



# & Trident Employment

The UK's industrial and technological network  
for nuclear weapons

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## Acronyms

AWE	Atomic Weapons Establishment
BAEC	Barrow Alternative Employment Committee
CAD	Computer Aided Design
CTBT	Comprehensive Test Ban Treaty
CVF	Future Aircraft Carrier
CSB	Clyde Submarine Base (Faslane and Coulport) formally HM Naval Base Clyde incorporating Faslane Naval Base and Royal Naval Armament Depot, Coulport
DIS	Defence Industrial Strategy
DSTL	Defence Science and Technology Laboratories
FOS	Follow-on System to the current generation of Trident
FTNW	Future Theatre Nuclear Weapon
GOCO	Government-Owned Company-Operated
JSF	Joint Strike Fighter Aircraft
KOFAC	Keep Our Future Afloat Campaign
MDA	Mutual Defence Agreement
MIS	Maritime Industrial Strategy
MUFC	Maritime Underwater Future Capability
NSRP	Nuclear Steam Raising Plant
NATO	North Atlantic Treaty Organisation
NPT	Nuclear Non-Proliferation Treaty
PBTC	Porton Bioscience and Technology Centre (PBTC)
PWR	Pressurised Water Reactor (nuclear power plant for SSBN and SSN)
R&D	Research and Development
RDA	Regional Development Agency
SSBN	Sub-surface Ballistic Nuclear Submarine
SSN	Sub-surface Nuclear Submarine

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## About the author

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## Foreword

**T**HE future of Britain's nuclear weapons system, Trident, has been at the top of the political agenda recently. In March 2007, the Government rushed a vote through Parliament, securing agreement to replace the submarines that carry Britain's weapons of mass destruction beneath the oceans.

Although the Government achieved Parliamentary support for its plans, it also faced the largest back-bench rebellion on a domestic issue since coming to power in 1997. And this parliamentary revolt was just the tip of the iceberg of opposition: the majority of public opinion was opposed, faith communities spoke out, and many who had previously backed nuclear weapons during the Cold War, now opposed them as irrelevant. Many trade unions were strong in their opposition too – in September 2006, TUC Congress voted overwhelmingly to oppose Trident replacement. But opposition was not unanimous because, understandably, concern remains in some sectors about the employment consequences of getting rid of nuclear weapons.

This publication – made possible thanks to Unison – makes the case that a decision not to replace Trident need not be detrimental to the workforce. As with so many things, it comes down to a question of government priorities. Investment in the nuclear weapons sector is substantial – up to £76 billion for the acquisition and running costs of a replacement. Consider what could be done if that money was spent elsewhere: if invested in the health service or housing, education or alternative energy forms, those billions could provide both significant employment in construction, engineering, nursing, teaching, scientific research and a range of other employment sectors and, at the same time, contribute substantially to the social wellbeing of the British people. That taxpayers' money could create economic growth and substantial job opportunities, without providing a means of killing and mass destruction.

This is an important debate – for the workforce, trade unions, and society as a whole. We invite you to read this well-researched publication and engage in the debate. Let's get the issues out in the open. After all, our futures depend upon it.

*Kate Hudson*

Kate Hudson  
Chair, Campaign for Nuclear Disarmament



## Executive summary

SINCE the 1950s the UK has invested billions of pounds in an industrial and technological network for nuclear warheads and ballistic missile submarines (SSBN). The main sites of the nuclear network are the Atomic Weapons Establishment (AWE) Aldermaston, run by a consortium of Lockheed Martin, BNFL and SERCO and responsible for the warheads; the BAE Systems shipyard in Barrow-in-Furness, West Cumbria, where SSBNs are built; the Devonport dockyard in Plymouth for refits of the submarines, recently acquired by Babcock Naval Services; and the Clyde naval base at Faslane and Coulport on the Gareloch, north of Glasgow, where the submarines undergo routine maintenance and where the nuclear warheads are stored, also run by Babcock Naval Services.

Collectively, these represent the largest, and on-going, capital investment programme ever undertaken by the state, in order to provide facilities for the giant submarines that house the Trident D5 missiles, including three docks each the length of Wembley stadium and as high as a ten-storey building, and for the sophisticated laser and hydrodynamic testing equipment at AWE that is being upgraded in order to develop a new generation of variable yield nuclear warheads for both strategic and sub-strategic roles.

At the same time, the private sector companies that own or run these facilities have all carried out substantial rationalisation of employment in order to cut costs. The largest has been at Barrow-in-Furness where employment has declined from 12,500 in 1990 to 3,400 in 2006. Overall employment in the network has fallen by nearly 60% from 26,300 to 11,300, during the same period. This also reflects the decline in military-related employment in the UK, which according to MoD figures, fell from 510,000 in 1991/2 to 260,000 in 2003/4.

If a replacement for Trident (FOS – follow on system) goes ahead, it is clear that employment levels will be lower and costs will be higher than on the original Trident programme. A conservative estimate would put employment at 35-40% less while costs on FOS will be anywhere between 25%-100% more. In employment terms, therefore, FOS represents a very poor rate of return for a multi-billion pound investment.

The White Paper on the future of the UK's nuclear weapons is a quasi-democratic exercise in the legitimising of decisions already made in secret to modernise the nuclear weapons network around a new generation of nuclear submarines and warheads and to maintain compatibility with the United States over its future options for nuclear missiles

Employment levels will be lower and costs will be higher than on the original Trident programme.

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and other technologies on which the UK is dependent. This nuclear dependency has bred a form of tacit, and unacknowledged, obligation to support the USA in its broader military and foreign policy goals.

The main function of the White Paper was to close down democratic debate by making it seem imperative that a decision be taken now in order to have a replacement system ready in 2024, when it is clear that the operational lives of the existing fleet of submarines could easily be extended. A delay would provide time for serious debate and consideration of other options, including a renewed effort to support nuclear disarmament negotiations under the provisions of the nuclear Non-Proliferation Treaty.

If FOS were delayed, other submarine design, production and refit work could be carried out as compensation for the yards, but pressure would still exist on employment levels because of the ongoing corporate restructuring in the industry – the latest being the takeover of DML by Babcock Naval Systems, giving it an effective monopoly in both submarine maintenance and refit. Under the MoD's Maritime Industrial Strategy (MIS) for the naval shipyards and support industries, there is a clear requirement on companies to reduce what the MoD sees as wasteful duplication. Further job losses at all the major sites are likely in the medium term.

Under a non-nuclear defence policy, there would be work on the decommissioning of warheads and submarines but, over a period of five to ten years, the nuclear network would be run down and dismantled. The government could use the savings from FOS to support new civil R&D and investment in sectors like renewable energy. For example, a major programme of offshore wind and wave power could generate fifty per cent of the UK's energy needs, substantially reduce carbon emissions and enhance security of supply, while creating new industries generating 25,000-30,000 skilled jobs.

AWE, in this context, could become a leading centre for applied civil R&D in the physical sciences, leading, for example, on climate change modelling, and for verification and compliance technologies during a programme of international nuclear disarmament. Where opportunities for civil work are limited, as at the specialised shipyards, more emphasis should be placed on broader regeneration programmes to help diversify the local economies through a combination of both manufacturing and service sector work, as have been carried out in many areas across the country when dealing with the loss of staple industries.

The employment restructuring required under a non-nuclear defence policy is relatively small compared to many that have been experienced in other sectors of the economy and will be carried out over a reasonably extended period, allowing sufficient time to put in place civil reinvestment and regeneration programmes that more than compensate for the loss of nuclear weapons work.

## Introduction

**I**N 1968, *Resolution*, the first of the UK's Polaris ballistic missile submarines (SSBN), began active service. The government's decision to replace Trident will result in the construction of a new generation of submarines that will become operational in the mid 2020s to the early 2030s, and on patrol for another thirty years, or possibly longer. The UK, then, will have had at least one submarine continuously at sea for a century, capable of delivering nuclear weapons over thousands of miles and with a destructive capacity far more powerful than the bombs dropped on Hiroshima and Nagasaki.

An elite group of politicians, civil servants and military commanders working in secret, from the first post-war government, to the present government has been determined that the maintenance of the UK as a nuclear weapons power remains an absolute national priority. Moreover, according to the government, the UK must have a system capable of satisfying the esoteric tests of nuclear deterrence, being supposedly undetectable, invulnerable to pre-emptive attack, or to interception of missiles once launched.

Extraordinary amounts of public money have been spent on warhead research, development and production; on the design and manufacture of submarines; and on the construction of essential facilities for servicing nuclear weapons, to say nothing of the day-to-day operational costs and decommissioning costs. With that expenditure the government established an indigenous industrial and technological base for nuclear weapons, involving highly specialised scientific, technical and manufacturing workers. This network is the focus of research here, from its early evolution through to the present day, as well as its likely structure by the time of the Vanguard follow-on system (FOS) programme in the next decade.

Chapter One provides a brief historical background that covers the transition from an air to sea-based nuclear system in the early 1950s and 1960s, and the crucial relationship with the United States, not only for the purchase of Polaris missiles, but also support for warhead and submarine design. The consolidation of the network and the transition from Polaris to Trident in the 1980s to the 1990s is highlighted for the multi-billion pound investment programme in facilities to accommodate the much larger submarines and missiles. At the same time, a major rationalisation of the workforce took place, reflecting the general decline in arms-related employment during this period. Chapter Two is an assessment of the industrial and technological implications of the

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government's decision to replace the Trident submarines with a follow-on system costing an estimated £15 billion to £25 billion. The pattern of employment is expected to be similar to the original Trident programme but will be at substantially lower levels. The main pre-occupation of the government is to maintain a core element of expertise in nuclear weapons design and manufacture and to ensure a smooth transition from the existing work on conventional nuclear submarines (SSN) so that design work can begin now, leading to construction of FOS beginning in 2016/17.

Chapter Three provides alternative scenarios to immediate replacement and assesses their likely employment implications. A military continuity scenario looks to compensate for any delay to FOS by providing other armaments work including conventional nuclear submarine programmes and nuclear warhead maintenance. Alternatively, a disarmament and arms conversion scenario is put forward, where the UK abolishes its nuclear weapons as part of an international agreement on nuclear disarmament, and re-invests the savings in civil R&D and production, alongside local regeneration programmes for the few areas where nuclear weapons work remains significant, in order to provide alternative employment.

The Conclusion draws together these themes to highlight the low levels of employment generated through nuclear weapons, the continued dependency of a small number of communities on nuclear weapons programmes, despite previous waves of redundancies, and the economic benefits to be gained if the UK carries out nuclear disarmament.

## CHAPTER ONE:

## Historical background

### Development and consolidation: 1945-80

It is not the intention, here, to provide a detailed history of British nuclear weapons policy but rather to highlight the main decisions relating to the development of the nuclear weapons industrial and technological network (referred to here as the nuclear network) over the last sixty years.<sup>1</sup> The story can be traced back to the first post-war Labour government under Clement Atlee, or more accurately, an elite group involving the Prime Minister, the Foreign and Defence Secretaries, leading civil servants and military commanders acting in secret.

The United States had withdrawn co-operation on nuclear weapons research after the completion of the Manhattan project at the end of the Second World War and the Labour leadership was determined to build an independent capability. Work on warhead design and manufacture was begun in 1950 by scientific and technical personnel at the Aldermaston Atomic Weapons Research Establishment, near Reading in Berkshire. (Subsequently it was renamed the Atomic Weapons Establishment (AWE) to more accurately reflect its role across the full spectrum of research, production, maintenance and decommissioning.) AWE also incorporated the Burghfield site close to Aldermaston, where final assembly of warheads took place, and a Cardiff factory where non-critical elements of the warhead were manufactured.

Plutonium was provided by the first generation of, ostensibly, civil nuclear power stations, and after the first successful test explosion in 1952, the RAF took responsibility for the Blue Danube free fall bomb, followed by the Blue Steel air-to-surface missile.<sup>2</sup> In 1958, as the Cold War entered a new phase, the Macmillan government successfully negotiated the UK/US Agreement for Co-operation on the Uses of Atomic Energy for Mutual Defence Purposes (MDA), that allowed the UK to draw on US warhead design, on access to special materials including tritium to enhance explosive yields, and on the use of nuclear propulsion equipment for the first generation of nuclear submarines.<sup>3</sup>

During this period, work began on a joint project, the Skybolt air-launched stand-off missile, that the UK saw as fundamental to its future nuclear posture. But the Kennedy administration cancelled Skybolt in 1962, much to Macmillan's embarrassment, and after hasty negotiations an

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agreement was reached to purchase the submarine-based Polaris missile as an alternative.<sup>4</sup> This decision was to have a profound effect on the industrial and technological network supporting nuclear weapons in the UK.

Interestingly, the Labour Party, under Harold Wilson, had entered the 1964 General Election campaign with a commitment to cancel Polaris, ridiculing the whole idea of an independent nuclear deterrent and arguing that there were no circumstances in which the UK could launch nuclear weapons against the Soviet Union in isolation from its NATO allies. On election, Wilson and his Defence Secretary, Dennis Healey, came to the conclusion that the costs of cancellation would be too high and decided to continue with the programme, but the emphasis was on Polaris as a contribution to NATO's nuclear capabilities rather than as an independent force.<sup>5</sup>

The ballistic nuclear submarine elements of the network were firmly established during this period, with two of the submarines built at the Vickers shipyard in Barrow-in-Furness, Cumbria, and two at the Cammell Laird shipyard in Birkenhead, Liverpool through from 1964 to 1968. Rolls Royce Associates, based in Derby, provided the nuclear propulsion plant (PWR). Polaris submarines were, essentially, a modification of the existing Valiant Class, the first generation of UK nuclear-powered submarines, having a new central section to house the 16 Polaris A3 missiles, which increased the dimensions of each submarine to 130 metres long, 10 metres in width and 9 metres high.

The submarines and warheads were to be serviced at the naval bases of Faslane and Coulport (the Clyde Submarine Base – CSB) on the Gareloch, some 25 miles north west of Glasgow, while major refits were to be carried out at the Rosyth Royal Naval Dockyard on the east coast of Scotland.<sup>6</sup>

In the mid 1960s, the Government had concluded that the Polaris system was at risk from Soviet improvements to anti-ballistic missile defences. The United States had already responded with a new, multiple-warhead missile, Poseidon, but rather than purchase this, the UK decided to upgrade its Polaris warheads with a similar capability. A secret programme, Chevaline, was initiated by the Conservative government of Edward Heath in 1972 and carried forward by the Callaghan Labour government during the mid 1970s. Originally estimated to cost £200 million, the programme had increased to nearly £1 billion by the early 1980s. This involved a considerable workload for AWE during the 1970s, as the Chevaline upgrade was fitted to all existing Polaris missiles and was in service from 1982 to 1996.<sup>7</sup>

### **From Polaris A3 to Trident D5**

By the late 1970s preliminary work was already underway on replacing Polaris with a new generation of US nuclear missiles, when the submarines came to the end of their operational lives in the mid to late 1990s. Again, decisions were being taken in secret that would have

serious implications for the nuclear network. Originally, the MoD had looked to the Trident C4 submarine-launched missile system but the United States was already developing a much larger version of the missile, the Trident D5.

Rather than risk obsolescence, plans had already been put in place to upgrade facilities so that they could accommodate the giant submarines required to house the missiles. Although smaller than the US Ohio-class Trident submarines, having a 16 rather than 24-missile compartment, at over 150 metres in length, 12 metres wide and 12 metres high they still had a 16,000 tonne displacement, about twice that of the Polaris submarines.

The first significant investment was £300 million for a covered construction hall and shiplift at the Vickers shipyard in the late 1970s, that would facilitate the modular assembly of submarine-hull sections. The Devonshire Dock Hall is 268 metres long, 58 metres wide and 51 metres high, providing sufficient space to work on up to three Trident submarines at various stages of production, and, therefore, eliminating the need to maintain two separate shipyards for nuclear submarine construction.

This was the first of what was to prove a consistent pattern in the nuclear network – large public investment in facilities that would subsequently be privatised and contractorised, as part of the Thatcher government’s general drive to introduce market forces into the public sector. The VSEL group took over the Barrow yard in 1986, when British Shipbuilders was privatised, and it relegated Cammell Laird to a subsidiary role in the manufacture of small, diesel-electric submarines, before the yard was eventually closed down with the loss of 1,200 jobs.<sup>8</sup>

British Shipbuilders had already been working on designs for the larger D5 missile submarines by the late 1970s, even though officially, it was at pains to point out that the MoD had not formally contracted for them.<sup>9</sup> The decision to replace Polaris with Trident was made in 1980 but it was only in 1982 that the government formally announced its plan to move from the C4 to the D5 missile. By this time, the House of Commons had grown increasingly concerned about the secrecy surrounding decisions on nuclear weapons, especially the way that the Chevaline programme had escaped scrutiny in the 1970s because expenditure was hidden in the MoD’s unallocated contingency fund.

As a House of Commons Defence Committee report said at the time:

*Parliament’s role in the decision to procure a successor system to Polaris has been limited to endorsing a decision already taken. Decisions on defence, and on Britain’s strategic nuclear deterrent have historically been taken by a small elite of very senior Cabinet Ministers, Civil Servants, and Service Chiefs, and this present decision was no exception... We urge, therefore the present Government, and future Governments to take Parliament, the public, industry and the defence policy institutions more into its confidence in the future.<sup>10</sup>*

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Both the Defence and Public Accounts Committee were determined to put Trident under scrutiny and regular reports were published through the 1980s and 1990s on the programme. These included overall costs, estimates of employment generated, and progress on the large construction projects, including the submarines themselves, missiles, and related shore and refit facilities.<sup>11</sup>

Original costings in 1982 put total spending at £7.5 billion, including a substantial element of expenditure in the United States, mainly for the purchase of the Lockheed, D5 missiles at £1.3 billion. In the UK £2.6 billion was allocated to VSEL and its main subcontractors like Rolls Royce for the submarine construction programme. The MoD also announced an initial estimate of employment that would be generated overall by the construction of Trident in the UK, at 25,000 direct and 20,000 indirect jobs during the peak period of production in the late 1980s and early 1990s, and 9,000 direct and 7,000 indirect jobs as an average over the ten-year lifetime of the programme. The bulk of this direct employment would be at the VSEL shipyard when construction of the submarines began in the mid-1980s.<sup>12</sup>

In its peak years of the late 1980s and early 1990s, employment at VSEL reached 12,500 but declined steeply afterward. By the mid-1990s, when GEC had taken over the yard, employment was down to 6,000, partly because the Trident programme was nearing completion, and partly because, with the end of the Cold War, the MoD had reduced the size of its conventional nuclear submarine fleet. BAE Systems (referred to here as BAE) took over GEC's military interests in 1999, including the Barrow yard, reflecting the further consolidation and rationalisation of the UK military-industrial base.

By 2006, employment at the yard had declined further to 3,400. The remaining workforce included 400 design staff, 1,200 professional engineers in areas like combat systems integration, and 1,500 production workers in specialised areas of steelworking, pipe fabrication and electrical installation.<sup>13</sup>

### **Faslane and Coulport – CSB**

The other major UK investment, running alongside the construction of the submarines, was the works programme, originally estimated to cost £640 million, for the upgrading of facilities at CSB. The facilities would be used for a range of submarine and surface vessels but over half the cost was attributable to the Trident programme.<sup>14</sup> Work included the construction of a large submarine lift at Faslane to enable routine maintenance of the submarines between patrols, and the expansion of Coulport to house new storage bunkers for nuclear warheads and missiles.<sup>15</sup>

For the MoD this was one of the most complex capital works programmes ever undertaken. Severe problems were experienced due, in no small part, to the very tight timescales for

completion that led, in some cases, to concurrent design and construction before a full technical appraisal could be made. The MoD was fully aware of the dangers in such practices but felt that there was no other option if the Trident timetable was to be met.<sup>16</sup> Most serious was the foundation work for the shiplift which was found to be faulty and required a complete overhaul at an extra cost of £200 million. The programme's total cost escalated to £1.96 billion by the mid 1990s after several delays, redesign and re-engineering work – an increase in real terms of £800 million.<sup>17</sup>

By 1987, CSB was being run by Balfour Beatty as a Government-owned, Contractor Operated (GOCO) facility. At this time, there were 1,800 civilian staff employed at Faslane and 1,500 at Coulport, in a variety of skilled and non-skilled industrial and administrative tasks. Although the actual construction phase involved a temporary and small increase in employment, it was expected that employment would fall slightly after the construction phase was completed.<sup>18</sup>

However, the government announced that, rather than carry out full servicing of the missiles in Coulport as originally intended, the UK would use the existing facilities at Kings Bay, Georgia. This was estimated to provide a substantial saving of £3 billion, but clearly, there would be less work at Coulport. As a result employment was reduced by half from 1,500 to 775 during the mid 1990s.

Further rationalisation took place in 2002; when Babcock Naval Services, a subsidiary of Babcock International, was awarded an £825 million contract to run CSB until 2013. Although the base is still owned by the MoD, all staff were transferred to the company and 300 redundancies were carried out in a further effort to cut costs.<sup>19</sup>

### **AWE – Phase One Investment 1980-1995**

AWE also received considerable investment during the same period for the upgrading of its facilities. This included a new plutonium production building, an experimental non-nuclear testing facility and a radiation liquid effluent treatment centre. The plutonium building was subject to severe delay because of major technical problems and only became fully operational in 1995. The treatment centre suffered corrosion of piping that led to the leakage of radioactive materials. After several years of failed attempts to rectify the problem, the whole project was written off at a cost of £147 million.<sup>20</sup>

The total amount invested grew from an original estimate of £879 million to £1,113 million but unlike the construction work at Faslane and Coulport, only a small proportion (less than 10%) was attributed to the Trident programme. Although the original construction programme may not have been undertaken specifically for Trident, it was the decision to purchase Trident that transformed it in terms of scale, complexity and eventual cost.<sup>21</sup> Employment at the site was also expected to remain stable at just

over 7,500 people, including scientific, technical, skilled and semi-skilled manufacturing and craft workers – the majority employed at Aldermaston and Burghfield.

### Final Trident costings

By the time of the completion of the Trident programme, there had been substantial variations against the original costings partly because of fluctuations in the exchange rate between the dollar and the pound. However, the final cost of £12,153 billion was, in real terms, much lower than original estimates – a saving of £3.4 billion mainly because of the decision to service the missiles in the USA rather than in the UK. The submarine element was £4,571 million in 1994/95 prices.<sup>22</sup> (See Table 1)

**Table 1: Trident submarines – an element of the final costings**

Submarine	£ million
Vanguard	1,705
Victoria	975
Vigilant	929
Vengeance	962
<b>Total</b>	<b>4,571</b>

(1994-5 prices)

For a £12 billion programme, though, the level of employment had also declined substantially from those original estimates, to 14,500 direct (from 25,000) and 12,000 indirect jobs (from 20,000) in the peak years, and 7,500 direct (from 9,000) and 6,000 (from 7,000) indirect jobs over the lifetime of the programme.<sup>23</sup> (See Table 2)

**Table 2: Government estimates of employment generated by the Trident programme**

	1980	1984	1995
<i>Peak Years</i>			
Direct	25,000	17,000	14,500
Indirect	20,000	15,000	12,000
<b>Totals</b>	<b>45,000</b>	<b>32,000</b>	<b>26,500</b>
<i>Lifetime</i>			
Direct		9,000	7,500
Indirect		7,000	6,000
<b>Totals</b>		<b>16,000</b>	<b>13,500</b>

*Notes: Peak Year expenditure was over the five years of highest expenditure and lifetime expenditure was over the ten years of the programme. Direct employment is that generated at the main contractors while indirect is with subcontractors and the supplier base.*

### Post-Trident investment programmes 1995-2010

#### Refit facilities

The 1990s and early 2000s were significant for the next phase of major investment plans in the nuclear weapons network and also for the further contractorisation and,

privatisation of many of the key establishments that were previously under state control.

Having concentrated on the more immediate issues of submarine construction and operational support, the MoD was concerned to expand the facilities for refitting the Trident fleet, the first of which was planned for 2002/03.

Refits are an essential ingredient in the maintenance of the submarines, involving a two-year programme of refuelling of the PWR2s, as old fuel rods are replaced with new ones, refurbishment of literally thousands of pieces of equipment, and the upgrading of weapons,

communication systems, etc, worth an average of £250 million on each submarine. Radioactive waste materials are then transported to Sellafield for disposal. Previously, the Rosyth Naval Dockyard had carried out all major, nuclear submarine refits but in 1992, the MoD received a proposal from Devonport, the other naval dockyard based in Plymouth, to carry out this work.

Partly, this reflected the impact of the Options for Change Defence Review at the end of the Cold War, with cuts to both the surface fleet and submarine fleet and the recognition by the Devonport management that because of the decline in its surface fleet work, nuclear submarine refits would represent a core workload, without which the company might not survive. Both dockyards were now operating as GOCOs and Rosyth would have appeared to be in the stronger position with its existing specialism and the fact that the MoD had already spent £100 million on upgrading its facilities in the first stage of the Trident modernisation programme.<sup>24</sup>

But the MoD decided to run a competition for the Trident refit programme between the two yards in 1993 and, controversially, selected Devonport based on a slightly lower bid and the expectation of longer-term efficiency savings.<sup>25</sup> Of course, this was a major blow to Rosyth and, although it was guaranteed a work programme on surface vessels until 2005 as compensation, the yard experienced a major redundancy exercise beginning in the mid 1990s, with the loss of 1,500 jobs and closure of part of the docks.

In 1997, Devonport was fully privatised as Devonport Management Ltd (DML) with the American corporation, Halliburton, taking a 51% share through its subsidiary KBR. Balfour Beatty and the Weir Group both had a 24.5% stake, although the government retained what was described as a 'special share' to protect national security interests.<sup>26</sup> (Babcock International recently acquired DML after Haliburton decided to sell its majority share).<sup>27</sup> Despite securing the refit contract, employment levels were now at 4,800 for both submarine and surface vessel refits, from a peak of 10,000 in the late 1980s, reflecting the overall decline in naval repair and refit work.

The construction programme for the upgraded refit facilities was as challenging, if not more so, than that for the Clyde Submarine Base. Major programmes included the construction of a new docks ship lift, nuclear-reactor decontamination buildings and equipment refurbishment workshops, all of which had to be ready for the first Trident refit in 2002 and had to comply with new, and more rigorous nuclear inspectorate standards. The MoD was acutely aware of the potential for cost overruns and wanted to pass the risks onto the new private management consortia.

In 1998, the target costs for this work were £576 million but due to a series of technical problems centred on the strengthening of the dock foundations and shiplift for the submarines, and a range of nuclear safety compliance issues for facilities handling radioactive materials, the costs had increased to £933 million by 2002. Far from protecting itself from

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cost over-runs, the MoD had to pay £890 million of that extra expenditure. And is still liable for all future costs on the final phase of the works programme.<sup>28</sup>

However, the main facilities are operational and the first Trident submarine, *Vanguard*, began its refit in 2002 on schedule and this was completed in 2005 in a contract worth £290 million to the company. Major refits of all four submarines are expected to be completed by 2012 to be followed by a second non-core refit from 2017 onwards, where other essential refit work will be carried out to maintain the submarines until the end of their operational lives.<sup>29</sup>

The employment profile at DML is similar to Barrow, including mechanical fitters, electrical fitters, fabricators, welders and pipe fitters as well as project management staff. However, DML has no design staff for nuclear submarines and a much larger, specialist workforce for nuclear refuelling as well as radiological support staff to handle the large amount of radioactive material generated during a major refit. About 2,300 of the total workforce of 4,700 are involved in nuclear submarine refit work – both for SSN and SSBN work.<sup>30</sup>

### **AWE modernisation – Phase Two 1996-2010**

Even AWE, the most secret and highly sensitive of the facilities essential for Trident, had become a GOCO in 1990, run through a consortium of Hunting, Brown and Root, and AEA Technologies. It oversaw a process of rationalisation, involving the closure of the Cardiff factory, in 1997 with the loss of 350 jobs and the withdrawal from Foulness test-range site in Essex, with the loss of a further 200 jobs during the mid-1990s. There was also speculation that Burghfield might be closed and all its activities transferred to Aldermaston. However, the main functions were retained after a substantial rationalisation of the site and the loss of a further 300 jobs.<sup>31</sup>

During this period there was speculation about the future viability of AWE. The completion of the Trident warhead programme in the mid 1990s and the cancellation of the Future Theatre Nuclear Weapon (FTNW) could have left AWE without any new warhead production work by the end of the century. Serious questions were asked as to whether AWE could simply revert to its former role as a weapons research establishment and whether continued large-scale investment could be justified.<sup>32</sup> Yet, within a few years, the decision was taken by the MoD to embark on another massive investment programme.

This included the Orion laser facility to create high-temperature pulses intended to simulate nuclear detonations that are then photographed by X-ray machines; a new hydrodynamics facility to replicate the behaviour of warhead materials during nuclear detonations; and a new building to house a CRAY supercomputer to evaluate the results of these tests and provide three-dimensional models to assess warhead performance. The latest estimate puts these investments at over £1.05 billion pounds.<sup>33</sup>

The MoD has argued that these are essential to the maintenance of the existing stockpile of nuclear warheads, consistent with the UK's obligations under the Comprehensive Test Ban Treaty (CTBT), for safely disarming and disposing of warheads, and for improving techniques of verification as a contribution by the UK to arms control. However, in the United States, the language of continued reliability has been interpreted to mean that the nuclear weapons laboratories, there, are working on the modification of existing warheads to incorporate new capabilities, including replacing the airburst arming and firing fuse with a new ground-burst fuse and variable yields for hard targets. There has been strong speculation that the UK has been involved in new design work, particularly through joint testing at Los Alamos, for a sub-strategic warhead fitted to Trident.<sup>34</sup>

What cannot be in dispute, though, is the long-term nature of these investments. In April 2000, for reasons not entirely clear but probably because of project management failures on the abandoned radioactive waste treatment centre, the Hunting consortium lost the management contract and was replaced by a new consortium, AWE(ML) (Management Ltd) jointly owned by the American corporation Lockheed Martin, BNFL, and SERCO.<sup>35</sup> Originally the contract was worth £2.3 billion over ten years but has now been extended to twenty-one years and worth £5.3 billion.

A recruitment campaign is underway, partly driven by the need to replace a large number of staff who have retired or are nearing retirement age. Around 350 new staff are being taken on each year from 2003-2007, including scientific and technical staff in nuclear physics, chemical and electrical engineering, metallurgy, computer sciences, project management and

*Notes: The figures for SSBN employment are based on continuity of employment between SSN programmes and SSBN programmes. The Barrow shipyard has worked on surface vessels, including the recent contract for the LPD support ships and will be involved in constructing a section of the new aircraft carriers. But the vast majority of work, over 95%, is on nuclear submarines and other work is temporary. Similarly, Faslane carries out some surface fleet work but is mainly involved in SSBN maintenance. Devonport was not involved in SSBN refit work until winning the contract from Rosyth in 1993, and the figure for 1990 is a conservative estimate based on probable employment levels, using Rosyth figures and subsequent unemployment there when it lost the contract to Devonport.*

**Table 3: SSBN/SSN employment**

	1990	2006	% decline
Barrow	12,500	3,400	73
Faslane	1,800	900	50
Devonport	3,500	2,300	34
<b>Total</b>	<b>17,800</b>	<b>6,600</b>	<b>63</b>

**Table 4: Nuclear warhead employment**

	1990	2006	% decline
AWE	7,500	4,200	44
Coulport	1,500	500	67
<b>Total</b>	<b>9,000</b>	<b>4,700</b>	<b>48</b>

**Table 5: Overall employment**

	1990	2006	% decline
<b>Total</b>	<b>26,300</b>	<b>11,300</b>	<b>57</b>

There has been strong speculation that the UK has been involved in new design work, particularly through joint testing at Los Alamos, for a sub-strategic warhead fitted to Trident.

Figure One

**Summary of the UK's Nuclear Weapons Industrial and Technological Network**

<i>Facility</i>	<i>Main functions</i>	<i>Ownership</i>	<i>Investment</i>	<i>Employment</i>
Barrow Shipyard	Design and construction of SSBNs	Privatised as VSEL in 1986. Taken over by GEC in 1995 and by BAE in 1999.	1980s – £300 million Covered Construction Hall, Shiplift	1990 – 12,500 1995 – 6,000 2006 – 3,400
AWE	Design and manufacture of nuclear warheads	GOCO – 1990 Hunting, Brown and Root and AEA Technologies.  GOCO – 2000 AWE Management Ltd Lockheed, BNFL & Serco.	1980-90s – £1.1 billion plutonium production facility, radioactive waste treatment centre.  2000-2010 – £1 billion Laser, hydrodynamics, supercomputer facilities.	1990 – 7,500 1996 – 5,000 2006 – 4,200
Faslane/ Coulport (CSD)	Routine maintenance of SSBNs and processing of warheads	GOCO – 1987 Balfour Beatty.  GOCO – 2002 Babcock Naval Services.	1988-95 – £1.9 billion. Shiplift and expanded missile, warhead handling and storage facilities.	1990 – 3,200 1995 – 1,800 2006 – 1,400
Devonport Dockyard	Major refits of SSBNs	GOCO – 1987 DML. Privatised in 1997. DML Management Ltd Halliburton (KBR subsidiary), Balfour Beatty and Weir Group. Babcock International buy out DML – 2007.	1995-2005 – £900 million. Shiplift and radioactive materials handling facility.	1990 – 10,000 1995 – 6,000 2006 – 4,700

*Notes: There are significantly more people employed at Faslane and Coulport as MoD civilian staff, with 1,080 at Faslane and 670 at Coulport and also nearly 2,500 workers employed through external contractors. These are employed mainly in security & servicing the submarine crews accommodation, restaurants, leisure facilities etc. Devonport also carries out major surface vessel refits and of the 4,700 personnel employed by the company, 2,300 are employed in the refitting of SSBNs and SSNs. Both Devonport and AWE employ temporary staff as well. But the focus here is on directly employed people.*

telecommunications. Overall there may be an increase in employment of around 500 to 4,700 by 2010 but this will still be well below its peak employment of 7,500 during the 1990s.<sup>36</sup> (See Tables 3-5 on page 13 for a summary of employment changes in the nuclear network)

## Conclusion

An elite group at the heart of the British state has, over the past fifty years, secured massive public investment in an infrastructure to sustain the indigenous industrial and technological network for nuclear weapons. The two main elements are, firstly, the nuclear warhead infrastructure centred on design and manufacture at AWE Aldermaston and assembly at AWE Burghfield, with some basic servicing work at Coulport where the warheads and missiles are stored. Secondly, the nuclear submarine infrastructure, centred on the BAE yard in Barrow where the submarines are designed and constructed; on Devonport where the submarines are refitted; and Faslane where routine operational maintenance work is carried out.

Despite this extensive, indigenous network the UK has, paradoxically, become more dependent on the United States, not simply for the purchase of ballistic missiles but also for their servicing, and for other on-going support in warhead and submarine design. In 2004 the 1958 Mutual Defence Agreement was renewed between the two states. The maintenance of this long-term relationship with the United States is central to the elite decision-makers' strategy of sustaining the UK's nuclear weapons capability until at least the middle of the century. But, precisely because it is so central, this dependency has bred a form of tacit, and unacknowledged, obligation to support the USA in its broader military and foreign policy goals.

The scale of investment is almost impossible to exaggerate. Transition from Polaris to the much bigger Trident submarines and missiles required a construction and engineering programme, that collectively, was more expensive and more challenging than any major equivalent civil programme of the period, including the Channel Tunnel or the THORP nuclear reprocessing plant at Sellafield. Partly, this was an issue of size, with three submarine facilities to build at Barrow, Faslane and Devonport, each as long as Wembley stadium and as high as a ten-storey building, as well as a new warhead manufacturing plant and a laser testing laboratory at AWE. But there were also very demanding nuclear safety requirements on the integrity of the facilities and associated buildings and for the safe handling of highly-radioactive materials, given their close proximity to densely-populated areas.

The capital works programme at Faslane experienced massive cost overruns to the extent that it now seems to have become a prime example for government departments of how not to carry out a major construction project, given the problems and the overall increase of £800 million caused by concurrency between design and construction and lack of clear management accountability for certain elements of the programme.<sup>37</sup> (A similar critique could be made of the Devonport nuclear refit construction programme and the AWE first-phase investment.)

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Yet that rather misses the point. The MoD was faced with a combination of very demanding targets and timescales for the construction of the submarines and their support facilities in order to ensure Trident submarines were operational and the warheads had sufficient plutonium. It is unsurprising that technical problems and cost increases were experienced on such complex programmes. In the worst cases, some expenditure was simply written off as with the £100 million investment in Rosyth which lost the contract to refit the submarines and the £147 million on the radiation liquid effluent treatment centre at AWE that was declared unfit for purpose.

But the MoD proved remarkably resilient in pushing the main elements through to completion, even if some costs were far in excess of original estimates. As a result, every element of the Trident programme was available on time, from the construction of the submarines and their first refitting, to the manufacture and maintenance of nuclear warheads. The government can confidently rely on the full range of facilities to sustain the UK's nuclear industrial and technological network for the next fifty years.

It is often argued that Trident was a relatively cheap option, compared say to France's nuclear weapons, because the UK was not required to pay any of the research and development (R&D) costs on the missiles and because the decision to service the missiles in the United States led to further reductions on what would have been a multi-billion pound upgrade of Coulport.

Yet some costs were never allocated to the Trident budget, including most of the major investment at AWE which was classified as general expenditure, even though it is clear that the scale of investment would never have been countenanced without the need for Trident warheads. Also, expenditure, as at Devonport, on the new refitting facilities for which the MoD is liable, is still ongoing well after the Trident programme ended. Suffice to say, there are a range of general expenditures that might reasonably be considered to be part of the Trident programme and should be set against the savings normally identified.

Employment generated by the Trident programme also declined from an original estimate of 45,000 direct and indirect jobs during the peak period of production to 26,500, while only 13,500 direct and indirect jobs were sustained over the lifetime of the programme compared to an original estimate of 16,000. For a £12 billion investment, this was a very poor return, even by the standards of military procurement. Indeed, despite the continued emphasis by the MoD and successive governments on employment generated by nuclear weapons, nothing could disguise the long-term rationalisation of the network and substantial job losses.

Surplus to requirements was the Cammell Laird shipyard which was eventually closed, while there were massive job losses at the VSEL shipyard, Barrow down from its peak of 12,500 in the late 1980s to 3,400 in 2006. Devonport also experienced serious reductions during the

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same period, from 10,000 to 4,700, and AWE's fell from 7,500 to 4,200. From a lower level of overall employment, the Clyde Bases also saw a fall from 3,200 to 1,400. In total, employment in the nuclear network declined by nearly 60% during this period. What remains is a highly specialised workforce, configured around technically demanding industrial processes and quality control criteria: from nuclear physicists working on warhead design to naval architects ensuring interoperability between complex weapons and communication systems on nuclear submarines, and skilled welders and fabricators working to high tolerances on metals that have to withstand extreme pressures and degradation from exposure to radiation.

This partly reflects the general decline in military employment as a long-term trend and the investment in capital equipment that reduced the demand for labour. According to MoD figures, overall military-industrial employment in the UK was 510,000 in 1991/92 and declined to 260,000 by 2003/4. Crucially for the MoD, there remains a core skills base to sustain the nuclear weapons infrastructure even though, in employment terms, it is small.

And, of course, arguments about employment generation will be used to support nuclear weapons programmes despite this decline, because there are a range of skilled jobs still available, and for a small number of areas like Barrow-in-Furness, they continue to represent an important source of manufacturing work. Yet it is clear that similar funds invested in civil R&D and production could have created more employment over a similar timescale and that investment in nuclear weapons has had a serious economic opportunity cost.

Finally, the transition from public to private ownership and management has further reinforced the long-term trend to rationalisation. Both the Conservative and Labour governments have argued that private management would lead to a more commercial culture and efficiency savings. All the new private managements have benefited from sustained public investment on facilities and capital equipment that have reduced the cost base (mainly through shedding labour), but the MoD still found itself liable for substantial losses on major capital works programmes. Despite these problems, the MoD has extended the timescale of contracts, in the case of AWE, to twenty years, and the CSB, twelve years, reflecting the long-term strategy for privatisation and contractorisation.

In the case of the Barrow yard, ownership has been transferred from the local management, to GEC and finally to BAE, the largest UK contractor with an effective monopoly in nuclear submarines, frigates and fighter aircraft. Indeed, it could be argued that BAE has by far a stronger monopoly position in the UK than when British Shipbuilders and British Aerospace operated as separate nationalised industries in the 1970s, with over 50% of the MoD major procurement programmes. BAE is continuing to look for further acquisitions both here and abroad, is aggressively pursuing export contracts like the highly controversial al Yamamha programme with Saudi Arabia for Typhoon fighter aircraft, and has become

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one of the largest contractors to the US Department of Defense, presenting itself as both as a global military-industrial corporation and a ‘national champion’.

American corporations also play a key role, as with Lockheed at AWE, which has long experience in nuclear weapons work in the United States. As well as corporate influence, there are senior American managers, as at AWE and Barrow, further re-inforcing the strong institutional and personal networks between the UK and their US equivalents.

Although the MoD has long-standing relationships with these companies, there are still real tensions, partly over cost-controls on major programmes and on potential corporate restructuring that have implications for the management of nuclear facilities. Most notable has been the recent decision of Halliburton, as part of its broader international restructuring, to sell its Brown and Root subsidiary, partly responsible for the running of the Devonport dockyard.

The MoD has made it clear that it was not originally consulted and requested Halliburton to, at least, delay the sale, while the full implications are considered. The MoD has the option of buying back the shares if it feels the UK’s national interests are at stake, but the potential for further restructuring by these large private sector corporations is clear and suggests possible tension between the perceived benefits of commercial operation and the MoD’s desire for long-term security of the indigenous nuclear weapons infrastructure.

It is this context, of rationalisation, potential corporate restructuring and long-term investment by the state in the maintenance of the nuclear weapons network and its specialised skills that provides the industrial and technological context for the recent decision by the government to replace Trident with a new submarine-based system.

## CHAPTER TWO:

## Options for a replacement to Trident

### Introduction

**T**HE WHITE PAPER on a replacement for Trident, published in December 2006,<sup>38</sup> and the vote in March 2007 confirm the government's position that a continued nuclear weapons capability is considered essential to national security. Like all previous nuclear weapons programmes, major decisions have already been taken in secret to ensure a predetermined outcome. The White Paper and the subsequent Parliamentary debate are, from the government's perspective, necessary inconveniences that provide a fig-leaf of accountability but which really serve to highlight the lack of transparency and democratic participation in the decision-making process.

Two elements are essential to understanding the government's real concerns. Firstly, the need to truncate the political timescale so that it appears a decision has to be made in 2007, with the only option being to build another generation of ballistic missile submarines, rather than allow time for further reflection on other options, including renewed efforts at international nuclear disarmament in line with the UK's obligations under the nuclear Non-Proliferation Treaty. Secondly, the need to secure the future of the industrial/technological network, not simply for the follow-on Trident system but with a view to the longer-term and to maintaining compatibility with the United States as it considers its own options for the replacement of Trident missiles.

### The White Paper and options for a replacement to Trident

The case for and against nuclear weapons in the post-Cold War world is comprehensively covered in recent publications and is not the focus of this report.<sup>39</sup> Suffice to say that both strategic and sub-strategic roles are emphasised in the White Paper, although the government will not be drawn on operational choices:

*We deliberately maintain ambiguity about precisely when, how and at what scale we would contemplate use of our nuclear deterrent. We will not simplify the calculations of a potential aggressor by defining more precisely the circumstances in which we might consider the use of our nuclear capabilities. Hence we will not rule in or out the first use of nuclear weapons.<sup>40</sup>*

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However, with the end of the Cold War and the acknowledged lack of any threat to territorial security, it is no surprise that new scenarios are given prominence. These relate to the sub-strategic role, as against ‘rogue states’, whereby the UK can destroy key targets including underground bunkers, or protected facilities for the construction and deployment of weapons of mass destruction.<sup>41</sup> The use of the UK’s own weapons of mass destruction then becomes a form of pre-emptive and discriminatory attack, focused on political and military leaderships where ‘collateral damage’, i.e., the deaths of ordinary civilians is somehow kept to a minimum.

But the White Paper also clings onto the comfort blanket of traditional nuclear deterrence theory; that we live in a dangerous and unpredictable world, that history tells us we may be faced with the rapid emergence of a powerful enemy, and that the UK need to retain the ultimate threat of a large-scale nuclear strike.<sup>42</sup>

An FOS is enthusiastically endorsed as the superior system compared to the main alternatives that are all, summarily, dismissed. What can be described as generic models are introduced only to be swatted down again like a row of aunt-sallys, in what is typical of the superficial approach taken throughout the White Paper. A Land-based silo system equipped with Trident ballistic missiles; long-range aircraft equipped with cruise missiles; and large surface ships equipped with Trident ballistic missiles are rejected because they are all deemed to fail, in various ways, the tests of vulnerability, detectability and interception, which the nuclear planners insist, can only be satisfied by a submarine-based ballistic-missile system. Even the option of cruise-missiles launched from submarines is rejected because they can be intercepted in flight.<sup>43</sup>

Nowhere is there any attempt to assess alternatives to these generic models and when similar operational concerns are raised about the potentially increased vulnerability of ballistic submarines to new forms of underwater detection and attack, the MoD is quick to argue that counter-measures are available and that their advantages can be maintained.<sup>44</sup>

Significantly, however, these options are also rejected on cost grounds because, according to the MoD, apart from the surface fleet option, they would all involve considerable extra expenditure, running into billions of pounds, to build a new support infrastructure. While there may be merit in this argument, no serious attempt is made to provide detailed costings and it is not clear, for example, that an existing design of aircraft armed with cruise missiles would be as expensive as a ballistic-missile submarine system. A free-fall bomb dropped from an aircraft would have clearly been the cheapest option but was not considered in the White Paper.

(A radical option, again not considered, would be the ‘virtual arsenal’, where the UK decommissions the Trident submarines and dismantles the warheads but retains the fissile

materials at Aldermaston. The UK, in this scenario, would play an active role in nuclear disarmament negotiations but retain, temporarily, the option to reconstitute its nuclear weapons in some form while international progress is made in a phased reduction and elimination of nuclear arsenals.)<sup>45</sup>

Here, the government shows its acute sensitivity to claims that FOS will be grossly expensive and is at pains to portray it, not only as the best strategic option, but also the most cost-effective one, and affordable within the broader framework of MoD expenditure on both nuclear and conventional equipment.

Various estimates have been made about the total cost of the new system. According to the White Paper, a four-submarine replacement would cost between £15-20 billion in 2006/07 prices, spread mainly over a fifteen-year period between 2012 and 2027. These are further broken down as £11-14 billion for the submarines, £2-3 billion for the refurbishment or replacement of warheads and £2-3 billion for infrastructure costs. Operational costs are expected to be about the same as now, at between 5-6% of the total military budget.<sup>46</sup>

Again, it is far from clear how the overall figures and allocations have been calculated. For example, if the figures are based on the original Trident programme, then some explanation is needed as to the difference between the original costs of purchasing the D5 missiles at over £1 billion and the relatively small payment of £250 million required now as the contribution to the US mid-life extension programme, and why the submarine element should be over 70% of the total expenditure.<sup>47</sup>

Hartley, using an inflation-adjusted figure taken from the final costings on the original Trident programme in 1995/96, puts the total at £15.2 billion in today's prices, with the caveat that each new generation of military equipment is usually more expensive than its predecessor, as it incorporates enhanced capabilities and increased technological sophistication that tends to drive up costs.<sup>48</sup> Accepting that considerable uncertainty still exists on the total cost and on how to allocate expenditure for each element of the programme, the general inflationary trend for military equipment needs to be acknowledged. A total higher than the government's estimate seems reasonable, in the range of £18-£25 billion, allied to running costs of £1.8 billion-£2.3 billion a year over a thirty year operational life.

For the MoD and some commentators this is still relatively cheap and manageable within the overall procurement budget because expenditure will be spread over 15 years. Other large programmes have been accommodated in the past, including, of course, the first Trident submarine, and more recently the Typhoon (Eurofighter) aircraft that was the most expensive UK programme ever, costing more than £18 billion. However, various methods have been used to control costs, in Typhoon's case, reducing the order from 250 to 232 aircraft, as well as stretching programmes over a longer timescale in order to delay expenditures.<sup>49</sup>

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These sorts of budgetary pressures are bound to continue as there are several multi-billion pound equipment programmes over the next decade including two new aircraft carriers (CVFs), a second batch of 4-5 Astute class conventional nuclear submarines (SSNs), 8 Type 42 Destroyers, and up to 150 American, Joint Strike Aircraft (JSF) to replace Harrier jump jets on the aircraft carriers.<sup>50</sup>

Sensitivity over the issue of costs has led to the consideration of options that still retained a submarine force but had the potential for savings. Rather than design and construct a completely new generation of ballistic missile submarines, it has been suggested that the existing conventional nuclear submarine, SSN Astute Class, be used as the basis for a hybrid system. This requires adding a central missile section to the existing design (as with Polaris) but in this case with the missile tubes to be used both for vertically launched, conventionally-armed cruise missiles and Trident ballistic missiles.<sup>51</sup>

The Astute class was first designed in the 1980s, and there would probably be upgrading required to incorporate a ballistic missile section; a matter complicated by having two different weapons systems using the same launch tubes. There would also still be a requirement for these hybrid submarines to guarantee the same level of patrols for their ballistic missile role as those provided by a dedicated ballistic submarine fleet. On these grounds, it is difficult to see either significant savings or operational benefits.<sup>52</sup>

The second option is to cut the fleet from four to three submarines, and possibly also reduce the number of missile tubes from sixteen to twelve, given the reduced number of missiles and warheads that are said to be in the UK's stockpile.<sup>53</sup> Having four submarines was seen as essential during the Cold War to guarantee at least one submarine on patrol. But, in the post-Cold War environment, with the submarines on lower alert levels and carrying a reduced missile load, coupled with expected efficiency improvements to the nuclear power plant three may be perfectly sufficient. A decision to build a fourth submarine could, in any case, be made during the next decade, dependent on a future government's assessment of the international security situation.<sup>54</sup>

The White Paper looked more favourably at the three-submarine option rather than the hybrid option and the government has left the final decision open at this stage. But the savings from not building a fourth submarine might be less than expected (even one with a smaller missile section), as it is usually the case that unit costs decline through the learning process from the first-of-class onwards.

Also there may still be operational issues. In the worst-case scenario, the three submarine option leaves the possibility that one could be involved in a serious accident, while another is in refit. The third submarine might then be the only operational one for a period much longer than its normal tour, while repairs and refits are carried out on the others. This may

jeopardize the requirement to have at least one submarine continuously on patrol.<sup>55</sup> It is probable that the government would argue for the insurance of a fourth boat once the contractual commitment to FOS is made.

### **Trident replacement and the industrial/technological network**

The White Paper, not surprisingly, focuses on strategic considerations, predicated to some extent by cost factors. What it cannot acknowledge is the crucial, determining influence of the nuclear weapons industrial/technological network on the government's choice for a replacement system and the timing of that replacement. There is a symbiotic relationship – the future of the UK as a nuclear weapons state depends on its industrial/technological network for ballistic missile submarines and the future of the industrial/technological network depends on the UK remaining a nuclear weapons power.

Two key elements are central to understanding this relationship. Firstly, the actual timing of the decision to replace Trident is determined by the network's need for an assured design and production timescale, including the smooth transition from the Astute programme to Trident. Secondly, there is a longer-term commitment by the government to maintain this nuclear submarine capability well into the 2030s and 2040s, as the basis for a continued strategic relationship over nuclear weapons modernisation with the United States when it considers future options for nuclear missiles.

Identifying the date for a replacement system to become operational is not clear and has been deliberately manipulated in the White Paper. Originally, the MoD considered Trident submarines to have an operational life of 30 years, and as the first Trident submarine, Vanguard, started patrol in 1994, the replacement date should be 2024. Assuming a 14-year timescale from decision to deployment, as with the first Trident, then the decision could have been deferred to 2010.<sup>56</sup>

But more recently, the MoD has referred to a 25-year lifespan, meaning that work should already be underway for deployment in 2019. It has emphasised increased running and maintenance costs experienced on ageing submarines and the negative effect that can have on operational availability.<sup>57</sup> The emergency on SSN Tireless in 2000, when there was a serious breach of the reactor cooling system, may have influenced MoD thinking since the submarine was reaching the end of its operational life.<sup>58</sup> Although the reactor on Trident is an upgraded design, it must be the MoD's abiding nightmare to have a nuclear reactor accident on a ballistic missile submarine.

Whatever the reasons, this is certainly a contrast to the United States where the equivalent Ohio-class Trident submarines are going through a major mid-life extension programme that will see their operational life increased to 44 years. The UK fleet has also been on reduced intensity of operations since 1998, with only one submarine on

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patrol at any one time, so easing the general ‘wear and tear’ on the submarines and their nuclear reactors. For many commentators, therefore, a replacement can be deferred, at least to 2010 and probably longer.<sup>59</sup>

But the White Paper has made the timescale for decision-making even tighter. Firstly, it sets the date when the first Trident submarine, *Vanguard*, was launched in 1992, as the baseline for the 25-year timescale rather than its first patrol in 1994. And it extends the timescale from decision to deployment to 17 years for FOS rather than the 14 years required on Trident because it claims that this is more representative of recent experience in submarine design and build, both here and in the United States and France.

In this way it becomes absolutely imperative to begin the initial work in 2007 because the earliest that the first-of-class can be deployed is now 2024 when two Trident submarines should have been decommissioned (in 2022 and 2024 respectively), even though their operational life will have been reluctantly ‘extended’ to thirty years by the MoD.

What precisely is going on here? Why does the MoD attach such importance to this new timescale and is so insistent that arguments for a delay in making the decision and/or extending the operational life of the existing fleet are unacceptable? Essentially, the MoD has another agenda, which is to maintain continuity of nuclear submarine design and production, and it has been profoundly alarmed by the recent experience on the Astute class built at the BAE shipyard in Barrow.

Up to eight submarines were intended as a replacement for the Swiftsure and Tragalgar Class nuclear attack submarines but, as with many Cold-War military platforms, a new strategic rationale was needed. The emphasis has shifted from the traditional anti-submarine warfare role to new missions including land attack and support for special forces. Astute is also a larger submarine than previous SSNs, to accommodate the larger version of the PWR2 for longer, sustained patrols. This is a substantial programme, originally worth £2,578 million for the design, build and service support for the first-of-class and two follow on submarines, awarded to the company in 1997. (The shipyard was then owned by GEC, before BAE took control of GEC’s military interests.)<sup>60</sup>

There have been major problems with the first-of-class that have led to massive cost overruns and delays. One of the major reasons cited was the eight-year gap in design work between the first Trident programme and Astute that led to the fragmentation of design capacity in the company and to a series of technical problems, particularly in the application of new Computer Aided Design (CAD) equipment.<sup>61</sup>

The situation became so serious that in 2003, the company called on help from the United States with the Electric Boat Company, responsible for building the Ohio Class Trident

submarines, providing a new engineering management team. Electric Boat is also carrying out work at the company's Groton yard in Connecticut to support the design effort on Astute, with BAE and UK MoD staff working there.<sup>62</sup> Since then, the leader of the US team, Murray Easton, has become the managing director at Barrow, tasked with improving the overall performance on Astute.

In 2003 the contract was renegotiated to separate the design, development and build of the first of class from the follow-on submarines, with the MoD paying an extra £430 million and the company contributing an extra £250 million. As of 2006, the cost of the three submarines had increased to £3,656 million from the original £2,578 million, and the in-service date for the first-of-class had been put back from 2005 to early 2009.<sup>63</sup>

Clearly, delays in the construction of Astute submarines have implications for the timing of FOS in terms of balancing the workload to ensure the shipyard can make a smooth transition. The MoD will be extremely concerned to avoid similar problems with the design phase and early build on FOS that might lead to cost escalations and delays.

The three Astute class submarines are in various stages of production and are expected to be commissioned in 2009, 2011, and 2012 respectively.<sup>64</sup> Both the shipyard management and the unions have also been lobbying hard for the MoD to confirm the order for another three or four submarines without which there would be a considerable shortfall of work by 2008.<sup>65</sup> But the MoD has been pressing for a substantial price reduction before proceeding, although it is expected that the contract for the next batch will be confirmed by early 2007. This will ensure that Astute continues as the main programme up to 2015-2017.

Having experienced such difficulties with Astute, the MoD faces a dilemma over its handling of the FOS contract. It will want to control costs while BAE will want a price that reflects the technological challenges and uncertainties with a new design, while guaranteeing a clear profit. BAE is the UK's only manufacturer of nuclear submarines and in dealing with a monopoly supplier the MoD will have to rely on a firm-price, incentivised contract, as with the first Trident.

Negotiations could prove difficult and time-consuming. At the same time, the MoD will have to balance the search for cost controls against any potential problems that a long delay could mean to the 'drum beat' of design and build that will be essential to the continuity of submarine construction at the yard. It is vital, from the MoD's perspective that the design capability is not undermined by any delay because of protracted contract negotiations.

Theoretically, the MoD could even threaten to buy the submarines from the United States if contract negotiations are not satisfactory and the White Paper emphasised that there was no guarantee that the submarines would be built in the UK unless satisfactory conditions were

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negotiated with BAE. But, apart from the industrial and technological consequences of ending SSBN construction in the UK, the strategic implications are also serious. Not only will the missiles have been purchased from the United States but also, now, the submarines. It will be increasingly difficult to argue that the Britain has an independent nuclear system in those circumstances.<sup>66</sup>

Assuming that the negotiations are successful, BAE will be able to continue the preparatory work on design and the purchase of long-lead items from 2008 onwards. This is the industrial/technological network's ideal solution – guaranteeing production on a fleet of seven or eight fleet SSN submarines, allowing a reasonable time for the design phase and a smooth transition into follow-on Trident production by 2015/16. This also avoids a bulge of work on both the last Astute submarines and the first FOS that would put serious capacity pressures on the yard.<sup>67</sup>

From the MoD's perspective on the timing of the Trident replacement, it will be happy that the initial phase allows the company sufficient time to rebuild its design capability, and steadily gear up production, because it is simply not acceptable for a ballistic missile submarine programme to experience anything like the delays and technical problems that have occurred with Astute. This is in contrast to the official position that the process is driven by the need for a longer design phase, based on evidence from the United States and France. Indeed, the Electric Boat Company has said that its next design effort on a follow-on SSN programme will only require 60-70% of the resources required for the existing Virginia class submarines because of advances in computer software and lessons learned from previous programmes.<sup>68</sup>

Other elements of the Trident network would also benefit from this ordering pattern. Devonport is presently carrying out the first refits of the original Vanguard class submarines to be completed by 2012, followed by other SSN refit work, and a second batch of non-core refit work on the Trident submarines in 2018-2025 that will take them through to the end of their operational lives. Again, this provides a steady flow of work in parallel with the main FOS construction programme.<sup>69</sup> In budgetary terms, this timescale also has advantages, since the peak years of Trident expenditure would be 2018-2024, when other major naval expenditures on the aircraft carriers and Type 42 destroyers should have been completed, although there are still other very expensive programmes like the JSF to consider.

Nor should we underestimate the longer-term significance of this ordering pattern because the MoD and BAE are already looking to a completely new design of SSN from the mid 2020s onwards, the Maritime Underwater Future Capability (MUFC).<sup>70</sup> This will ensure continuity of design and production at Barrow in the longer-term and in relation to any future options that the United States chooses for the replacement of its Trident missiles and SSBNs.

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## The Trident Network and the Defence Industrial Strategy

Here, the superficiality of the White Paper can be contrasted with the MoD's Defence Industrial Strategy (DIS) that gives some flavour of this longer-term perspective. Published in 2005, it set out in great detail what it viewed as the essential, indigenous industrial and technological capabilities that had to be maintained for UK security.<sup>71</sup> These were wide-ranging and, not surprisingly, included the nuclear infrastructure for warheads, nuclear submarines and nuclear power-raising plant:

*It is a high priority for the UK to retain the suite of capabilities required to design complex ships and submarines from concept to point of build, and the complementary skills to manage the build, integration, assurance, test, acceptance, support and upgrade of maritime platforms through-life. For the foreseeable future, the UK will retain all of those capabilities unique to submarines and their Nuclear Steam Raising Plant (NSRP) to enable their design, development, build, support, operation and decommissioning.<sup>72</sup>*

The MoD, in what is generally characterised as a partnership arrangement with industry, accepted its responsibility to secure this capability through close liaison with key suppliers on procurement, through-life upgrades and other forms of critical support.

Already, in the case of FOS, the MoD has invested £20 million in training for key manufacturing skills that it wants to see retained in nuclear submarine construction.<sup>73</sup> While price negotiations are still ongoing for the first batch of Astute submarines, the MoD has allowed BAE to begin ordering long-lead items for the follow-on order in recognition of the need for continuity of production,<sup>74</sup> and has also provided financial support to Rolls Royce on the new generation of PWRs to power the submarines, effectively a subsidy in order to retain key industrial and technological skills before the full contract is awarded.<sup>75</sup>

In this way, the MoD is taking a strategic perspective that the retention of the Trident network will be secured, both through the short-term difficulties caused by delays on the Astute programme, but more importantly, through the continued capacity for design and construction of future generations of nuclear submarines well into the middle of the century.

## The follow-on system and employment

What will be the significance of FOS for employment? The White Paper provides no assessment apart from a passing reference to the 'thousands of skilled jobs' that will be secured. But overall employment levels will be significantly lower than those on the first Trident programme, both in the peak years of production and as an average over the lifetime of the programme.

Partly, this is the result of significant rationalisation through the investment in capital equipment that has reduced the demand for labour. Also there is a lack of major infrastructure work compared to those in the late 1980s and early 1990s. Only Aldermaston

Employment levels will be significantly lower than those on the first Trident programme, both in the peak years of production and as an average over the lifetime of the programme.

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and Devonport have outstanding build programmes that should be completed by 2010. The main, additional investment will be at CSB to upgrade facilities that will be thirty years old by the time the new fleet starts patrol.

A final but more difficult element to analyse in the calculation of employment generation is the role of the supplier chain, with anything up to 50% of the value of contracts passed down from the prime contractor. The main subcontractors are readily identifiable, including Rolls Royce, based in Derby, where the PWR is designed and manufactured, and employing 900 people both on production of the nuclear core and the steam generating plant.<sup>76</sup> BAE has also established a 'critical suppliers' network on the Astute programme that is intended to develop closer links and longer-term relationships.

These companies are likely to be involved in FOS and include, THALES Underwater Systems, for periscopes (based in Stockport, 300 employees), Strachan and Hernshaw, weapons discharge and handling, (based in Bristol, 500 employees), McTaggart Scott, non-hull penetrating masts, (based in Edinburgh, employing 250 people) and Alstom, steam turbines, (based in Derby, 300 employees). Evidence from some of these companies to the Defence Committee indicates a level of specialism and dependency on continued nuclear submarine production.<sup>77</sup> Other significant subcontract work includes the handling and storage of the nuclear submarines' radioactive waste at Sellafield with a contract worth £230 million awarded to the British Nuclear Group.<sup>78</sup>

But there are real difficulties in mapping contract values and employment impact below the level of these major subcontractors, since literally thousands of other companies serving both civil and military markets may be involved in components manufacture that eventually finds its way into a large weapons platform. Suffice to say that a full evaluation of FOS would need to assess the wider distribution of employment across the supplier network, dependency of suppliers on nuclear submarine work, and the balance between civil and military contracting.

However, the fundamental issue remains that employment on FOS will be much lower than Trident. Even in the peak years, when there will be some additional demand for shipbuilding trades in Barrow, as three submarine will be in various stages of production, the extra workforce may be in the hundreds rather than thousands. A conservative estimate is that overall, there will be 35-40% fewer people employed than on the first Trident programme. And FOS will be anything from 25%-100% more expensive in real terms than Trident. However, the MoD and some trade union representatives from the nuclear network will continue to argue that FOS is vital to the UK's industrial base, providing highly skilled manufacturing and technical jobs, especially in areas where traditional manufacturing work has declined and other skilled jobs are in short supply.

Even in the peak years... the extra workforce may be in the hundreds rather than thousands.

## Conclusion

Only a few weeks prior to the publication of the White Paper, the MoD was coyly hinting that radical alternatives to a submarine-based system were under active consideration. But the elite group responsible for decisions on the replacement of Trident was always set on one course with a predetermined outcome, namely the construction of another submarine fleet to carry Trident ballistic missiles.

The White Paper, in that context, is a shoddy, superficial and disingenuous document, providing little useful information and whose main function is to close down all options other than an immediate political decision to build FOS. Indeed, there is a strong case for a new White Paper to answer a series of questions on the strategic rationale; detailed costs of alternative systems; the discrepancies between the breakdown of expenditure on the original programme and FOS; closer scrutiny of the arguments for and against extending the operational life of the submarines; the industrial and technological consequences of delaying a decision; as well as an in-depth study of both direct and indirect employment that might be generated by the programme.

The MoD simply went through the motions of rejecting alternatives on strategic and cost grounds but that was not the main issue. Apart from the option of a free-fall nuclear bomb dropped from a fighter aircraft (and the ‘virtual arsenal’ option), all would have required a new, indigenous infrastructure for the design and manufacturing of platforms, delivery vehicles and possibly, warheads. The British state has invested far too much in the ballistic missile submarine industrial/technological network to abandon it in favour of other, untried alternatives, that risk failure and might also undermine the long-term relationship with the United States in the sharing of essential nuclear technology.

The White Paper might, therefore, more accurately be titled, ‘Stitch Up – Collusion Between the MoD and the Nuclear Industrial and Technological Network’, in order to present Parliament with a *fait-accompli*. On the demand side, the MoD has arbitrarily reduced the operational life of the Trident submarines from 30 to 25 years – referred to in all policy documents and ministerial statements prior to 2006 and has used the launch date of 1992 for the first submarine, *Vanguard*, rather than the commissioning date of 1994, to set the clock ticking.

On the supply side, the industrial/technological network has arbitrarily increased the period from design to construction to 17 years rather than 14, reinforcing that pressure, since the earliest that the first submarine can be completed becomes 2024, when two of the existing fleet should already have been decommissioned. Extending rather than reducing the life of the submarines is a straightforward proposition, as evidenced by the US, Ohio-class ballistic submarines, that are expected to remain operational for well over forty years, coupled to reduced intensity of patrols that should have lessened the wear and tear on both the submarines and the nuclear reactors.

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Compatibility of design features between the existing fleet of nuclear submarines and FOS mean that a 14 year design to construction timescale is not unreasonable, and with innovations in computer-aided design and manufacture, might even be reduced to 10 years or less.<sup>79</sup> On both counts, a decision could easily be delayed until 2010 or even longer, allowing budgetary savings and further reflection on other options, including the UK's role in nuclear disarmament negotiations like the review conference on the Non Proliferation Treaty due in 2010.

For the MoD, the absolutely crucial consideration is to maintain the ballistic-missile industrial/technological infrastructure in the context of its long-term planning for the UK's nuclear weapons; while for the industrial/technological network, it is important that there is a smooth transition from the present programme of conventional nuclear submarine construction to the design and full production of FOS in the second half of the next decade. For some reason, neither argument is given prominence in the White Paper.

Two aspects are important. Firstly, the MoD has been profoundly shocked by the technical problems experienced on the Astute SSN programme which were partly attributable to the run-down of design expertise at the Barrow shipyard following the completion of the first Trident programme, leading to a four year delay on the first-of-class submarine. It is doubtful that the programme could have got back on track without major design support from the American Electric Boat Company responsible for the construction of Ohio Class nuclear submarines.

The MoD simply cannot accept similar problems for the UK's ballistic-missile submarine programme, and it is determined to rebuild a stable design/production pattern well before the construction of follow-on Trident. In that context, it is also prepared to accept a large level of 'redundancy' in both timescale and resources during these early stages of design and first-of-class production, so that any technical problems can be resolved and the overall timescale for construction maintained.

Secondly, a programme of 7/8 Astute submarines will provide a steady flow of work that retains skills and capacity at the yard, and, in turn, allows for the smooth transition to follow-on Trident in the latter half of the next decade, so avoiding a bulge of production on both programmes that would have a negative effect on the Trident build programme.

Proposals to extend the life of the existing fleet are simply incompatible with the MoD's strategy, since they would create precisely the sort of gap in design and production between Astute and Trident that it is desperately trying to avoid. Any delay that put replacement back to the late 2020s or 2030s might place strains on the industrial/technological base, with the potential break up of skills and industrial capacity.

According to this perspective, the longer the delay, the greater the damage, to the point where it might prove impossible for a medium-sized economy like the UK to reconstitute that capacity, without massive new expenditure. But, essentially, the design and systems integration elements appear to be the only unique skills that could not easily be bought in when they are needed. That being the case, it would be possible to maintain a core design team by working up the existing designs for the next generation of conventional submarines, MUFC, as well as FOS, and to consider alternatives for the future construction of submarines should they be required later.

The DIS demonstrates that, from the MoD's perspective, such an outcome is undesirable, as it looks to maintain key industrial and technological capabilities in the UK, including those for nuclear submarines at Barrow, nuclear warheads at AWE, and nuclear power plants at Rolls Royce, Derby. The objective remains to guarantee a continued industrial/technological capability that can offer long-term options compatible with the United States future replacement of its D5 missile with a new system in the 2040s.<sup>80</sup>

From this historical perspective, it might also be useful to re-evaluate the role of conventional nuclear submarine programmes like the Trafalgar and Astute (and MUFC) classes. Many Cold-war military platforms have been provided with new roles, in this case from anti-submarine warfare to ground attack and insertion of special forces. But the SSNs main function, both for the MoD and the nuclear network, is to act as an industrial and technological life-support system in order to ensure continuity of production during the periods between ballistic submarine programmes. The true costs of the UK's nuclear weapons programmes might, therefore, more accurately include expenditure on Astute and MUFC.

This issue of continuity is, of course, central to the question of employment, since the jobs generated by the FOS have to be seen in the context of this longer-term support for the nuclear network. Thousands of jobs have disappeared since the first Trident programme as a result of capital expenditures and industrial restructuring, a pattern that reflects the general decline in military employment.

The government made no real estimate in the White Paper of the total jobs it expects to be generated, and it is not clear if there have been any internal studies made as yet by the MoD, but a conservative estimate would put the figure at 35-40% less than the first Trident programme. For a programme that will be anything from 25%-100% more expensive in real terms this represents a very poor rate of return. Indeed, if the objective was to use public expenditure to maximise employment, then building nuclear weapons is probably the worst way to go about it.

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The obvious point is that the MoD is not in the employment generating business. Its overriding concern is to maintain the industrial/technological base for nuclear weapons. Employment is a secondary issue, although a useful one in terms of building support amongst key groups including some trade unions with members in those industries. Despite the decline in employment, (or even because of it), organisations like Keep Our Future Afloat Campaign (KOFAC), a Barrow-based lobby group made up of trade unions and other local organisation, seek assurances from the MoD on securing submarine and surface vessel contracts, and portray continued ballistic missile submarine work as essential for Barrow and other areas which, it is claimed, face a form of economic meltdown if FOS does not go ahead.

The final chapter takes this as its starting point, the restructuring of the Trident network under a non-nuclear weapons policy that sees the delay/cancellation of FOS and alternative scenarios for employment without nuclear submarine and nuclear warhead design and production.

## CHAPTER THREE:

## Alternative employment scenarios

### Introduction

**B**EFORE turning to the scenarios it may be useful to reiterate key findings – that the nuclear network sustains relatively few jobs and that these are concentrated in a small number of facilities where employment has declined substantially over the last twenty years. Therefore, employment issues can be considered in various ways: the direct impact on the main military-industrial sites; on their local economies and supplier base; as well as the potential for generating alternative employment through other military and civil work.

There are two broad scenarios considered here – firstly, a military continuity scenario that centres on the maintenance of the nuclear infrastructure during a period of delay to, and possible future cancellation of, FOS; and secondly, a disarmament scenario where a non-nuclear weapons policy is adopted and the nuclear network is dismantled.

### Military continuity scenario

The delay and possible future cancellation of FOS is, here, compensated by military programmes intended to maintain key elements of the nuclear infrastructure. The existing Trident fleet continues on patrol and the submarines remain operational through to the mid-2020s. A large element of scheduled work would, therefore, remain including maintenance of the warheads at AWE. Also, the major reactor-core refits for the existing Trident fleet that are already underway at Devonport would continue, as would the second batch of non-core general refits in the later part of the next decade to ensure that the submarines remain operational until the mid-2020s.<sup>81</sup> Faslane and Coulport carry on with the routine maintenance and servicing of the submarines and missiles.

The Barrow shipyard is in the most difficult position in this scenario, since it faces a large order gap once the Astute SSN programme is completed. The simplest solution might seem to be an expansion of the programme beyond the original 7-8 submarines, as essentially the same mix of skills are required for both SSNs and SSBNs. However, there will be a serious and fairly immediate problem for the design staff expecting to continue work on FOS within the next two years. One option might be to introduce new design features into the second

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batch of Astute submarines that would begin construction in 2009/10.<sup>82</sup> But it is difficult to see how even extensive modifications will keep the full quota of design staff employed.

At some stage, therefore, there may have to be a commitment to accelerate the design and development of the next generation of conventional nuclear submarine, MUFC, that was planned for the 2020s, after FOS was completed. MUFC could incorporate many radical features and the timescale for design, and development, might not be dissimilar to that for FOS. Assuming a 7-8 Astute programme, work could begin on a batch of MUFCs by 2018-2022, ensuring a similar continuity as the rest of the nuclear weapons network.<sup>83</sup>

However, in industrial terms, there are serious questions about the actual volume of work required to compensate for the loss of an SSBN programme. Assuming the normal pattern of production on SSNs it would require something like a 16-20 SSN programme, counting both Astute and MUFC, to compensate fully for the loss of FOS.<sup>84</sup> Such a large programme may seem justified if the main concern is continuity of production but it raises serious strategic issues. The MoD has consistently reduced the size of its conventional nuclear submarine fleet, down most recently from 12 to 8 submarines for its new role in land attack and to support special forces. The government will have to balance strategic issues against the need to maintain the submarine industrial base, especially as this combined SSN programme will be far more expensive than any other naval programme.

But this is not the only dilemma when considering the future of the nuclear weapons network in this scenario. From 2010 onwards, employment trends will be affected by the broader restructuring of naval shipbuilding in the UK and the strong possibility that the leading companies will further rationalise production. Over the next four to five years there is a substantial naval order book for surface vessels and submarines, led by the two giant aircraft carriers, the biggest surface ships ever built in the UK to replace the Invincible class, and the remaining batch of Type 42 destroyers, as well as Astute. There will be a strain on existing capacity and the demand for skilled shipyard workers is expected to increase overall in the short term. For example, the Barrow yard may have to take on temporary contract workers for the section of the aircraft carrier that it is expected to build.<sup>85</sup>

However, the MoD has stressed that, in the medium term, there will be a much smaller programme of new build after this initial bulge of contracts and that the emphasis will be on upgrades of existing platforms. It has developed a Maritime Industrial Strategy, (MIS) as part of the broader DIS, in which the leading corporations are expected to carry out a radical restructuring that tackles what the MoD sees as wasteful duplication of facilities in the industrial base.<sup>86</sup>

From 2010 onwards, employment trends will be affected by the broader restructuring of naval shipbuilding in the UK and the strong possibility that the leading companies will further rationalise production.

Already there is a close relationship on the aircraft carrier programme and on the Type 42 destroyers between BAE and VT, the other major UK contractor for surface vessels. Further restructuring could see BAE take outright control of production with VT concentrating on a systems integrator role for complex upgrade programmes.<sup>87</sup> BAE, in this context, may want to cut costs by carrying out any basic manufacturing at overseas shipyards while retaining the added-value upgrade work in the UK. Further rationalisation of capacity, therefore, might include the Barrow shipyard, as BAE concentrates surface-vessel upgrade work at its two yards in Scotland.

Devonport also faces real uncertainties in the longer term. The new generation of PWR reactors that have already been installed in the Astute class submarines, are more efficient and are planned to run for the full operational life of the submarines without needing a major refit for refuelling.<sup>88</sup> Also, the MoD is presently carrying out a review of the three naval bases, at Portsmouth, Devonport and Faslane, which may lead to the closure of one or substantial rationalisation.<sup>89</sup> The Devonport refit yard, in particular relies on surface vessel work to maintain production alongside its core activity of nuclear submarine refit, so another source of work might possibly dry up.<sup>90</sup>

In other words, the short to medium-term compensation for the loss of FOS through other nuclear submarine work, and possibly some surface vessel work, has to be seen in the context of further consolidation and rationalisation of industrial capacity in naval shipbuilding that will reduce overall employment including potential job losses at Barrow, Devonport and Faslane.

A final issue is the role of civil work as an addition to military production and employment. DML, for example, has two subsidiaries, one refurbishing railway engines and the other building luxury yachts.<sup>91</sup> These remain a very small part of the overall business and are treated, essentially, as discrete subsidiaries that do not distract from the core programme of work on nuclear submarines. At present, Barrow has no civil work and although the company has expressed an interest in civil nuclear power work, should a new batch of nuclear power stations be built, senior management are at pains to point out that future viability rests in continued nuclear submarine manufacture.

This is not to say that other opportunities in civil shipbuilding do not exist. There are areas of growth expected such as cruise ships, with some UK yards gaining a market share and taking on extra employees.<sup>92</sup> But the competition for civil work is intense and companies like BAE Barrow face considerable difficulties because of their specialist facilities and skills base, the associated high costs of quality control and the complex bureaucratic structures associated with MoD specifications. If diversification on site is problematic, then other forms of employment and regeneration policies will be needed to compensate for lost military work.

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## Disarmament and civil reconstruction scenario

What would be the industrial/technological implications of a disarmament scenario? Here it is assumed that the UK takes a leading role in nuclear disarmament under the terms of the nuclear Non-Proliferation Treaty (NPT), does not replace Trident and pursues a phased elimination of nuclear weapons. In a new climate of international disarmament, the UK could also reconsider its broader security role, not as a junior partner to the United States that requires a conventional force structure based on large military platforms for global force projection, like the new giant aircraft carriers, but as a leading contributor to UN peacekeeping and civil reconstruction. However the focus here is on the process of nuclear disarmament and its implications for the nuclear weapons network.<sup>93</sup>

The Barrow shipyard, without SSN or SSBN design and production work after Astute, and with very limited prospects for new civil work because of the specialised nature of its production facilities and skills, faces run-down of employment and eventual closure by 2018-2020.<sup>94</sup> Here, acknowledgement should be made of the efforts to support alternative civil work at the Barrow shipyard, notably the campaign by a local trade union group, the Barrow Alternative Employment Committee (BAEC) in the 1980s.

Its report, *Oceans of Work* put the case for the company to invest in civil R&D, in particular, marine technologies like offshore wind and wave power equipment. But the report was dismissed by the company's management who stressed the importance of continued nuclear submarine work, even though employment has fallen substantially since. This combination of a management culture wedded to military work and highly specialised facilities geared to MoD specifications and bureaucratic procedures makes the transition costs from military to civil work, high, and successful adaption to civil work, problematic.<sup>95</sup>

Devonport faces similar issues as no further refit work will be required for the existing Trident fleet. However, there will be a sizeable programme for the defuelling and decommissioning of the Trident submarines which might employ up to 500 people at the refit yard, allied to some surface vessel and SSN refit work.<sup>96</sup> CSB also faces an uncertain future with the closure of Coulport and rationalisation of Faslane, which would be the operational base only for the Astute submarines, and a small fleet of surface vessels.

Assuming the closure of the Barrow shipyard and the significant run-down of Devonport and CSB, the focus might reasonably shift to the impact on their respective local economies and the potential for new manufacturing and service sector work to compensate for lost military work. Various studies point to a consistent pattern of a declining but still significant contribution by the nuclear weapons network to their local economies, despite serious job losses during the last twenty years.

A study of both the Devonport dockyard and the naval base assessed their contribution to the local and sub-regional economies. In 1991 both facilities generated about £520 million of income for Devon and Cornwall representing 5% of regional income. By 1998, after a series of redundancies, this had declined to £376 million, or 2.7% of regional income, while providing 10% of all local employment in the Plymouth area. The latest study for 2005, showed a further fall from 2.7% of regional income to 2.0% and from 10% to 8% of all local employment in Plymouth. However, DML was still the largest private employer in the city, the remaining jobs at the dockyard offered wages that were up to 40% above the average for the city and, of course, there was still the multiplier effect from wages and salaries spent locally.<sup>97</sup>

A similar picture emerges from studies in Barrow, where 40% of all male employment in the Barrow district depended on the shipyard in the 1980s, a figure that had fallen to less than 15% of the total district workforce by 2005. Again though, the yard remained by far the largest employer, offering higher wages than most of the other employment available in the district and providing over £70 million annually to the local economy.<sup>98</sup> Another study by the Scottish Executive focused on employment generated indirectly by the CSB, suggesting that, even after the various redundancies at the base, it still supported 9,100 jobs in Dunbartonshire, 11% of all jobs in the local area. This reflects the importance of both the industrial workforce employed by Babcock Naval Services and also the MoD civilian employees working in base security and the servicing of the navy crews.<sup>99</sup>

But there are also significant problems of local deprivation in some of these areas with the successive waves of military redundancies having left long-term unemployment and the associated run-down of local areas. Six wards close to the shipyard in the Barrow-in-Furness local authority district were classed as in the 10% most deprived for the whole of the UK in 2005, and the Devonport ward adjacent to the refit yard was one of the first to gain New Deal for Communities (NDC) funding, because of its acute deprivation and problems in terms of unemployment, poor housing, crime levels, etc.<sup>100</sup> It is one of the less acknowledged aspects of the prosperity associated with nuclear shipbuilding and repair facilities, that their local wards have borne the brunt of previous redundancy programmes and are some of the most deprived in the country, gaining little benefit from shipyard employment.

Of course, there have been efforts to attract new industries into these areas, supported by local and regional economic development agencies and assisted by government grants. Regeneration programmes have included new business parks on reclaimed brownfield sites, and retraining programmes for redundant workers. But these have tended to be in the lower-paid service sector, such as call centre jobs, and have provided only limited compensation for lost military employment.

40% of all male employment in the Barrow district depended on the shipyard in the 1980s, a figure that had fallen to less than 15% of the total district workforce by 2005.

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Not surprisingly, this acts as a further incentive to preserve existing employment at the yards for relatively skilled and well-paid jobs in areas where other manufacturing work is lacking. Lobby organisations like KOFAC have been mobilised around this theme – that the future of the yards as nuclear facilities is essential to the future prosperity of the local economies even though employment has declined dramatically and their preservation will do nothing to address the underlying problems of local deprivation.

This collective experience calls into question the effectiveness of regional and sub-regional economic policy for what are often described as ‘peripheral’ areas and certainly raises the question of why, twenty years after the first wave of redundancies, that such an unbalanced form of local economy has emerged. Understandably, local opinion, including business, trade union and political representatives, is strongly in favour of nuclear submarine manufacture, refit and maintenance. But what these areas are in greatest need of is balanced economic development that, allowing for a short-term disruption from lost employment at the yards, can create robust and diversified local economies, providing both new service sector and manufacturing employment in the medium to long term.

For example, one study carried out in Barrow argued for the redeployment of national civil service functions to areas of deprivation. Although not directly compensating for lost arms manufacturing work it would provide real opportunities for local people and would signal to the private sector that the government was committed to the regeneration of these areas, encouraging further investment.<sup>101</sup> Reclamation of disused land from the yards could also stimulate investment in new commercial activities and residential development. Nor should the prospects for tourism and other leisure industries be discounted. The Clyde bases, of course, are in an area of outstanding natural beauty, but both Barrow and Plymouth have real tourist potential, especially around recreational sailing or other marine sports.

As well as an intensive programme of regeneration support, there needs to be a serious evaluation of how these areas might benefit from a major government-led investment in new civil programmes like renewable energy. For example, partly financed by savings from the cancellation of FOS, the government could embark on a multi-billion pound programme for offshore wind and wave power that has the potential to satisfy up to 50% of the UK’s electricity supply, substantially reduce the UK’s carbon emissions, and form the basis for a major new industry employing 25,000 to 30,000 people.<sup>102</sup> There would be a range of work in the design and manufacture of large wind turbines and wave machines, the construction of sea-based foundations, platforms, electrical cable laying, etc. Workers made redundant from the yards could be retrained and re-employed in companies encouraged to set up in these areas.<sup>103</sup>

Lobby organisations like KOFAC do not see these as realistic options and for them there is simply no alternative to continued nuclear submarine work other than economic meltdown.

As well as an intensive programme of regeneration support, there needs to be a serious evaluation of how these areas might benefit from a major government-led investment in new civil programmes like renewable energy.

But there are examples of recent economic restructuring, such as the Rover car factory in Birmingham that involved much larger job losses and took place over a much shorter timescale than what would be the phased run down of the nuclear network. When Rover closed in 2005 with very little prior warning, 6,300 Longbridge workers lost their jobs and were registered as unemployed. The MG Rover Task Force was set up through the Regional Development Agency (RDA), Advantage West Midlands, to support people back into work and to help the many local subcontractors to diversify their customer base.

A review of the Task Force activities in March 2006 concluded that 4,000 people had found other work and 1,000 were in some form of training. Issues still remained over lower wage levels than those in the factory for about 40% of the workers, while 1,000 people were still unemployed after nine months. But the rate of new employment had been maintained at about 100 a week, and those still without work were being provided with extra support.<sup>104</sup>

These findings were challenged by the Amicus trade union in a recent survey of its members who were previously employed at Longbridge. Of the 1,750 surveyed, 23% were still unemployed or on training courses and one in five were working on the minimum wage level.<sup>105</sup> For Amicus, the evidence pointed to a broader problem of limited government support and protection for UK manufacturing at a time of serious erosion of manufacturing capacity and employment.

Clearly, there are very serious issues about the future of manufacturing in the UK, although how far it is possible for governments to support continued employment in sectors like car manufacture, which are characterised by international over-production, is questionable. More effective would be to provide incentives for investment in the new industries like renewable energy and environmental technologies generally, and to provide comprehensive retraining programmes, as there could well be skills shortages for these sectors in the future.

Another element of the Longbridge regeneration strategy was to assist local subcontractors to Rover, again a key issue in terms of economic adjustment. Many had recognised their potential exposure, as Rover had experienced trading difficulties over several years, and during this period they attempted to diversify into supplying other major companies. The Task Force provided some financial support to assist companies after the Longbridge closure, including funding for the retention of staff, and only eleven suppliers closed down out of the hundreds that were expected to be vulnerable.<sup>106</sup>

While the nuclear submarine supplier network may have more specialised companies, the general proposition still applies, that the supplier base is more robust than might be considered, and that given a reasonably long timescale to prepare for the loss of orders from a prime contractor, in general, it can make a successful adjustment to other supplier work.<sup>107</sup>

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If the vast majority of former employees from Longbridge are either in work or training and the supplier base has successfully adjusted to the loss of Rover, questions remain about the quality of jobs on offer and the future regeneration of the local economy. The litmus test has to be how the immediate support is complemented by longer-term strategies. In the case of Longbridge, the RDA has an ambitious plans to regenerate the site as a catalyst for new employment above the levels previously generated by Rover, including a new high technology business park and a training centre for skills in computer engineering, electronics and computing.<sup>108</sup>

Another related example, is the Rosyth dockyard after the loss of its submarine refit work, where a large section of the site was sold on to a regeneration company, Rosyth 2000, to develop a mixed industrial, business, leisure, tourism and retail complex. The objective is to create 4,000 to 5,000 jobs, more than compensating for the loss of submarine refit work.<sup>109</sup>

These sort of integrated regeneration packages are ambitious, focusing on retraining, supporting the supplier chain and sustained longer-term investment. Compared to the local economies of the nuclear network there are some obvious contrasts, including the relative isolation of Barrow and to a lesser extent CSB. But the main lesson remains a powerful one, that a comprehensive regeneration programme can help overcome the immediate impact of a major closure, combined with ambitious, longer-term plans to develop a range of new employment opportunities; and that local economies can adapt to what would have previously been considered the disastrous loss of a staple industry.

### **AWE – new roles**

The key question for AWE is what roles it could play without nuclear warhead design and manufacture. A central function will be to take responsibility for the decommissioning of the UK's nuclear warheads during a phased programme of international nuclear disarmament. Estimating the number of people required to carry out this task is difficult, although previous experience in the civil nuclear industries provides some parallels.

The most significant has been the decommissioning of the Dounreay fast-breeder test reactor on the north coast of Scotland. Fast breeders were expected to form the basis for a new generation of nuclear power plants in the 1980s and 1990s but the prototype suffered a series of technological failures. In the mid 1990s the decision was made to end the programme, but only after hundreds of millions of pounds had been spent in research and development, and in sharp contrast to the lack of government support for renewable energy during the same period.<sup>110</sup>

At its peak, 2,600 were directly employed on site but this had declined to 1,184 by 2006, with the remaining staff responsible for the decommissioning process. According to a study by the local Caithness and Sutherland Enterprise Agency this programme of work will lead

to a further decline to 700 employed by 2016 and full closure and reclamation of the site by the late 2020s. Certainly, the Agency recognises that the future of the area lies in diversifying the local economy.<sup>111</sup>

Although the range of decommissioning work will be different for AWE, the dismantling of warheads and buildings could be expected to provide a similar pattern of tapered employment. Also, AWE could play a central role in international disarmament by developing improved verification and compliance technology, based on its already well-established reputation for participating in verification programmes under the NPT. There are difficulties in estimating the total numbers who might be expected to be employed but there are opportunities both in monitoring for underground test violations and also international inspections of designated sites for the storage and decommissioning of nuclear materials.<sup>112</sup>

However, it is probable that a majority of the workforce will need other forms of work apart from decommissioning and verification, and AWE does have some previous, if limited experience in applied civil research on which it could build. During the 1960s, for example, the Labour government under Harold Wilson encouraged all the military research laboratories to develop civil research programmes as a contribution to the modernisation of the UK's industrial and technological base in response to growing international competition from countries like Japan and Germany.

AWE was a leader in the use of supercomputers and teamed up with private sector companies to develop modelling techniques for computer-aided design. Health care was also identified as a research priority, both through new materials for surgical implants and the use of lasers in new surgical techniques.<sup>113</sup>

But, the momentum for this diversification programme was not sustained and by the early 1970s AWE was again concentrating on its core programme of nuclear warhead work. Similarly, in the late 1990s, another attempt was made to support diversification when AWE faced uncertainties over its future work programme, after the cancellation of the FTNW. But those efforts have been very limited, and only intended to complement existing skills in nuclear weapons work.<sup>114</sup>

A similar picture emerges in the United States, where the national research laboratories that carry out nuclear weapons work were encouraged under the Clinton administration, to diversify into applied civil research at the end of the Cold War, a policy continued under the Bush administration.<sup>115</sup> For example, the Sandia laboratory in New Mexico has been involved in research projects with private sector partners to develop hydrogen fuel cells as an alternative form of electrical power for motor vehicles, as well as computer simulation of climate change.<sup>116</sup> However, nuclear weapons research remains the central priority for all the laboratories.

AWE could play a central role in international disarmament by developing improved verification and compliance technology, based on its already well-established reputation for participating in verification programmes under the NPT.

Alongside its decommissioning and verification work, AWE could become a national laboratory in applied civil research in the physical sciences to lead on climate change research and other national priorities.

If nuclear weapons research and production were brought to a close at AWE then the role of civil diversification would have to be given a much higher priority. Here, alongside its decommissioning and verification work, AWE could become a national laboratory in applied civil research in the physical sciences to lead on climate change research and other national priorities. A potential model for this exists in developments at the MoD's Porton Down, chemical and biological research centre. Now part of the Defence Science and Technology Laboratories (DSTL, Porton Down) its main role is research on defensive measures against chemical and biological agents. At its site near Salisbury, Porton Down set up a science park in 1997 to act as an incubator for small, start-up biotechnology companies and this has recently been expanded into the Porton Bioscience and Technology Centre (PBTC) utilising the scientific skills in DSTL to support a range of bio-technology industries in areas like health, genetics and food.<sup>117</sup>

However, serious questions remain over AWE's capacity to make a fundamental transition from specialised nuclear weapons research to new civil missions. The cultural change required, particularly from a senior management team that will have seen its specialist niche disappear, is formidable. An alternative to the national laboratory model is for the government to retain the core decommissioning function at Aldermaston, while supporting civil R&D through a regionally-based research network along the lines of the Fraunhofer Institutes for applied research in Germany.<sup>118</sup>

Here, AWE faces the loss of approximately half of its existing workforce as it concentrates on decommissioning and verification. But, AWE is located in the Thames Valley, one of the most buoyant regional economies in the country with the lowest level of unemployment. Serious skills shortages are emerging and there will be high demand for the sort of scientific and technical skills that former AWE staff can offer, assuming appropriate retraining from specialised nuclear work to the demands of the civil sector.<sup>119</sup>

## Conclusion

In employment terms, providing alternative military work through a large programme of SSNs to compensate for the loss of FOS may seem the simplest solution in terms of continuity of skills and facilities. But this option is difficult to justify either on strategic or cost grounds, while the continued process of corporate restructuring will lead to further pressures on employment. The other option put forward is civil work in associated types of large-scale engineering on site, but the specialised nature of nuclear submarine manufacture and repair makes the transition costs uneconomic.

Instead, policy should focus on broader regeneration programmes for these few local economies where nuclear weapons work still represents an important, if substantially reduced, source of employment. The phased transition would see the Barrow shipyard run down and closed by 2020. Devonport will continue in the short-term with SSN refit

work and with a core workforce of 500 to decommission Trident submarines, while continuing some surface vessel refit. Coulpport will close and Faslane will be left with operational maintenance of SSNs and some surface fleet maintenance.

Lobby groups like KOFAC will represent the closure and/or run down of shipyards as a disaster for their local economies. But the recent closure of the Rover car plant at Longbridge, although not entirely replicable, demonstrates how a much larger and sudden loss of employment can be absorbed in the short term, and ambitious plans put in place for the regeneration of the site and the local economy in the medium to long term. Job losses in the nuclear weapons network will be smaller in every case, and spread over a longer timescale of five to ten years. Indeed, although the closure of staple industries is often portrayed as unthinkable, it can serve as a catalyst for new economic development that in the medium to long-term, leads to increased employment prospects and to stronger, diversified local economies.

More ambitiously, while these local regeneration activities are underway, the government could use the savings from the cancellation of FOS and the operational costs of Trident to help support a new R&D and investment programme in renewable energies to tackle the real security threat of the 21st Century, climate change. A major expansion of offshore wind and wave power could provide 50% of the UK's total electricity-generating needs by 2030, significantly reducing the UK's carbon emissions and our dependency on foreign supplies of oil and gas. Incentives could be provided for renewable energy companies to set up in Barrow, Plymouth and the Clyde areas. Redundant shipyard workers could be offered retraining programmes and be considered for employment in these new industries.

AWE, without nuclear warhead design or production, has the potential to build on a core programme of decommissioning to become a leader in verification and compliance technologies for international nuclear disarmament. It could also be given a new role as a national laboratory for new national scientific missions including renewable energy and climate change, utilising its skills in materials science and computer modelling. But the cultural challenge of managing the transition from specialised nuclear weapons research to applied civil research is a formidable one and the lessons from the lack of success in diversification exercises at AWE need to be acknowledged, particularly in terms of a managerial commitment to fundamental change.

Alternatively, AWE could be left with a core staff simply for decommissioning and verification while funding is provided to a network of regional centres for civil research. In both cases, any staff made redundant from AWE can expect that their scientific and engineering skills will be in demand from companies experiencing skills shortages in the South East.

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During the ten year restructuring period to the nuclear weapons network, this combination of investment in new, civil R&D and production, allied to specific regeneration support for local economies, can maximise the economic benefits of nuclear disarmament and ensure that the loss of a small number of jobs is more than compensated by new opportunities in civil work.

## Conclusion

**T**HE retention of the UK's industrial and technological network for nuclear weapons has been a priority for successive governments intent on maintaining a long-term strategic relationship with the United States. In that context, the White Paper represents a quasi-democratic exercise in legitimisation for decisions already taken, in secret, by the elite group that has always been responsible for nuclear weapons policy.

The process of White Paper, expert evidence gathering, and Defence Committee reports, has led to one of those rare parliamentary phenomena, so rare in fact that it might be considered an endangered species, a House of Commons debate on nuclear weapons policy. But the window of opportunity for genuine and broad-based democratic participation was made deliberately narrow and the terms of reference rigged to ensure a predetermined outcome – the start to the new Trident ballistic missile submarine programme and the rejection of any other options. Yet this is one of the most important decisions Parliament has ever taken, with profound implications for the UK's role in the world.

Since the Atlee government, billions of pounds have been invested in the nuclear weapons infrastructure, the purchase of American missiles and the design and production of warheads and submarines. The main facilities at Aldermaston, Barrow, Faslane, Coulport and Devonport collectively represent the biggest state investment programme in post-war history, far bigger than any other government-funded civil engineering programmes in terms of size and complexity. Most recently, there has been a £1 billion investment at AWE to ensure the development of a new generation of nuclear warheads for both strategic and sub-strategic roles. These long-term investments are intended to maintain the nuclear weapons infrastructure both for FOS and beyond, into the middle of the century, as the United States considers its future options for nuclear weapons modernisation.

Crucially, at this stage, the government wants to secure support for FOS, while making it appear imperative that a decision has to be made now, even though it could easily be delayed and serious considerations be given to alternatives, including a renewed effort by the UK to support international nuclear disarmament. The MoD has effectively colluded with BAE and the other leading companies in the nuclear submarine network because it is in their mutual interest to secure an early decision. By reducing the operational life of the existing fleet of submarines from 30 to 25 years while extending the design to construction phase for the

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new submarines from 14 to 17 years, the MoD, in one swift sleight of hand, satisfies the political goal of making an immediate decision seem imperative if FOS is to be ready in 2024; while BAE will be guaranteed the optimum transition period from its existing work on Astute SSNs presently being built in Barrow to FOS.

Tensions may still exist over the monopoly power that BAE holds, reflected in the cost overruns, delays and contract renegotiations on Astute. But the MoD is ready to accept a large degree of 'redundancy' in the design and construction phase on the first of class FOS in order to guarantee that it will be ready by 2024 and because it also reinforces the political imperative to make a decision now. Yet there is strong evidence that the operational life of the submarines can be extended and the design phase reduced so that the decision can be delayed until 2010 and probably much longer. Staff employed on the design of FOS could be redeployed to other conventional submarine work during this period.

The government has suggested that there is no guarantee that the submarines will be built in the UK unless satisfactory contractual arrangements are concluded. But the only serious alternative to building the submarines at the BAE yard is to have them constructed by the Electric Boat Company in the USA. The UK is already dependent on the United States for missiles and support on warheads and submarine design. If the submarines were constructed in the United States, then the government might as well paint a stars-and-stripes on them, crew them with Americans, and ask for an occasional postcard in between patrols, because the illusion of operational independence would finally be shattered.

Here, the issue of employment in the UK plays a secondary but, nonetheless, useful role for the government in bolstering support for nuclear weapons. Stress is laid on the thousands of jobs dependent on nuclear weapons work and the accusation is then easily laid against those who support nuclear disarmament, that such a policy would lead to major job losses. (Logically, of course, this should mean an international agreement on nuclear disarmament is impossible, a quite ridiculous proposition.)

There is one simple answer to this. If you started with a blank slate and wanted to use £25 billion of public expenditure to maximise employment, then the last thing you would do is build nuclear weapons. Several studies have demonstrated how disarmament and reduced military expenditures, if matched by alternative expenditure in the civil economy, can provide increased employment opportunities. Indeed, over the past fifteen years there have been a series of massive redundancies in the nuclear weapons network, reflecting the general decline in arms related employment. Notably, employment at Barrow has declined from 12,500 to 3,400 and overall there has been nearly a 60% reduction in employment at these facilities. FOS will be more expensive in real terms and employ far fewer people than the original Trident programme.

If you started with a blank slate and wanted to use £25 billion of public expenditure to maximise employment, then the last thing you would do is build nuclear weapons.

In keeping this small group of people employed, one might also reflect on the true cost of the nuclear weapons infrastructure. Not only is there the £18-25 billion on Trident but the capital costs of the facilities, most of them built at massive extra charge to the taxpayer compared to original estimates; conventional nuclear submarine programmes like Astute which are essentially a form of industrial life-support to ensure continuity between ballistic missile submarine programmes; operational costs over the thirty years of the submarines' lives; and potentially serious liabilities over the final disposal of the irradiated hulls of decommissioned submarines. The government's new-found enthusiasm for civil nuclear power may also be driven by the growing awareness that it is probably a contradiction in terms to be a military nuclear power without a civil nuclear industry; even if the economic price to pay is a high one, compared to other forms of energy supply.

Of course, lobby groups will argue that nuclear weapons still provide highly skilled jobs, especially in areas where other manufacturing work is in short supply. This argument needs careful assessment. The configuration of skills to satisfy the highly specialised demands of nuclear submarine and nuclear weapons construction, such as integrated weapons-handling design, are so technically specific as to have no equivalent in the civil sector.

If the UK adopted a non-nuclear weapons policy there are two main employment policy options. One is to compensate for the loss of FOS with other conventional nuclear submarine work, as this provides a relatively straightforward match of skills and production. Both the shipyard and the repair yard could be filled to the gunnels with up to twenty SSNs. But what would be the point? Certainly there is no strategic justification and the cost of a large SSN programme would run into billions. Nor would it save the workforce from further job losses in the medium term, as the MoD looks to cut industrial overcapacity in the naval sector as part of its Maritime Industrial Strategy, and the private sector companies that run and own these facilities continue with programmes of consolidation and rationalisation, including the option of overseas subcontracting.

Rather than follow this course, the UK could adopt an arms conversion policy that sees the savings from the cancellation of FOS used to support civil R&D and production. In this way the UK could satisfy 50% of its electricity generation needs from a multi-billion pound investment in offshore wind and wave power, providing 25,000 to 30,000 jobs, that would more than compensate for lost military employment, while significantly reducing carbon emissions and enhancing security of supply.

Although there will be a core programme of nuclear warhead decommissioning at AWE and nuclear submarine defuelling and decommissioning at the Devonport refit yard, the

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nuclear network faces run-down and eventual closure. Because of the highly-specialised configuration of skills and facilities on site at the shipyards, there is little prospect of adaption to civil work and the focus of economic policy should be on encouraging a broader base of both, manufacturing and service industries, in those few local economies like Barrow-in-Furness that still have a residual dependency on nuclear weapons work.

This is particularly important, given the successive waves of redundancies in those areas and the underlying problems of economic and social deprivation that the continued presence of the shipyards has done nothing to alleviate. Lessons from previous examples of the regeneration of local economics after the closure of staple industries, including the retraining of redundant workers, re-use of brownfield sites and support for the supplier base, could be usefully applied. The transition period will be over five to ten years allowing sufficient time to put forward a range of programmes including, for example, the relocation of civil service functions into these areas and incentives for renewable energy companies to set up in these areas.

AWE, has a special status compared to the nuclear submarine network because it has a recognised expertise in both decommissioning and verification. This expertise could be made available to the international community with AWE establishing itself as one of the leading institutions for verification technology and for compliance procedures. Even more ambitiously, AWE could become a national laboratory leading the UK's efforts in long-term applied research in the physical sciences.

But this raises serious issues. AWE has already absorbed a vast level of public investment and taken a significant proportion of scarce scientific and technical staff for nuclear warhead design and manufacture. Its record on diversification into civil research is poor and there would have to be a major cultural change if it was to make the successful transition from nuclear warhead research to the very different demands of the civil sector. Alternatively, the government might consider funding a regional network of civil R&D institutes as a way of compensating for the heavy bias of government military R&D funding to the South East. In both cases, where staff are made redundant from AWE, they could expect to find other employment relatively easily in the Thames Valley region where skills shortages already exist.

Still, there will be little enthusiasm for an arms conversion policy in the nuclear weapons network, because it can only offer the prospect of new employment opportunities in the future against the reality of existing employment now. Some trade union officials, not surprisingly, are at the forefront of the campaign to retain jobs in nuclear weapons work, given their responsibility to protect their members' interests. It is unfortunate that job protection is sometimes conflated with strong support for nuclear weapons, in contrast to the proud tradition that the trade union movement has on policies for international disarmament and on arms conversion.

Perhaps local opposition is inevitable but this should not distract from the positive economic benefits of an arms conversion programme, in terms of new opportunities for civil work that far outweigh the loss of jobs in the nuclear weapons industries. Even those few local economies with a residual dependency on nuclear weapons work would benefit from a coordinated programme of comprehensive regeneration, so that the closure of a staple industry, once considered unthinkable, becomes the catalyst for a stronger, diversified economy.

Decisions on the future of the UK's nuclear weapons must be made on the basis of its long-term security interests. But it is also important, in the context of this debate, that employment issues are desensationalised. Far from being an economic disaster there are positive benefits to be gained from the dismantling of the nuclear weapons industrial and technological network, if the UK, as it should do, takes a leading role in international nuclear disarmament.

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## Footnotes

- <sup>1</sup> The early history is covered in Margaret Gowing's *Independence and Deterrence, Britain and Atomic Energy 1945-52, Vol 1 & II* (Macmillan, 1974) and also Lorna Arnold, *Britain and the H Bomb* (Palgrave Macmillan, 2001). Dan Plesch, *The Future of Britain's WMD* (Foreign Policy Centre, 2006) [www.comeclean.org.uk/content/dan\\_plesch\\_report\\_march2005pdf](http://www.comeclean.org.uk/content/dan_plesch_report_march2005pdf), provides a recent review that looks in detail at the long-term dependency of the UK on the USA for key nuclear technologies and the policy implications of that dependency. The relationship can easily be viewed as a one-way-street, but the USA also benefits from having access to AWE and to highly-skilled scientific and professional staff, working in partnership with its national research laboratories. Nevertheless, Plesch is right to argue that the UK's role as a loyal lieutenant to the USA in the broader context of its foreign and defence policy has been profoundly influenced by the need to maintain access to crucial nuclear capabilities. The full significance of this dependency is rarely acknowledged.
- <sup>2</sup> Claire Taylor, Tim Youngs, Ross Young & Gavin Berman, *The Future of the British Nuclear Deterrent*, pp. 9-10 (House of Commons Library, Research Paper 06/53, 2006)
- <sup>3</sup> John F. Schank et al., *The UK Nuclear Submarine Industrial Base – Sustaining Design and Production Resources*, p. 85. The US agreed to provide a complete and proven Skipjack-class reactor plant for installation into Dreadnought, the UK's first nuclear submarine. The UK also decided that Rolls Royce Associates would be the single point of contact to the Westinghouse Corporation, the US provider of nuclear equipment and the company continues to run the MoD's Vulcan experimental nuclear reactor at Thurso in the north of Scotland.
- <sup>4</sup> Taylor, op. cit. An amendment to the 1958 agreement gave the UK access to nuclear test facilities in Nevada. The Nassau Agreement 1962, formalised the relationship through the purchase of Polaris missiles in return for the basing of American, Poseidon nuclear submarines at Holy Loch near Glasgow. The MDA was last renewed by George Bush in 2004 to run until 2014.
- <sup>5</sup> *Labour Party Manifesto* (Labour Party 1964) (<http://www.psr.keele.ac.uk/area/uk/man/lab64.htm>), 'Nor is it true that all this costly defence expenditure will produce an "independent British deterrent". It will not be independent and it will not be British and it will not deter. Its possession will impress neither friend nor potential foe. Moreover, Britain's insistence on this nuclear pretence carries with it grave dangers of encouraging the spread of nuclear weapons to countries not possessing them, including Germany. The Government bases its policy on the assumption that Britain must be prepared to go it alone without her allies in an all-out thermo-nuclear war with the Soviet Union, involving the obliteration of our people. By constantly reiterating this appalling assumption the Government is undermining the alliance on which our security depends.'
- <sup>6</sup> The official title is HM Naval Base Clyde, incorporating the Faslane Naval Base and the Royal Naval Armament Depot, Coulport, but referred to here as the Clyde Submarine Base. See Peter Naylor, *The Nassau Connection: The Origin and Management of the Polaris Project* (HMSO, 1988) for an historical account of the UK Polaris programme including the discussions on the various sites for the submarine base and the debate on whether to build four or five submarines to ensure that two submarines were always on patrol. The government eventually cancelled the fifth submarine on cost grounds.
- <sup>7</sup> G. Spinardi, Aldermaston and British Nuclear Weapons Development: Testing the Zuckerman Thesis, *Social Studies of Science*, Vol 27, 1997, pp. 547-582. Again, there was considerable liaison with the United States, and although Chevaline was designed in the UK, it was heavily dependent on the Lockheed, Antelope warhead for the US Polaris missiles. It has been estimated that half of the total programme costs were spent in the United States. The Chevaline project was kept secret by four successive British governments and was only revealed in 1980 because the project had almost

- quadrupled in price from the original estimate. While the upgrading of Polaris was taking place, it became clear that the Soviet ABM system was not capable of protecting Moscow.
- 8 Maggie Mort, *Building the Trident Network: A Study of the Enrollment of People, Knowledge and Machines* (MIT Press, 2002) and Steven Schofield, *VSEL Barrow and Arms Conversion* (Phd Thesis, Bradford University, 1990) for background information on the investment and company structure during this period.
  - 9 House of Commons Defence Committee, *Strategic Nuclear Weapons Policy*, p. 18 (HC 36, 1980-81). The fact that Dr Kinloch, from British Shipbuilders, felt compelled to deny that the MoD had specified the expected submarine size, even though the D5 programme was well advanced, speaks volumes for the way that the government handled the decision on Trident.
  - 10 *Ibid*, p. xxxviii.
  - 11 Various reports are referred to including, House of Commons, Defence Committee, *Strategic Nuclear Weapons Policy* (HC 36, 1980-81), Defence Committee, *The Trident Programme* (HC 479, 1984-85), Comptroller and Auditor General, *Ministry of Defence and Property Services Agency : Control and Management of the Trident Programme* (HC 27, 1987-88), Defence Committee, *Progress of the Trident Programme* (HC 422, 1987/88), Defence Committee, *Progress of the Trident Programme* (HC 297, 1993-94), Public Accounts Committee, *Management of the Trident Works Programme* (HC 621, 1993-94) Defence Committee, *Progress of the Trident Programme* (HC 350, 1994-95), National Audit Office, *Major Projects Report* (HC Paper 238, 1995-96).
  - 12 House of Commons Defence Committee, *The Trident Programme*, pages xii, xvi (HC 479, 1984-85)
  - 13 House of Commons Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent : The Manufacturing and Skills Base*, EV 114 (HC 59, 2005-06).
  - 14 The programme also included initial work for Trident at the Rosyth naval dockyard but this was stopped when the government transferred refit work to Devonport.
  - 15 House of Commons Defence Committee, *The Trident Programme*, p. 39 (HC 479, 1984-85) Coulport is a massive site, covering some 1,000 acres, surrounded by razorwire fence and floodlight at night.
  - 16 Comptroller and Auditor General, *Ministry of Defence and Property Services Agency : Control and Management of the Trident Programme*, p.9 (HC 27, 1986-87).
  - 17 Public Accounts Committee, *MoD, Management of the Trident Works Programme* (HC 486, 1994-95).
  - 18 Alternative Employment Study Group, *Polaris and Trident – The Myths and Realities of Employment*, pp. 7-8 (AESG, 1985). Construction contracts went to specialised firms and much of the work was carried out by external contractors rather than local firms.
  - 19 *Scotland on Sunday*, 25/05/06. Babcock Naval Service also owns the Rosyth naval yard in Scotland. The MoD still employs a large number of civilian and service personnel on site (1,080 at Faslane and 670 at Coulport), mainly in security and administrative posts. *Hansard* 09/01/2007 col 522w and 08/01/2007 col 321w and there are substantial numbers of contractor personnel, 2,478, *Hansard*, 5/11/2006 col 363w.
  - 20 House of Commons Defence Committee, *Ministry of Defence Annual Reports and Accounts 2004-2005*, Annex A (HC 822, Session 2005-06).
  - 21 House of Commons Defence Committee, *Progress of the Trident Programme* (HC422, 1987-88). The Committee questioned this but accepted that it was consistent with accounting conventions.

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- 22 *Hansard*, 14/3/1996, col 679w, and House of Commons Public Accounts Committee, *MoD Major Projects Report 1995* (HC 677, 1995-96).
- 23 House of Commons Defence Committee, *The Trident Programme*, p. xvi (HC 479, 1984-85) and Defence Committee, *Progress of the Trident Programme*, (HC 350, Session 1994/95).
- 24 National Audit Office, *MoD, Sales of the Royal Dockyards*, (HC 748, Session 1997-98).
- 25 DML's proposal was £236 million compared to Rosyth's £248 million. The efficiency savings were estimated to be £52 million over 15 years but the methodology was challenged and various counter proposals were made to retain Rosyth, all of which the MoD rejected. See Defence Committee, *The Royal Dockyards*, (HC 829, 1992-93).
- 26 *Hansard*, 18/4/1996, col 584w.
- 27 *The Plymouth Herald*, 29th June 2007.
- 28 Public Accounts Committee, *MoD, The Construction of Nuclear Submarine Facilities at Devonport* (HC 636, 2002/03). The MoD had to reluctantly accept that the sheer scale of the cost increases, caused by an underestimation of the technical issues of safety compliance, could not be met by DMS without risking its solvency.
- 29 DML *Link*, November 2005, [www.devonport.co.uk](http://www.devonport.co.uk)
- 30 House of Commons, *The Future of the UK's Strategic Nuclear Deterrent: The Manufacturing and Skills Base*, EV 113 (HC 59, Session 2005-06).
- 31 House of Commons Defence Committee, *Progress of the Trident Programme*, p.10 (HC 297, 1993-94).
- 32 *Ibid*, Also, Defence Committee, *Progress of the Trident Programme* (HC 350, 1994-95). The Defence Committee had suggested that AWE consider the potential for diversification into non-nuclear weapons work but the management did not give this any real priority.
- 33 *Hansard*, 19/07/2005, col 232w.
- 34 Robert S. Norris & Hans M. Kristensen, 'Britain's Nuclear Forces', *Bulletin of Atomic Scientists*, pp. 77-79 (Nov/Dec 2005, Vol. 61, No. 6). See also, Acronym Institute, *Disarmament Diplomacy*, 'Why is Britain's Nuclear Weapons Infrastructure being Upgraded?' (Issue No 76, March/April 2004) [www.acronym.org.uk/dd/dd76/76news03.htm](http://www.acronym.org.uk/dd/dd76/76news03.htm).
- 35 [http://www.awe.co.uk/main\\_site/about\\_awe/the\\_company/index.html](http://www.awe.co.uk/main_site/about_awe/the_company/index.html)
- 36 *Hansard*, 7/11/2006, col 1448w.
- 37 HM Treasury, Central Unit on Procurement, *The Trident Works Programme – A Study* (HMSO, 1995).
- 38 Ministry of Defence and Foreign and Commonwealth Office, *The Future of the United Kingdom's Nuclear Deterrent* (Cm 6994, 2006).
- 39 See for example, Ken Booth and Frank Barnaby, *The Future of Britain's Nuclear Weapons – Experts Reframe the Debate* (Oxford Research Group, 2006); the special edition of *International Affairs* (Vol 82, No. 4, 2006); and the House of Commons Defence Committee, *The Future of the United Kingdom's Nuclear Deterrent: The Strategic Context* (HC 986, 2005/06) for an extended appendix.

- 40 Cm 6994, p. 18.
- 41 The idea of ‘bunker-busting’ nuclear missiles is well-established in the USA, requiring the development of new warheads with ground-based detonation rather than air-burst. Interestingly the USA is also converting some Trident missiles to carry conventional warheads – with similar arguments of responding to real-time intelligence about a terrorist leadership centre, or to destroy early warning radar without a forward deployment or visible presence. The Trident submarine then becomes a vehicle for flexible response for conventional, sub-strategic, and strategic nuclear force, see Military.com, *A New Role for the Trident Fleet*, 31/07/2006.
- 42 This is called having your nuclear cake and eating it. Obviously, using this logic, any country could respond to the same threats and potential threats by developing nuclear weapons. There could be no clearer case to be made for nuclear proliferation.
- 43 Cm 6994, Appendix B, Options Assessment Process.
- 44 Ibid.
- 45 Paul Ingram, *Decisions over the future of British Nuclear Weapons*, p.14 (BASIC, 2006).
- 46 Cm 6994, Appendix B, p. 26.
- 47 Ibid.
- 48 Keith Hartley, 'The Economics of UK Nuclear Weapons Policy', *International Affairs*, Vol. 82, No.4, pp. 675-684, suggests a 10% rise in real terms each year for military equipment, p. 684.
- 49 Typhoon has been ordered in three batches, the last of which will be placed in 2007, see National Audit Office, *Ministry of Defence, Major Projects Report 2006 - Project Summary Sheets* (HC 23 II, 2006/07), For a general critique of UK defence procurement policy see Steven Schofield, ‘The Levene Reforms: An Evaluation’, *Defense Analysis* (Vol 11, No 2, pp. 147-74, 1995).
- 50 See National Audit Office, *Ministry of Defence, Major Projects Report – Projects Summary Sheets* (HC 23 II, Session 2006/07).
- 51 This was essentially how Polaris submarines were designed, as an extension to the first-generation SSN.
- 52 House of Commons Defence Committee, ‘Rusi Memorandum’, *The Future of the UK’s Strategic Nuclear Deterrent: The Strategic Context* (HC 986, 2005-06).
- 53 There has been a 20% reduction in the number of warheads to no more than 160 and a reduced number of missiles from 58 to 50 since a number have been used in test flights and not replaced.
- 54 Michael Quinlan, ‘The Future of United Kingdom Nuclear Weapons – Shaping the Debate’, *International Affairs*, pp. 627-637 (Vol. 82, No. 4, 2006). It is generally assumed that since the 1998 Strategic Defence Review, lower alert levels refer to not having two submarines on patrol at the same time.
- 55 This contrast with the original proposal for Polaris that included a five boat programme to ensure two submarines were permanently on patrol.
- 56 House of Commons Defence Committee, *Progress of the Trident Programme* (HC 297, 1993-94) refers to lifetime operational costs over 30 years. More recently, the MoD's DLO Nuclear Cluster, responsible for co-coordinating all nuclear project planning, refers to a thirty-year life expectancy

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- until 2024. See DLO, *The Nuclear Cluster*, <http://www.mod.uk/NR/rdonlyres/F25A7345-AA9D-46E8-B33A-76304FBF7B53/0/NuclearclusterPDF.pdf>.
- 57 MoD, *Memorandum to the Defence Select Committee*, (HC 835, 2005/06).
- 58 The problem was so serious that all the Trafalgar class SSNs were brought back to base and found to have a similar design fault, requiring immediate repair. *Hansard*, 23/11/2000, 272w.
- 59 Paul Ingram, op. cit., provides a comprehensive case for delaying the decision on Trident's replacement.
- 60 National Audit Office, *MoD Major Projects Report*, HC 595-I, p. 13 (Session 2005/06).
- 61 Ibid.
- 62 <http://news.bbc.co.uk/1/hi/england/2930237.stm>.
- 63 National Audit Office, Ministry of Defence, Major Projects Report 2006, p. 13 (HC 23-I, 2006-07).
- 64 Ibid.
- 65 House of Commons Defence Committee, 'KOFAC Memorandum', *The Future of the UK's Strategic Nuclear Deterrent* (HC 986, 2005-06).
- 66 There is co-operation with France as well as the USA on nuclear submarine design but not to the extent of threatening design and production capability in the UK.
- 67 Schank, op.cit., p. 48.
- 68 Ibid, p. 15.
- 69 House of Commons Defence Committee, 'Memorandum from Devonport Management Ltd', *The Future of the UK's Strategic Nuclear Deterrent: The Manufacturing and Skills Base* (HC 59, 2006-07).
- 70 <http://navy-matters.beedall.com/mufc.htm>.
- 71 Ministry of Defence, *Defence Industrial Strategy* (Cm 6697, 2005/06).
- 72 Ibid, p. 70 (Cm 6697, 2005/06).
- 73 North West Evening Mail, 28/07/06
- 74 <http://navy-matters.beedall.com/astute.htm>
- 75 Janes Defence Weekly, *UK fuels nuclear propulsion studies*, 21/09/2005.
- 76 Information on company location and employment is taken from the annual reference work, *Kompass, Company Information* (Kompass, 2006). Rolls Royce also employs around 200 people at the Vulcan nuclear reactor test site at Thurso.
- 77 House of Commons Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent: The Manufacturing and Skills Base*, p. 12 (HC 59, 2006-07).
- 78 Financial Times, 23/05/06.

- 79 Electric Boat company in the USA has given evidence that it expects that it will only require 60%-70% of the design resources required for the new generation of SSNs compared to the Virginia class because of advances in computer software and lessons learned from previous programmes. See Schank, op.cit., page 15.
- 80 The Ohio Class submarines are set to continue in service until 2042 and Trident D5 may be replaced by another system. Even if there is a level of obsolescence, it should be possible for the UK to run its allotted D5 missiles through new servicing and refitting arrangements until the time comes to replace Trident submarines in the 2050s.
- 81 DML, *The Link*, No 134, 2005 ([www.devonport.co.uk/images/LINK%20magazine](http://www.devonport.co.uk/images/LINK%20magazine)).
- 82 This is referred to as 'spiral design' where new operational features are added including the replacement of older weapons systems, communication systems, etc with more modern systems in a form of continuous design improvement for each new submarine. See Schank, op. cit., p. 22.
- 83 Ibid., p. 56.
- 84 House of Commons Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent - The Manufacturing and Skills Base* (HC 59, 2006-07).
- 85 North West Evening Mail, 29/01/2007.
- 86 House of Commons Defence Committee, *Defence Industrial Strategy*. p. 12 (HC 824, 2005-06).
- 87 Ibid. BAE and VT have also expressed an interest in taking over Balfour Beatty's naval work - including the Roysth yard where the aircraft carriers will undergo final assembly. *The Scotsman*, 11/05/2006.
- 88 <http://www.naval-technology.com/projects/astute/>.
- 89 MoD, *Naval Base Review - Terms of Reference* [www.mod.uk/Defence/Internet](http://www.mod.uk/Defence/Internet).
- 90 Devonport management, in partnership with the South West of England RDA have been lobbying hard for the retention of the naval refit work in Plymouth, arguing that it complements submarine refits and without that balance, there will be future gaps and inefficiencies that will ultimately damage the company's capacity to deliver its core programme of nuclear submarine refits. <http://www.southwestrda.org.uk/newsrelease.asp?Release>
- 91 DML, *The Link*, No 131, 2005 ([www.devonport.co.uk/images/Link%19magazine](http://www.devonport.co.uk/images/Link%19magazine)).
- 92 Sector Skills Council for Science and Engineering and Manufacturing Technology, *Sector Skills Agreement for the UK Marine Sector*, pp. 9-10 (SEMATA, 2005).
- 93 Steven Schofield, *The UK and Non-Offensive Defence - An Introductory Study on the Implications of the UK adopting a Non-Offensive Defence Policy* (Security Studies Network, 2002).
- 94 Theoretically, the Trident submarines could be adapted for a conventional role but it is assumed here that the 7-8 Astute programme will be continued because of contractual commitments. If not, and the adaption of Trident submarines is feasible, then there would be no requirement for the last four Astutes which would accelerate the run-down and closure of the Barrow yard.
- 95 Barrow Alternative Employment Committee, *Oceans of Work - The Case for Non-Military Research, Development and Production at VSEL, Barrow* (BAEC, 1987), I was employed as the researcher for BAEC from 1985-87.

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- 96 House of Commons Defence Committee, *The Future of the UK's Strategic Nuclear Deterrent: The Manufacturing and Skills Base*, EV 113 (HC 59, 2006-2007). This assumes long-term storage afloat but there remains the problem of complete disposal of nuclear submarines.
- 97 Paul Bishop, *The Economic Impact of Devonport Dockyard and Naval Base* (South West Economy Centre, University of Plymouth, 2005).
- 98 Steven Schofield, *Oceans of Work – Arms Conversion Revisited*, p. 26 (BASIC, 2007).
- 99 Scottish Executive Research, *Scottish Coastal Socio-Economic Scoping Study* (Scottish Enterprise, 2002).
- 100 Schofield, op.cit., p 27. Each NDC areas was provided with £50 million to help tackle the multiple causes of social exclusion including improved housing, health, employment.
- 101 Stephen Fothergill et al, *Relocating Public Sector Jobs – The Case for Deprived Non-Traditional Locations* (Centre for Regional Economic and Social Research, Sheffield Hallam University, 2005).
- 102 Schofield, op.cit., p. 18.
- 103 Macro-economic analysis supports this case. One study in the UK analysed how a reduction in military expenditure of 50% could have very different outcomes dependent on whether the government provided compensatory expenditure or not. In the first case, where military spending was simply cut, overall demand in the economy declined, Gross Domestic Product (GDP) fell by 3.5% and unemployment increased by half-a-million. In the second where the cuts were balanced by a proportionate increase in other forms of public expenditure, there was an extra 1.8% growth in the economy and a reduction in unemployment by half-a-million. See Terry Barker et al, 'Measuring the Peace Dividend in the UK', pp. 359-375, *Journal of Peace Research* (Vol. 12, No. 4., 1991).
- 104 MG Rover Task Force, *Final Update Report – The Work Goes On* (Advantage West Midlands, 2006).
- 105 Guardian, 05/02/2007.
- 106 MG Rover Task Force, op.cit., p. 15.
- 107 Schank, op.cit, p. 69.
- 108 MG Rover Task Force, op.cit. The Nanjing Automobile Corporation that took over the assets of Rover will be manufacturing an MG sports car and employing 250 workers. Guardian, 05/02/2007.
- 109 [http://www.scottishenterprise.com/sedotcom\\_home/about\\_se/local\\_enterprise\\_companies/fife/fife-local\\_initiatives/the\\_regeneration\\_of\\_rosyth.htm](http://www.scottishenterprise.com/sedotcom_home/about_se/local_enterprise_companies/fife/fife-local_initiatives/the_regeneration_of_rosyth.htm)
- 110 See Schofield, op.cit, pp.18-25, for an historical review of energy research in the UK and successive governments' failure to support renewable energy compared to the continued support for both fast breeder and fusion technologies.
- 111 Caithness and Sutherland Enterprise, *Opportunities Arising from the Decommissioning of Dounreay* (Caithness and Sunderland Enterprise, 2006) The range of industries under consideration include industrial site reclamation, renewable energy, oil and gas, and tourism.
- 112 House of Commons Defence Committee, NIS Memorandum, *The Future of UK's Nuclear Deterrent – The Manufacturing and Skills Base* (HC 59, Session 2006-07).

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- 113 Richard Coopey, 'Restructuring Civil and Military Science and Technology: The Ministry of Technology in the 1960s' in Richard Coopey et al, *Defence Science and Technology – Adjusting to Change* (Harwood Academic Publishers, 1993).
- 114 Scientists for Global Responsibility Newsletter, *AWE, A New Role* (SGR, Summer 1999).
- 115 U.S. Department of Congress, Office of Technology Assessment, *Defense Technology – Redirecting Defense R&D* (OTA-ITE-552, 1993).
- 116 [http://www.fuelcell-magazine.com/fc\\_newsletter\\_1-05.htm#gm](http://www.fuelcell-magazine.com/fc_newsletter_1-05.htm#gm)
- 117 *Hansard*, 4/9/2006, col 1711w. The government funds the Defence Diversification Agency to support the commercial application of military research.
- 118 <http://www.fraunhofer.de/fhg/EN/company/index.jsp>
- 119 <http://www.cbi.org.uk/pf/tveconomy0606.pdf>



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