devonport. In 2011, the unemployment rate in Plymouth was similar to that for Great Britain whilst the South West Region had lower unemployment rates than the North West Region.

53. Devonport Dockyard (Babcock International Group) has the critical skills and facilities needed to service the nuclear reactors for submarines as well as to de-fuel and re-fuel them. The necessary skills include the capability to handle active waste, fuel handling and the necessary engineering skills for writing procedures and safety cases. Most of the staff and facilities are transferable between submarine and 'other work, where 'other work' includes work on surface warships and support with some commercial work. However, some staff and facilities are so highly specialised that they can be used only for submarine work (Hartley, 1999). Highly specialised staff include NSRP refuelling and support personnel; nuclear safety groups; and some weapons personnel. There will be some redundancies since the PWR3 reactor will not need in-service refuelling. Submarine-specific and highly specialised facilities include the reactor support plant; the re-fuelling and operational docks; fuel handling activities; and the nuclear utility infrastructure. Cancellation of the Trident replacement will have adverse employment effects (see Table 2) but Devonport will continue to have a major role in repairing and refitting the Astute class submarines (and possible further work on the Vanguard Life Optimisation Programme if the existing boats need another refit).

## The location of other suppliers

54. Estimates suggest that the UK submarine industry provides work for 1,200 firms in Britain located in most Parliamentary constituencies (there is a complete list of suppliers to the UK submarine industry and their locations by town/city: KOFAC, 2006). Table 4 shows towns and cities with 10 or more firms involved in supplying the UK submarine industry in 2010.

55. The regional distribution of spending by the UK submarine industry on the Astute class for the period 2004 to 2009 was:

i) North West England: £76 million spent with 90 suppliers at an average spend of £0.84 millions per firm.

ii) South West England: £256 million spent with 10 suppliers giving an average spend per firm of £25.6 million.

iii) Midlands: £238 million spent with 50 suppliers at an average spend of £4.8 million per firm.

iv) Southern England: £56 million spent with 70 suppliers at an average spend per firm of £0.8 million.

v) Eastern England: £8 million spent on 10 suppliers at a firm average spend of £0.8 million.

vi) North East England: £70 million spend on 50 suppliers with an average spend of £1.4 million.

vii) Wales: £4 million spent on one supplier.

viii) Scotland: £79 million spent on 40 suppliers with an average spend of almost £2million per firm (Furness Enterprise, 2011).

**Table 4**

**Location of Suppliers**

| Town / area | Number of firms |
|---|---|
| Glasgow | 44 |
| Barrow-in-Furness | 40 |
| Manchester | 35 |
| London | 23 |
| Warrington | 17 |
| Preston | 16 |
| Leeds | 14 |
| Poole | 14 |
| Southampton | 14 |
| Stockport | 13 |
| Portsmouth | 12 |
| Aberdeen | 12 |
| Bristol | 11 |
| Lancaster | 11 |
| Ulverston | 11 |
| Birmingham | 10 |
| Farnborough | 10 |
| Liverpool | 10 |
| Milton Keynes | 10 |
| Reading | 10 |
| Weymouth | 10 |

**Notes:**

Excluding all cities/towns with 9 or fewer firms supplying the UK submarine industry.

**Source:** KOFAC (2006).

## Conclusion

56. Four local economies are vulnerable to the cancellation of a Trident replacement; but Barrow-in-Furness is the most vulnerable. The job losses at BAE Systems from the cancellation of a Trident replacement will also have *induced multiplier effects* as redundant workers will reduce their spending in the local economy (respending effects: Asteris, *et al,* 2007). For example, there will be less consumer spending with impacts on local shops, restaurants and leisure outlets. Since Barrow is a relatively isolated town, it is likely that these respending effects will 'leak out' to other local economies so reducing the immediate impacts on Barrow (i.e. other local economies are the source of suppliers to Barrow). For illustration, an induced multiplier of 0.2 would mean a loss of 20 jobs locally for every 100 job losses at BAE Systems in Barrow.[18] However, the time-scale of the adjustment for Barrow is lengthy. Even with a Trident cancellation in 2016, there will remain substantial work on the Astute class SSNs to around 2024/25 resulting in an adjustment period of some 8-10 years (see Chapter 8). Such a lengthy adjustment period allows time for appropriate public policies to be introduced to ease any adjustment costs.

57. One study estimated the importance of submarines to Barrow. It concluded that "In employment terms, future contracts for Astute boats are overwhelmingly important. One more Astute boat will employ 2-3,000 people for 18 months to two years. The (best) diversification options might realistically realise... 500 jobs, this is not on the same scale as further Astute orders..." (PA, 2003).

18 Induced multipliers apply to all respending effects and would not normally be included in the analysis of employment losses in a town simply because redundant primary/direct workers find alternative jobs in the local economy so continuing respending effects. Barrow is different and redundant workers are unlikely to find new employment in the local economy: hence, induced multipliers can be included in the analysis for Barrow.

19 In 2009, MoD announced that it would cease to compile national and regional employment estimates for the UK defence industry "because the data do not directly support MoD policy-making and operations" (DASA, 2009).

20 Assuming a 25 year life for the Astute class means that the first Astute will reach retirement around 2035 and a five year life extension means around 2040. A replacement SSN submarine is assumed to require a seven year design and development period and a seven year construction period with some overlaps possible.

21 It has also been estimated that a one year gap in the production of nuclear reactors would cost about £51.4 million (HCP 59, 2006, Ev61).

# Chapter 8. Industrial Impacts

58. The UK submarine industry is unique within the UK defence industrial base. It supplies a single high technology product in small numbers to a single customer. It is a small part of the UK defence industrial base, accounting for some 3% of total industry employment.[19] However, Government policy is committed to retaining a UK-based industrial capability for nuclear-powered submarines (Chapter 4).

59. Cancellation of a Trident replacement will create problems for the future of the UK submarine industrial base. Currently, the replacement SSBN submarines will provide design, development and production work enabling the industry to be sustained until 2034/37 after which a new replacement for the Astute class SSNs might be available. Without a Trident replacement, then design and development work on a 'follow-on' replacement for the Astute class is unlikely to start before the early 2020s with initial service delivery starting around 2035-40.[20] As a result, cancellation of a Trident replacement in 2016 will lead to a possible gap in design and development work of up to nine years (2016-2025) and a similar gap in manufacturing work (2025 to 2035). Previous experience of the gap between the Vanguard class and the Astute class shows the difficulties and costs of retaining skill competence during such substantial gaps in both development and construction work (including the need to continue to demonstrate competence to retain a nuclear site licence). As a result, if the United Kingdom decides to cancel a submarine replacement for Trident, it will also face some difficult choices about the future of its nuclear submarine industry.

60. Without a Trident replacement, the United Kingdom has various policy options for its nuclear-powered submarine industry. These include:

i) Retain the industry and be willing to pay the costs of retention and re-constitution of the industry. For example, to retain the core design capability for nuclear-powered submarines requires a minimum design staff of some 200 personnel at an annual cost of £17.5 million (2010/11 prices: Rand, 2005). To sustain production resources, the UK submarine industry claims that it needs to produce one boat at 18 month intervals. This 18 month 'drumbeat' was later raised to one boat every 22-24 months. Delays to the Trident replacement has led to further delays to the seven boat Astute programme to avoid production gaps in the submarine construction industry. For example, work is due to start on the seventh Astute boat in early 2014 with the vessel planned to be ready to deploy in mid-2024.
   Overall, delays to the Successor nuclear deterrent submarine programme stretched out the seven boat Astute build programme by a further 96 months in 2010-11 (HCP 1520, 2011). All of which suggests that the length of drumbeat is a flexible rather than a rigid time-period but with different employment levels. More analysis and evidence is needed on the costs and benefits of different lengths of drumbeat (e.g. impacts on unit costs and on employment).[21]

ii) Withdraw from submarine manufacturing and import future nuclear-powered submarines from either France or the United States. The extra costs of importing submarines would have to be compared with the costs of retaining a UK submarine industry.

iii) Collaborate on development and production of future nuclear-powered submarines with either France or the United States. In principle, collaboration would allow development costs to be shared and production orders combined to achieve economies of scale and learning. In practice, international collaboration often results in cost penalties and delays.

iv) Withdraw from nuclear-powered submarines and replace them with conventional diesel-powered submarines. These could be either new UK designs or imported from established suppliers in Germany or France; or built under licence from either of these countries. A judgement is needed on whether conventional submarines would meet the United Kingdom's operational requirements (e.g. protection of its aircraft carriers and amphibious fleet).
   There is a prior more complex question related to the United Kingdom's foreign policy objectives and its world military role. The SSNs main role is protection of the SSBNs: without SSBNs, does the United Kingdom need its SSNs? The future of aircraft carriers as a technology relevant to the late twenty first century is also questionable. Overall, decisions about SSBNs, SSNs and aircraft carriers are related to the United Kingdom's world military role.

## Conclusion

61. This Chapter has outlined some possible industrial impacts of the Trident replacement decision. Again, it is not argued that Trident should be replaced to retain the UK submarine industry or to support Barrow-in-Furness (although such claims have been made). It is sufficient to identify possible industrial impacts of the choice so that policy-makers are fully-informed of the consequences of their choices.

# Chapter 9. Wider Economic Benefits

62. Wider economic benefits usually comprise jobs, any resulting exports or technology spin-offs for the rest of the economy. Doubts are often expressed about some of these wider economic benefits and whether they are forms of market failure which would justify state intervention in these areas. Nor are there readily available published data on exports and technology spin-offs. Often, such data are obtained from a detailed reading of Company Annual Reports. This Chapter presents some limited examples of wider economic benefits: there are probably many more. Data are not available on the market value of these wider economic benefits (e.g. Company Reports do not usually provide contract values for exports and technology transfers). Employment and skills benefits were assessed in Chapters 5 and 6.

63. UK nuclear-powered submarines are not exported. However, there are exports of some equipment and technologies. UK supplier firms have established reputations from work on nuclear submarines and have exported some equipment as well as technical advice and technologies. For example, MacTaggart Scott has relied on the UK domestic market through its involvement in supplying equipment to Royal Navy submarines to establish their reputation in export markets. In 2006, the firm exported 60% of its output (HCP 59, 2006, Ev12). MacTaggart Scott is also involved in work on the Australian Collins class submarines and on the Spanish submarine programme. In addition, Wellman Defence supplies oxygen generation systems for the new generation of French SSNs (based on systems for the Astute class). Previously, earlier work on the Vanguard/Trident submarine led to the development of a radome, some of which were exported (Mort, 2002, p43).

64. Within the wider economic benefits, there are also examples of possible technology transfers and spin-offs arising from the UK nuclear submarine industry. Published examples include Weir Strachan and Henshaw supplying AWE; the possible application of Rolls-Royce technology on nuclear submarine reactors to civil nuclear power generation; the possible applications of AWE technology to civilian uses; and the transfer of 'best practice expertise' from nuclear submarines to civilian nuclear technology (HCP 59, 2006, Ev63). The development of advanced radiological detectors and sensor technologies for use within the submarine programme has resulted in improved technology being available to the civil nuclear power sector and other industries that utilise ionising radiation (KOFAC, 2007). The active mount technology developed to reduce the acoustic signature of a submarine has possible applications for engine mounts used in prestige cars (KOFAC, 2007). Further sources of technology transfer arise from staff mobility from the UK nuclear submarine industry to other UK industries. The submarine industrial base has also contributed to the development of UK science and engineering skills through links with universities at Lancaster, Liverpool, Newcastle, Sheffield and Warwick (e.g. radiological sensing technology; acoustic signatures of submarines; the development of advanced gearbox designs: KOFAC, 2007).

## Conclusion

65. There is evidence suggesting that there are wider economic benefits from the UK nuclear submarine industry. It is not obvious that all of these wider benefits represent genuine market failures which would justify state intervention.[22] And even where there are genuine market failures, these have to be identified and valued and the appropriate form of state intervention has to be assessed. For example, depending on the form of market failure, it might be that the most appropriate form of state intervention might be competition policy or subsidies for research and development. A Trident replacement is not an obvious solution to removing failures in labour, research and development and foreign exchange markets! Even where wider economic benefits exist and represent market failures, a Trident replacement is not the most cost-effective method of removing failures in these various markets.

22 Market failures mean that private markets are not working properly and are failing to fully respond and satisfy consumer preferences. Market failures arise from imperfections (e.g. monopoly), externalities and public goods. Market failure provides an economic basis for state intervention (Tisdell and Hartley, 2008).

# Chapter 10. Overall Assessment of the Employment and Industrial Impacts

66. The BASIC Trident Commission is attempting a broad assessment of the costs and benefits of options facing Britain in the decision to replace the Trident system. This Chapter estimates some of the costs of the programme and assesses the impacts of cancellation: a more detailed assessment is beyond the scope of this paper and will be dealt with by the Commission elsewhere. In this Chapter, all cost and employment estimates should be regarded as illustrative, presenting broad orders of magnitude.

## Costs of the Trident replacement

67. The official cost estimates for the ***acquisition*** of a four boat Trident replacement submarine fleet are some £20 billion to £25 billion (2011 prices). Within this total, submarine costs range from £14.6 billion to £17.5 billion, giving an average cost for each submarine of £3.65 billion to £4.375 billion (2011 prices). Acquisition costs occur over the 30 year period 2007 to 2037. For simplicity, it is assumed that the upper bound cost estimate of £25 billion is the final outcome. As a result, estimated average annual acquisition costs for the four boat fleet are some £0.83 billion per year (though there will be periods when spending is significantly higher at peak production points). Inevitably, high technology defence equipment is characterised by cost overruns and delays in delivery. For major UK warship programmes, cost overruns of 40% are typical with delays of up to three years.[23] On the Astute SSN submarines, cost overruns were 60% with a delay of almost five years (HCP 489, 2010; HCP 1520, 2011). Also, the cost figures are based on the 2006 White Paper (Cmnd 6694, 2006) excluding the costs of replacing the Trident missile system after 2042.

68. ***Annual running costs*** for a four boat fleet are estimated at £2.1 billion with about half of these running costs attributable to the costs of the AWE which are expected to peak around the year 2020. On this basis, the annual running costs of the four boat fleet are about £1.1 billion (2010/11 prices: without AWE costs).
This study assumes annual running costs of £2.1 billion over the period 2037 to 2062 (25 years after the delivery of the fourth boat in 2037). The outcome is total running costs of £62.4 billion for the period 2028 to 2062 (based on average annual running costs of £1.1 billion over the nine year initial period when the boats are being phased into service).

69. **Aggregating acquisition and annual running costs suggests total costs for a four boat Trident replacement (Option 1A) of £87.4 billion over the period 2007 to 2062: hence, average annual costs of some £1.6 billion (2010/11 prices).**[24] Possible cost escalation for both acquisition and running costs will raise these cost estimates. For example, cost escalation of 40% on acquisition costs will raise total acquisition costs to £35 billion (2010/11 prices).

70. The alternative to a four boat Trident replacement is a three boat fleet (Option 1B). This will produce cost savings in both acquisition and annual running costs. For acquisition, the costs of a fourth boat are likely to be less than the average costs of a four boat fleet (i.e. marginal costs are less than average costs). For illustration, assume that the cost of a fourth boat is 80% of average costs (i.e. 80% of £4.375 billion which is £3.5 billion): hence, a three boat fleet leads to **savings in acquisition costs of £3.5 billion over the period 2034 to 2037**. There will also be savings in annual running costs. Assuming annual running costs of some £1.1 billion leads to average running costs of £275 million per submarine (excluding AWE costs which are assumed to be a fixed cost regardless of the number of boats). On this basis, a three boat fleet will result **in annual cost savings of £275 million over a 25 year period from 2037 to 2062 resulting in an aggregate saving in running costs of some £6.9 billion. Total cost savings for a three boat fleet are estimated at £10.4 billion over a 28 year period equivalent to annual cost savings of £370 million over this period (2010/11 prices).**

23 These data were based on the average cost overruns and delays for three UK major warship programmes comprising Type 45 destroyers, the new aircraft carriers and the Astute submarines. Excluding the Astute submarine gives cost overruns of 1.36 and delays of 24 months (HCP 489, 2010).

24 For this study, all costs over future years are presented in the usual format, namely, an aggregate of annual costs at constant prices. Ideally, costs over future years need to be expressed as present values adjusted using an appropriate discount rate (e.g. on the basis that £1 today is worth more than £1 in one year's time: £1 now might only be worth, say, 96p in one year's time: see Dunne and Perlo-Freeman, 2007). Also, costs are adjusted to reflect the build-up and run-down of the fleet. Some studies include the costs of protection forces in costing the Trident replacement: this study does not include such costs (Ritchie, 2010). Nor does it include the costs of replacing the Trident missile system after 2042.

## Cancellation of the Trident replacement

71. Assume that the four boat Trident replacement is cancelled in 2016 (Option 2). At this point, some £3.9 billion will have been spent on the programme. **Adjusting for these 'sunk costs' results in total cost savings of £83.5 billion over the period 2016 to 2062, equivalent to an annual saving of some £1.8 billion.** Here, care is needed in interpreting the total cost savings from cancellation. First, the total savings accrue over the period 2016 to 2062: they are not available instantly, nor are they available in perpetuity. Second, the annual cost saving are averages which will vary during the acquisition phase reflecting build-up, peak and troughs in spending. Third, the costs savings are gross figures which do not reflect cancellation costs comprising payments to contractors for cancellation and the costs for decommissioning the SSBN Vanguard fleet, including its infrastructure (these points will be dealt with in other BASIC studies). Amongst the contractors, those most vulnerable to cancellation are the AWE, BAE Systems at Barrow and the nuclear reactor plant at Derby. In the interim, continued work on the Astute programme will provide work at Barrow and Derby to around 2025. Also, additional costs might be incurred if the existing SSBN fleet is retained to, say, 2028 (Option 3: these are extra costs from running-on the existing fleet). In other words, the estimated cost savings of £83.5 billion from cancellation should be regarded as an upper bound estimate which needs to be adjusted downwards to reflect all costs associated with cancellation.

72. An alternative to the current SSBN fleet would be a submarine deterrent based on four additional Astute submarines with nuclear-armed cruise missiles. This option involves considerable unknowns but is likely to be cheaper although less effective than a four boat Trident replacement. Such an option would be a follow-on to the current Astute programme which originally was planned to end in 2022 but was recently extended to around 2024/25[25]. Each Astute would be produced at a rate of one boat every two years starting in 2025 and ending in 2033 (an 8 year acquisition period and a 25 year operational life). On this basis, the total acquisition costs for an Astute-based cruise missile deterrent might be some £5.6 billion (priced at £1.4 billion per boat: HCP 489, 2010; HCP1520, 2011). Annual running costs are estimated at £550 million for the four submarines plus AWE costs at £1 billion per annum (AWE costs are assumed to be unchanged from the Trident replacement which is an upper-bound guesstimate). **The aggregate total cost for the Astute-based cruise missile option over the period 2025 to 2058 might be some £56.5 billion (submarine and annual running costs only) equivalent to an annual average cost of about £1.7 billion over the period.**

**This total cost is considerably lower than the four boat Trident replacement estimated at £87.4 billion. However, this cost estimate for an Astute cruise missile option is surrounded by considerable uncertainties.**

73. The major uncertainties for the Astute-cruise missile option concern the costs of the missile system. Sea-launched U.S. Tomahawk cruise missiles have been estimated to cost some £1 million to £1.3 million per missile. But there are two sources of additional and unknown costs, namely, the costs of adding a UK nuclear warhead to the U.S. missiles and the costs of ensuring that the United Kingdom retains an independent industrial capability for the missiles. Currently, the UK aerospace industry does not have a capability for the independent design and development of an advanced cruise missile. Creating such an industrial capability will be costly and will take time: hence, the attraction of importing U.S. cruise missiles and adding a UK warhead (c.f. Trident missiles). An alternative to creating and retaining a UK industrial capability for cruise missiles might be to purchase sufficient numbers from the United States for stockpiling to meet all possible future contingencies (assuming that the United States would be willing to supply such missiles for a UK nuclear deterrent). The analysis is further complicated by the assumptions about the ballistic missiles and their costs which will be deployed on any UK Trident replacement strategic nuclear deterrent force (Willett, 2010).

74. Table 5 presents a summary of the major cost and employment impacts of the Trident replacement decision and the alternative of cancellation of the project followed eventually by the complete withdrawal of all nuclear-powered submarines after around 2052[26] (SSBNs and SSNs): this represents the worst case scenario based on Table 1 with total employment attributed to the UK submarine fleet of almost 31,000 personnel. In fact, the United Kingdom is likely to retain a submarine fleet after 2052 which will support some of these jobs which would otherwise be lost; but it might be a fleet of conventional diesel-powered submarines.

25 The 2010 Strategic Defence and Security Review confirmed a requirement for a seven-boat Astute fleet. However, with delays to the Successor Deterrent Programme, the Astute programme's timeframe has been extended to avoid a production gap in submarine construction. Astute boat four is now planned to enter service in 2018 (HCP 1520-II, 2011).

26 End dates are approximations where 2052 could be 2050 to 2055. Also, there will be additional UK spending on a new missile system after 2042; but the employment impacts from such spending will be in the United States, so not affecting the UK employment estimates presented in this Chapter.

**Table 5**

**Cost and Employment Impacts**

| Options | Costs (£bn) | Cost savings (£bn) | Employment |
|---|---|---|---|
| Trident replacement (4 boats) | £87.4bn (2007-2062) Annual average: £1.6bn | | BAE: 11,000 (2020-2037) AWE: 9,000 From 2037: Operations / Devonport and suppliers: 5,880 |
| Cancellation of Trident replacement and end of SSNs in 2052 | | £83.5bn (2016-2062) Annual average: £1.86bn | Worst case: Loss of 9,200 manufacturing industry jobs after 2037; followed by a further 21,700 jobs after 2052 |

75. To summarise, a Trident replacement will support almost 26,000 jobs over its life-cycle (based on four boats and including some 1,850 Navy personnel jobs). The totals comprise the following employment numbers:

| | |
|---|---|
| BAE at Barrow-in-Furness: | 6,045 |
| BAE suppliers: | 5,017 |
| AWE: | 4,500 |
| AWE suppliers: | 4,500 |
| Devonport: | 1,590 |
| Devonport suppliers: | 1,590 |
| Operations and support: | 2,700 |
| **TOTAL** | **25,942** |

These employment estimates are upper-bound figures. They make no allowance for improvements in labour productivity over the life-cycle of a Trident replacement and some of the estimates of employment in the supply chain need to be treated with considerable caution. An alternative lower-bound estimate based on numbers directly employed, excluding military personnel, is some ***14,000*** civilian jobs attributed to the Trident replacement;[27] but this excludes any employment in the supply chains which is clearly unrealistic. A further employment estimate needs to allow for productivity improvements.

For example, a 20% productivity improvement over the life-cycle of the Trident replacement would reduce the upper-bound employment estimate to some 21,000 jobs and an estimate in this region might be regarded as a 'best guess.' Similarly, cancellation of a Trident replacement and the complete withdrawal of all nuclear-powered submarines might lead to some 31,000 job losses which is an upper-bound estimate (including Navy personnel).

76. Table 5 presents a simplistic and static view of the response of firms to the cancellation of the Trident replacement. Instead, private profit-seeking firms will respond to major project cancellations by seeking alternative markets and new profit opportunities. They are likely to enter new markets either in the United Kingdom or overseas; they might obtain new defence contracts; or they might merge with other firms in new markets. As a result, the estimated job losses from cancellation of the Trident replacement shown in Table 5 might be considerable over-estimates. More realistically, the jobs at risk will be those in the direct category amongst the prime contractors: firms in the supply chain are more likely to find alternative work for their labour and capital resources (e.g. submarine work might be a small proportion of their total business). On this basis, some 14,000 direct jobs are at risk; but, again, firms will seek new markets and alternative employment opportunities so that job losses will be considerably lower than the 14,000 figure. Where there are redundancies, labour, especially skilled labour will often find alternative employment and sometimes quite quickly (Hooper, *et al,* 1995).

27 Based on direct employment at BAE, Rolls-Royce (1,000 personnel), AWE, Devonport and civilians in operations and support. Whilst Rolls-Royce is a supplier to BAE Systems, it builds nuclear reactors which supply nuclear-powered submarines only: hence, it is included in the estimate of direct employment.

## Some alternatives

77. The costs savings from Trident cancellation are available over the period 2016 to 2062: hence, alternative uses of the funds and resources only occur over this period.[28] Alternatives include spending on conventional defence equipment and forces, spending on other public sector civil programmes and tax reductions.

78. Alternative spending will create and support jobs in various parts of the United Kingdom. The numbers of jobs created will depend partly on wage rates (where wages reflect labour productivity) and partly on an industry's labour-intensity. More jobs will always be created at lower wage rates. For example, construction is a relatively low wage and labour-intensive activity. As a result, construction will usually create more jobs per unit of expenditure than in the more capital-intensive and higher wage defence industries, including the UK submarine industry. There is, though, a more fundamental issue about the jobs impacts of a Trident replacement and its alternatives. A Trident replacement has to be assessed in terms of its contribution to UK defence, protection and security (Hartley, 2010). The task of the UK Ministry of Defence is to protect the United Kingdom and its citizens and not to protect UK jobs.

79. Caution is also needed in identifying apparently simple and attractive alternatives to spending on a Trident replacement. Resources currently employed in the UK submarine industry cannot be instantly and costlessly transferred to, say, construction and house building. Such transfers are not like shifting cash from one pocket to another: the world is not one of 'magic wand economics.' Instead, achieving a re-allocation of resources from the UK submarine industry to other industries will take time and involve transition costs (UNIDIR, 1993).

28 This means that the Trident cancellation savings will not contribute to the UKs deficit reduction programme which is planned for 2010/11 to 2016.

29 For example, if Scotland votes for independence, there might be questions about the future of the warship yards in Scotland, Current MoD policy favours retaining a UK warship building industry, including submarine construction. Scottish independence might mean that future warship building is undertaken in English shipbuilding yards, such as Barrow and Portsmouth.

## Conclusion

80. Decisions about a Trident replacement will have industrial and employment consequences which have been the focus of this study. All choices involve gainers and losers. A decision not to proceed with a Trident replacement will have major impacts on local economies in Barrow, Aldermaston, Derby and Plymouth. These are the areas likely to lose from cancellation of a Trident replacement which will also have major impacts on the future of the UK submarine industry. A cancellation decision will not occur before 2016 and there will be a long adjustment period which allows policy-makers to introduce adjustment policies for areas likely to be affected adversely. Adjustment policies include labour market policies associated with training, re-training, mobility, career advice and information as well as appropriate income-deficiency payments for labour groups worst affected by job loss (UNIDIR, 1993).

81. For the UK submarine industry, there is work on the Astute submarines to around 2025 after which there are possibilities of follow-on work or of alternative warship building at Barrow.[29] Without a Trident replacement, there will be serious questions about the future viability of the UK submarine industry. BAE Systems is a world-class defence specialist so it is unlikely that it will decide to enter completely new civil markets. Often, proposals for conversion from defence to civil activities (e.g. tanks to tractors; submarines to washing machines) represent a triumph of hope over experience (magic wand economics). Such proposals fail to recognise the basic economics of conversion, namely, its costs and the task of identifying profitable civil markets. Without alternative warship building work, then Barrow-in-Furness and other city economies such as Aldermaston and Plymouth need appropriate Government adjustment policies. Nor must it be forgotten that other towns and areas have adjusted and adapted to the loss of a major employer (e.g. UK pit closures of the 1980s). Generally, labour markets work reasonably well especially during times of economic expansion. Where such markets fail to work properly and fail to adjust quickly, Governments need appropriate adjustment policies to assist the affected area to adjust to major changes.

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# Notes

Options for the United Kingdom's Nuclear Weapons Programme

# Defence-Industrial Issues: Employment, Skills, Technology and Regional Impacts

Keith Hartley

Discussion Paper 2 of the BASIC Trident Commission

*An independent, cross-party commission to examine UK nuclear weapons policy*

## The BASIC Trident Commission

BASIC has set up an independent, cross-party commission to examine the United Kingdom's nuclear weapons policy and the issue of Trident renewal. The Commission is operating under the chairmanship of:

**Lord Browne of Ladyton** (Des Browne), former Labour Secretary of State for Defence;

**Sir Malcolm Rifkind**, former Conservative Defence and Foreign Secretary; and

**Sir Menzies Campbell**, former leader of the Liberal Democrats and Shadow Foreign Secretary.

Other members of the Trident Commission are:

**Professor Alyson Bailes**, Former Head of the Security Policy Department at the Foreign and Commonwealth Office

**Sir Jeremy Greenstock**, former UK Ambassador to the UN

**Lord Guthrie of Craigiebank**, former Chief of the Defence Staff

**Professor Lord Hennessy of Nympsfield**, Queen Mary, University College London

**Lord Rees of Ludlow**, Astronomer Royal and recent President of the Royal Society

**Dr Ian Kearns**, Chief Executive of the European Leadership Network.

It was launched on 9 February 2011 in Parliament. The Commission is:

- Examining the international context within which the decision on Trident renewal now sits;
- Assessing current UK nuclear weapons policy and the policy of the United Kingdom in efforts to promote multilateral nuclear disarmament and non-proliferation;
- Examining the costs associated with Trident renewal and any potential consequences for non-nuclear portions of the defence budget;
- Considering all possible future policy options with the potential to maintain UK national security while further strengthening efforts at multilateral nuclear disarmament and non-proliferation.

The Commission will report in late 2012.

### Why the Commission is sitting

The last Labour Government committed to renewing Britain's nuclear deterrent in 2006-07. The current coalition government recommitted to this decision in principle in its October 2010 Strategic Defence and Security Review (SDSR), but also decided to delay the timetable for the construction of the replacement submarines until after the next election (which must take place by May 2015). This has created a window of opportunity for further deliberation. The Commission was convened to make the most of this opportunity.

BASIC Trident Commission

We are living through a period of dramatic change in international affairs with new powers emerging, increasing nuclear proliferation risks within both the community of states and terrorist groups, and growing financial pressure on western defence budgets. There is a strong case, in the national context as well the international, for conducting a fundamental review of UK nuclear weapons policy. BASIC Trident Commission is filling the gap left by Government, by facilitating, hosting and delivering a credible cross-party expert Commission to examine this issue in depth.