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STEPPING DOWN THE NUCLEAR LADDER:

OPTIONS FOR TRIDENT ON A PATH TO ZERO

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BRADFORD DISARMAMENT RESEARCH CENTRE MAY 2009

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Cover photo: Astute-class SSN under construction at BAE Systems' construction yard in Barrow where the planned Successor SSBN submarines will be built.

Stepping down the nuclear ladder

Options for Trident on a path to zero

Summary

In December 2006 the government presented its case for beginning the process of replacing the UK's current Trident nuclear weapons system in a White Paper on *The Future of the United Kingdom's Nuclear Deterrent*. The decision was endorsed by parliament in a vote on March 14, 2007. The process will begin with the procurement of a new generation of 'Successor' ballistic missile submarines to replace the current Vanguard-class submarines that carry the UK's Trident nuclear missiles.

Throughout the debate on Trident replacement the government has insisted that there are only two options for the future of Britain's nuclear arsenal:

1. Business-as-usual through a like-for-like Trident replacement until a global nuclear disarmament process is well under way, or
2. Unilateral nuclear disarmament.

Unilateral nuclear disarmament remains politically unacceptable to the Labour government and Conservative Party for now, leaving only business-as-usual.

But is this really the case? Or are there further steps this or the next government could realistically take to further reduce the size and operational status of the British nuclear force?

This report argues that there are credible options that can be pursued in between these two poles. Implementing them, however, means reconceptualising prevailing understandings of 'minimum deterrence', rethinking the need for a continuous-alert nuclear posture that demands a UK Trident submarine at sea at all times ready to fire its nuclear payload within days or even hours of a decision to do so, and it means dealing with a number of conceptual and operational obstacles to change.

The purpose of this report is to open up the debate about realistic possibilities for UK nuclear weapons policy and challenge the assertion that policy choices are limited to the two above. It does so by exploring two political motivations for change, five future options that reflect different degrees of reduced force size and operational readiness based on precedents from current aspects of US and NATO nuclear weapons policy, and four conceptual obstacles and two operational obstacles to change that will have to be addressed and overcome.

The report shows that there is a genuine opportunity for the government to demonstrate international leadership with its own nuclear arsenal without recourse to unilateral nuclear disarmament that remains politically unacceptable at the present time. This includes opportunities to reduce the procurement and operational costs of the Trident replacement programme at a time of serious and growing pressure on the defence budget, to develop robust nuclear disarmament verification measures of international significance, and to reinforce the renewed global momentum towards a world free of nuclear weapons.

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The Trident system: The current Trident nuclear weapons system comprises four Vanguard-class nuclear-powered ballistic missile submarines (SSBNs), 160 operational nuclear warheads and 50 US-designed and built Trident II (D5) submarine-launched ballistic missiles (SLBMs) drawn from a common pool of Trident missiles based in the US (down from an original 58 missiles after test firings). At least one of these submarines is at sea at all times in an operational posture labelled 'continuous-at-sea deterrence' (CASD) and armed with up to 48 warheads, giving an average loading of perhaps 12-14 missiles carrying 3-4 warheads each. The submarines can carry up to 16 missile and the missiles are capable of carrying up to 12 independently-targetable warheads. The warheads are thought to have an explosive yield of 100 kilotons (kt). A 'sub-strategic' version with a yield of around 10kt is also available.[2]

Motivation (1): Demonstrate British leadership

Why should the government change the policy set out in its 2006 White Paper in order to facilitate further reductions in the size and operational readiness of the UK nuclear arsenal? The answer lies in the fact that two important processes have unfolded since the paper was published that warrant a serious re-appraisal of the government's case and generate important political motivations for change. First, a new global opportunity has emerged to rethink current nuclear weapons policies and take significant steps towards a nuclear weapons-free world. Second, the global economy has fallen in to a deep recession that has profoundly affected Britain's economy and future public spending plans.

In 2007 and 2008 four influential American statesmen (Henry Kissinger, William Perry, George Schultz and Sam Nunn) urged the international community to work towards a world free of nuclear weapons. Their call has injected the possibility and urgency of nuclear disarmament with new credibility.[3] It has led to a major new international 'Global Zero' initiative launched in Paris in December 2008 by a host of influential political, business and faith leaders, including many from the UK.[4] The British government has declared its full commitment to this goal and a desire to take an active leadership role in examining the practical steps and challenges involved. In June 2007 Foreign Secretary Margaret Beckett articulated a vision of the UK as a 'disarmament laboratory'.[5] In January 2008 and March 2009 Prime Minister Gordon Brown committed his government to leading "the international campaign to accelerate disarmament amongst possessor states".[6]

Britain certainly has the potential to take a major leadership role as the most progressive of the nuclear weapon states. It has ended nuclear testing and ratified the Comprehensive Test Ban Treaty; ended production of fissile materials for use in nuclear weapons; published accounts of its holdings and history of fissile material production; reduced to a single nuclear system in Trident; and undertaken important research on the technical verification of nuclear disarmament.

Britain can and should continue on this trajectory and demonstrate international leadership to the electorate and international leaders by taking concrete steps to reduce the salience of and reliance upon its nuclear weapons for national security and thereby reinforce the crucial but threatened global Nuclear Non-Proliferation Treaty (NPT).[7] This could include a detailed exploration of further steps to reduce operational readiness and force size and the degree to which such steps could be independently verified in order to lead and inform comparable steps by other countries and build confidence and trust between nuclear weapon states and non-nuclear weapon states.

The Trident system also includes a substantial UK-wide infrastructure comprising HMNB Clyde home to the Faslane submarine base where the Vanguard fleet is stationed and the Royal Naval Armaments Depot (RNAD) Coulport where warheads and missiles are stored for loading and unloading on to submarines; the Atomic Weapons Establishment (AWE) Aldermaston and Burghfield where warheads are designed and built; HMNB Devonport in Plymouth where Vanguard submarines undergo their major mid-life Long Overhaul Period (Refuelling) (LOP(R); the Rolls Royce Raynesway plant in Derbyshire where the nuclear power plants and fuel for the submarines are designed and manufactured; the MoD's Nuclear Operations and Targeting Centre at Northwood; and MoD's Chief Strategic Systems Executive that manages the Trident system and oversees nuclear cooperation with the United States.

Motivation (2): Reduce the costs

The UK has entered a period of deep recession. The government's budget delivered in April 2009 suggested that the national debt will increase substantially over the next five years with little prospect of any major increase in public spending for the next two parliaments.[8]

The UK defence budget is already under severe pressure. It cannot afford all of the large military projects currently in the pipeline or in the planning stages. This includes the new Astute-class attack submarine programme (£3.5bn for the first three of a possible seven), six Daring-class Type-45 destroyers (£3.6bn), two new aircraft carriers and Joint Combat Aircraft (£12-14bn), the Future Rapid Effects System range of armoured vehicles for the Army (£6bn for 3,500 vehicles), 232 Typhoon fighter aircraft (£21bn), and 14 new Future Strategic Tanker Aircraft (£13bn). Estimates suggested a multi-billion pound black hole in the procurement budget long before the recession began to bite. The additional financial pressure from the current economic downturn also comes at a time when there is substantial concern that the government is underfunding operational missions leaving UK troops deployed abroad with insufficient and ineffective materiel and support.[9]

In 2006 the government estimated that it would cost £15-20 billion to replace the Trident system but in November 2008 MoD's Permanent Under Secretary Sir Bill Jeffrey declared that these were only 'ballpark estimates'.[10] History suggests that this procurement figure is likely to be too low because of the impact of defence inflation. A report by the British American Security Informational Council warned in 2007 that "Defence economists estimate military inflation for new technology to run on average at 10% per year...a rule of thumb based on past experience with similar generational replacements would suggest that new weapon systems tend to cost around twice as much as their predecessors…Double the Vanguard-class would give a cost of £26bn in 2006 prices, including the cost of an eventual replacement for the warheads, but not including the missiles."[11]

This figure does not include the cost of operating the Trident system and the Atomic Weapons Establishment (AWE) Aldermaston that manufactures and maintains the UK's nuclear weapons. Annual running costs for the UK nuclear weapons programme are estimated at 5-6% of the defence budget, around £1.6-2.1 billion per year. Estimates carried out on behalf of the Liberal Democrat Party in 2007 set the total cost of replacing *and* operating a Trident replacement system over 30 years at £76 billion.[12]

It is extremely unlikely that the defence budget will be increased under either Labour or the Conservatives after the next General Election likely to be called in May 2010. Something will have to give and the economic, political and military wisdom of pursuing a like-for-like Trident replacement will face increasing scrutiny. It is noteworthy that leading figures in the Conservative Party announced in May 2009 that they will reconsider the need for a full like-for-like replacement of the Trident system on grounds of cost if they win the next election.[13]

This report acknowledges that any decision to constrain, reduce or give up nuclear weapons is a political decision involving first-order security considerations. These two political motivations for change are therefore predicated on an assessment by the government that further steps to reduce the size and operational status of the nuclear arsenal will not jeopardise national security and will not exact too high a political cost in other areas. A strong case can be made for such a positive assessment.[14]

Potential options (1): 'Trident lite'

This report examines five options for UK nuclear weapons policy based on decreasing levels of force size and operational readiness. The first, labelled 'Trident lite', represents business-as-usual but with a smaller nuclear arsenal and SSBN fleet. The government is currently exploring whether a continuous-at-sea deterrence (CASD) operational posture can be maintained with three rather than four Trident Successor submarines.[15] The new submarine nuclear reactor core developed by Rolls Royce (Core H) will last the full service life of planned Successor submarines and reduce the time each submarine needs to spend in long and expensive 3-4 year mid-life Long Overhaul Period and Refuel (LOP(R)) at the Devonport dockyard in Plymouth. This will increase the operational availability of submarines and may allow CASD to be maintained with three boats. Core H nuclear reactors are currently being installed in the new Astute-class attack submarines and in the current Vanguard-class SSBNs as they undergo their mid-life LOP(R).

In addition to a reduction to three submarines, a 'Trident lite' option could involve a smaller missile compartment and reduced missile and warhead inventory. The government declared in March 2009 that the Successor submarine will have 12 rather than the current 16 missile launch tubes.[16] This figure could be further reduced to 8 or 4 missile tubes with a corresponding reduction in operationally available warheads.

The current CASD posture is based on generating three operational submarines from four with one of those three on active operational patrol. A CASD posture based on a three submarine fleet will probably be based on having all three submarines available in the operational cycle at some point, plus periods of generating two submarines from three when one is in refit. Based on this assumption alternative 'Trident lite' configurations involving generation of two or three submarines in the operational cycle, 16, 12, 8 and 4 missile tubes and 3 or 4 warheads per missile produce the following permutations:

Table 1: Trident system configuration options

SSBNs in operational cycle	Missile compartment launch tubes	Average warheads per missile	Warheads per sub	Total operational warheads*	Plus 10% spares
3	16	3	48	144	158
2	16	4	64	128	141
2	16	3	48	96	106
3	12	4	48	144	158
3	12	3	36	108	119
2	12	4	48	96	106
2	12	3	36	72	79
3	8	4	32	96	106
3	8	3	24	72	79
2	8	4	32	64	70
2	8	3	24	48	53
3	4	4	16	48	53
3	4	3	12	36	40
2	4	4	16	32	35
2	4	3	12	24	26

The first option reflects current operational posture.

* Warheads per SSBN multiplied by the number of SSBNs in the operational cycle

Potential options (2): 'Reduced alert'

The next step beyond 'Trident lite' can be labelled 'reduced alert'. It envisages a fleet of two or three new SSBNs but an end to a CASD operational posture. SSBNs may go on frequent patrols based on regular or irregular deployment and duration patterns. Operational patrols for current Vanguard submarines routinely last 3 months, but this can be extended. For example in September 2008 HMS Vengeance had its patrol extended by 35 days.[17] There will be periods of weeks and perhaps months when there is no Trident submarine on operational patrol.

A 'reduced alert' posture may coincide with a decision to further reduce the nuclear stockpile, perhaps to between 50 and 80 warheads with fewer missiles and warheads per submarine than currently deployed reflecting some of the options in Table 1.

The operational focus of the SSBN fleet would remain delivery of Trident nuclear missiles and one submarine may be maintained in a state of readiness measured in weeks, providing policy-makers with reassurance that a Trident submarine could be at sea at relatively short notice. The operation of the SSBN fleet on 'reduced alert' would begin to reflect the operation of the UK's SSN attack submarine fleet with a mixture of long and short training and operational deployments and sustained readiness to deploy for combat/deterrent operations.

The primary advantage of this posture is a reduction to one crew per submarine rather than the current two and corresponding cost savings. Each Vanguard submarine in the current operational cycle has a Port and Starboard crew. Submarines are generally in port for 30-40 days after operational patrol. At this point the second crew takes over and prepares the submarine for its return to sea whilst the first crew takes leave or undergoes shore-based training. The government announced in the 1998 Strategic Defence Review its intention to reduce from double to single crews, presumably to reduce costs.[18] In May 1998 HMS Vanguard was reduced to one enhanced 'Gold' crew of 200 rather than the usual 140 but the single crewing experiment ended and the double crew system remained in place.[19]

Less frequent sailing will also reduce wear on the submarines and burn-up of nuclear fuel resulting in extended service lives and perhaps less costly maintenance.[20] This may require a more advanced nuclear reactor pressure vessel that can be safely certified for 30 or more years. The current Nuclear Steam Raising Plant (NSRP) reactor, Rolls Royce's Pressurised Water Reactor 2 (PWR2), has a safety justification of only 25 years.[21] Peter Whitehouse of Devonport Management Ltd stated that the life of the reactor "is an inherent function of the design features, metallurgy and duty cycle when the system is in use" suggesting that reduced operation of the submarines could extend the life of the reactor.[22] Rolls Royce is currently working on a new reactor design provisionally labelled the Next Generational Nuclear Power Plant (NGNPP) that could power the Successor submarines.

In 2007 in a response to a question by David Borrow MP on whether reduced operations would extend the life of the submarines, Rear Admiral Andrew Mathews stated that "It would help to extend, for instance, the core life… Hull fatigue is not an issue for the UK. The hull itself is good for as long as we want to operate these submarines". He also cautioned, however, that there were many life-limited components that require maintenance and replacement irrespective of the operational tempo of the submarines.[23]

Potential options (3): 'De-mated' alert

A further step to reduce operational readiness can be labelled 'de-mated' alert. Under this posture the risk of nuclear attack is accepted as extremely low now and for the foreseeable future and the UK's SSBNs do not routinely carry nuclear warheads.

It envisages a fleet of two or three new SSBNs that are regularly at sea but perhaps less frequently than under the previous 'reduced alert' posture and with a reduced number of un-armed Trident missiles either routinely stored ashore at RNAD Coulport or kept aboard the submarines. RNAD Coulport has 16 bunkers for storing Trident missiles and, according to the government, can "onload and offload of Trident II D5 missiles as required".[24] 16 missiles maintained ashore could arm two submarines in an operational cycle with 8 missiles each.

Under this option a reduced stockpile of Trident warheads would also be routinely stored ashore at Coulport. This might number 30-50. Procedures would be put in place to re-mate some or all of these warheads with Trident missiles should a profound nuclear threat to the survival of the nation emerge to provide a minimum but credible means of retaliation. Planning for such an eventuality might revolve around a redeployment timeline measured in months rather than weeks. These procedures may be tested during annual exercises to re-mate live or dummy warheads with missiles and redeploy a nuclear-armed Successor submarine.

This alert posture does not envisage moth-balling the SSBN fleet. Instead the two or three Successor submarines would routinely engage in other non-nuclear activities and operational missions facilitated by a new Common Missile Compartment currently underdevelopment by the UK and US.[25] A new multi-role submarine missile compartment could be capable of delivering a range of non-nuclear munitions, such as conventionally-armed Tomahawk cruise missiles or even conventionally-armed Trident missiles and attack/reconnaissance un-manned aerial and underwater vehicles. The decision announced in the 1998 Strategic Defence Review to reduce the routine notice-to-fire period for SSBNs to 'several days' allowed the submarines to engage in other "secondary tasks such as exercises with other vessels, equipment trials and hydrographic work".[26] The United States has recently completed the conversion of four of its Ohio-class Trident submarines for exclusively conventional military missions (see below).

This posture reflects the 'strategic escrow' scenario set out by former CIA Director Admiral Stansfield Turner in 1997. Turner envisaged a staggered 'de-alerting' of the US and Russian nuclear arsenals by removing increasing numbers of nuclear warheads from their delivery vehicles and storing them some distance away in secure facilities so that eventually there would be no nuclear weapons immediately ready to fire. These facilities could be open to external inspection by the International Atomic Energy Agency (IAEA) to monitor warhead movements. This process might require financing the construction of new warhead storage facilities designed to facilitate independent verification.[27]

Wider verification measures could be developed and enacted by the UK to verify the absence of nuclear warheads and/or missiles from submarines before they deploy on operational duty and verify the numbers and locations of warheads stored at Coulport and AWE Aldermaston. The UK has already taken a lead on the technical verification of nuclear disarmament through the Arms Control and Verification Research programme initiated at Aldermaston in 2000. In 2007 a new initiative involving AWE, MoD, the Norwegian government and London-based think-tank VERTIC was established to examine independent verification of warhead dismantlement as part of a wider nuclear disarmament process.[28]

Potential options (4): 'Emergency alert'

A final step before nuclear disarmament can be labelled 'emergency alert'. This, again, might involve a comparable force structure of two or three SSBNs configured for a variety of conventional military missions but with a small stockpile of Trident missiles either onboard submarines or stored at Coulport and a small number of 20-40 warheads maintained in a disassembled state for long-term storage at AWE Aldermaston.

Disassembly could take a number of forms and require different timescales for reassembly from days, to weeks and months. This scenario envisages a reconstitution time frame measured in many months based on removal of limited life components from warheads, such as neutron generators and tritium reservoirs, and other components leaving the core explosive nuclear warhead physics package intact. A further step would be to disassemble the physics package such that the UK's residual nuclear capability was based on a stockpile of weapon-grade plutonium and highly-enriched uranium (HEU) machined into the 'primary' and 'secondary' stages of the nuclear warhead physics package.[29]

AWE Aldermaston has the capability to disassemble and reassemble Trident nuclear warheads. A number of Trident warheads are routinely disassembled and some parts tested to destruction and then replaced as part of an ongoing quality assurance programme to ensure the safety, security and reliability of the nuclear arsenal. In an 'emergency alert' scenario warhead reassembly could be staggered such that a few weapons were made available on short notice with full-scale reconstitution and redeployment of functioning warheads measured in months. Again, annual exercises could be established to re-assemble actual or mock warheads and re-deploy to Coulport for loading on to Trident missiles to sail on operational patrol.

Additional verification measures could be developed and applied to monitor a small disassembled nuclear arsenal. British leadership in the development of robust measures for independent verification of a small nuclear arsenal in a de-alerted or de-mated state could lay the foundation for a multilateral verification agreement or code of conduct to build confidence in the ability of the international community to verify further global steps towards a world free of nuclear weapons.

This mirrors the concept of a 'virtual arsenal' set out by Michael Mazarr in 1995. In this context nuclear deterrence rests on the ability to reconstitute and re-deploy a survivable nuclear arsenal rather than the ability to retaliate within hours or days of an attack.[30] Further steps might be taken to harden nuclear facilities at Faslane, Coulport, and AWE Aldermaston to increase their capacity to survive a precision conventional attack in order to provide sufficient confidence that a deliverable nuclear force could be reconstituted within an acceptable time frame in a period of prolonged international tension.

Potential options (5): Cruise missile 'emergency alert'

Other riskier options, in terms of technology and expense, involve abandoning a ballistic missile based system and adopting a nuclear-armed submarine-launched cruise missile (SLCM) option for deployment aboard the Successor SSBNs and/or the UK's new Astute-class SSN attack submarines. The feasibility of this option has been frequently asserted during the debate on Trident replacement. An additional alternative could involve the development of a new nuclear gravity bomb or air-launched nuclear-armed cruise missile for delivery by the Typhoon Eurofighter, the new US F-35 Joint Strike Fighter/Joint Combat Aircraft that the UK plans to procure for its two new aircraft carriers, or a new long-range bomber. The Eurofighter is not configured to deliver nuclear munitions but the F-35 currently under development in the US has a design requirement for delivery of nuclear weapons.[31] Air-delivered options, however, present increased technological and financial risk and are not considered here.[32]

The United States currently maintains a stockpile of several hundred nuclear-armed Tomahawk land attack missiles (TLAM-N) that have a range of 2,500km compared to approximately 11,000km for the Trident II D5 missile (the conventionally-armed version of Tomahawk, the Block IV TLAM-E currently deployed aboard UK attack submarines, has a range of 1,600km). It is possible that the United States will retire this weapon after the forthcoming 2009 Nuclear Posture Review. It has no other nuclear-armed sea-launched cruise missile and no current plans to procure a replacement.

It has been asserted that the UK could adapt an existing nuclear warhead design for the conventionally-armed Block IV TLAM-E missiles it has procured from the US. This would carry financial and technological risk but it could constitute an alternative 'emergency alert' solution. If the US were to share is W80-0 TLAM-N nuclear warhead design with the UK, as it has done with the W76 Trident warhead, it is conceivable the UK could design and manufacture an Anglicised version without nuclear testing and within acceptable tolerances using US test data and the array of 'stockpile stewardship' facilities at Aldermaston. The UK would also have to develop appropriate procedures for marrying these warheads to existing Tomahawk missiles and configure the Astute-class SSNs and/or Successor SSBNs with fire control systems for targeting and launching nuclear-armed Tomahawk missiles, as opposed to their conventionally-armed variants. The UK would also have to be certain of continued operational support of the TLAM missile by the United States throughout its service life in the UK fleet.

If all of this were in place – a proven ability to manufacture a small (20-40) number of warheads within acceptable tolerances and timescales; a proven ability to marry those warheads to Block IV TLAM-E missiles in the UK inventory; a proven ability to successfully target and launch nuclear-armed Tomahawks; assurance of US in-service support – then it could provide a credible alternative 'emergency alert' minimum nuclear deterrent posture.

Trade-offs with a Trident system would have to be made. In particular, TLAM cruise missiles are much slower than Trident ballistic missiles and once detected can be more readily intercepted. They also have shorter range and it may therefore take longer for a submarine at sea to be in a position to fire the missiles. The missiles themselves can only deliver a single warhead compared to the multiple and independently-targetable warhead deployment capability of the Trident missiles.

Precedents (1): A conventional Trident system

The processes outlined in the options above have a number of precedents in US and NATO operational nuclear posture. In particular the reconfiguration of four US Trident submarines for conventional operations, the processes for maintaining the capability to deploy US nuclear-armed Tomahawk missiles, the alert status of NATO's nuclear-armed Dual Capable Aircraft, and warhead disassembly processes in the US.

In 2002 the US Navy began converting four of its 18 Ohio-class Trident missile submarines for conventional war-fighting missions. This involved converting the 24-tube Trident missile compartment to deliver up to 154 TLAM cruise missiles (7 in each of 22 tubes) together with an Advanced SEAL Delivery System in two converted missile tubes for deploying Navy SEAL special operations forces, up to 66 of whom can be accommodated aboard the converted submarines. The converted submarines, called SSGNs (known as guided missile submarines), are operated in a similar fashion to the Trident-carrying Ohio SSBNs with double crews rotating on and off the boats every three to four months and two of the four continuously forward deployed. Conversion was completed between 2006 and 2008 for an estimated $1 billion per boat, including refuelling of the nuclear reactors and replacement of the Trident SLBM fire control systems with tactical missile fire control systems.[33]

The operation of these submarines demonstrates that ballistic missile submarines can perform a variety of roles beyond strategic nuclear deterrence. It is possible to envisage a future UK Successor submarine with 4-8 launch tubes dedicated to delivery of Trident missiles if required with the rest of the missile compartment designed for delivering TLAMs, Unmanned Undersea Vehicles (UUVs), Special Forces or even Unmanned Aerial Vehicles (UAVs) for aerial operations.[34] The primary mission of the submarines would be conventional military missions together with an enduring secondary mission to deploy and fire nuclear-armed Trident missiles in a crisis within a fixed time frame.

A further possibility is the development of a conventional warhead for the Trident missile for deployment aboard an SSGN with the possibility of substituting the conventional warhead for a nuclear warhead if required. Nuclear warheads are routinely removed from Trident missiles still onboard the submarines whilst at RNAD Coulport. The US Navy has explored this option in order to fulfil the need for a prompt conventional global strike capability identified in the 2001 US Nuclear Posture Review.[35]

The US Navy began research in 2003 on a modified Trident warhead labelled Enhanced Effectiveness (E2) to integrate the existing inertial guidance system with global positioning system technologies to improve accuracy to within 10 metres and allow the missile to receive guidance updates during its flight. This developed into the Conventional Trident Modification (CTM) programme to install 96 GPS-guided non-nuclear warheads on 24 Trident II missiles throughout the SSBN fleet with total time from decision to 'weapon-on-target' of about one hour.[36]

Full operational capability was planned for 2012 but Congress cut funding due to concern that other countries' ballistic missile early-warning systems would not be able to distinguish between a nuclear-armed and a conventionally-armed Trident missile, leading to potentially disastrous escalation in a crisis.[37]

Precedents (2): US Tomahawk nuclear cruise missiles

The US Navy produced around 360 nuclear-armed Tomahawk Land Attack Missile-Nuclear (TLAM-N) cruise missiles in the 1980s for deployment aboard its SSN attack submarines.[38] They can deliver a W80-0 nuclear warhead that has a variable yield of between 5 and 150kt. All were withdrawn by 1992 after the end of the Cold War as part of President George H. W. Bush's Presidential Nuclear Initiatives. The missiles and warheads were "secured in central areas where they would be available if necessary in a future crisis".[39] They are now stored with Trident nuclear warheads and missiles at the Strategic Weapons Facility Atlantic at King's Bay, Georgia, and the Strategic Weapons Facility Pacific at Bangor, Maine.[40]

Procedures were put in place to enable the redeployment of the TLAM-N arsenal in a crisis. This includes periodic certification of a number of SSNs in the US Pacific and Atlantic fleets and Quality Assurance and Surveillance Tests (QAST) that can involve a live test firing of an unarmed TLAM-N to ensure the submarines can deploy and fire TLAM-Ns within 30 days of a decision to redeploy. Following certification the submarines are de-certified to save resources for more urgent, non-nuclear responsibilities.[41]

The 1997 Department of Defense report on *Nuclear Weapons Systems Sustainment Programs* stated that "Twice a year, Navy selects an attack submarine and conducts a regeneration exercise that demonstrates and appraises the capability to redeploy nuclear-armed cruise missiles on such submarines. This exercise tests the ability of the submarine and crew to re-establish nuclear weapons capability in a relatively short time."[42] For example, the command history for the USS Bremerton, a Los Angeles-class SNN, for the period March 18, 2000 to March 5, 2002 operating out of US Naval Submarine Base San Diego states that "BREMERTON successfully completed a Nuclear Weapons Acceptance Inspection, and proceeded to Bangor, Washington to load an exercise TLAM-N and conduct a successful QAST-TLAM-N launch in March."[43]

These redeployment exercises are often conducted as part of US Strategic Command's annual *Global Guardian* war game exercises to test the full US nuclear war plan and ensure training and force integration for all US nuclear forces, including nuclear-armed bombers, inter-continental ballistic missile, submarine-launched ballistic missiles, Dual Capable Aircraft tasked to carry non-strategic nuclear bombs and SSNs certified to deploy TLAM-Ns.[44]

The Combat Control System and TLAM-N Weapon Launching System have been upgraded since the late 1990s to meet TLAM-N regeneration requirements, provide increased flexibility and retargeting capability and a common launcher interface across all attack submarines. This system provides the capability to equip virtually any submarine with nuclear-armed Tomahawks.[45]

This process has implications for future options to reduce the operational readiness of the UK Trident fleet. Based on this example of a long-term working practice it is possible to envisage a fleet of two or three Successor submarines routinely operating at sea performing non-nuclear military missions but able to redeploy a small number of nuclear-armed Trident missiles within a specific period of time from weeks to months with the necessary combat control systems onboard and to sustain that nascent capability over many years with the requisite onshore submarine, missile and warhead support facilities. Clearly there are important operational differences, but the TLAM-N operation in the United States demonstrates the practicability of such an operational posture.

Precedents (3): NATO nuclear capable aircraft

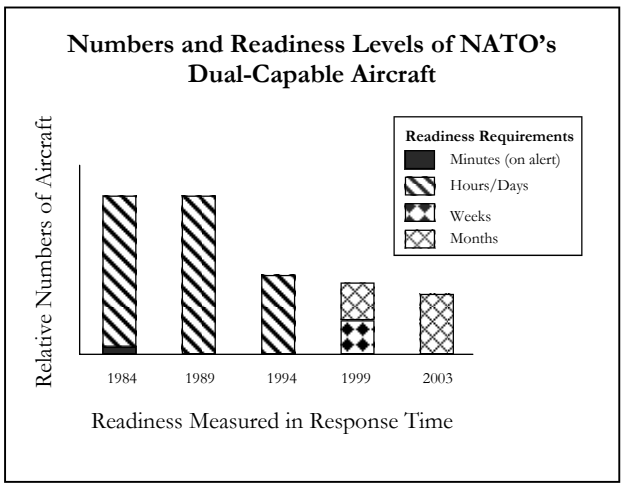
Nuclear deterrence remains a key part of NATO's military posture and the UK Trident force is formally committed to the defence of NATO.[46] The United States also maintains between 150 and 240 forward-deployed non-strategic B61 nuclear bombs at six airbases in Turkey, Germany, Italy, Holland and Belgium under 'dual key' arrangements. They are assigned for delivery by F-15, F-16 and Tornado fighter aircraft referred to as Dual-Capable Aircraft (DCA).[47]

This forward-deployed nuclear arsenal has been reduced considerably in terms of size and operational readiness and NATO argues that it represents "the minimum level consistent with the prevailing security environment."[48] Kristensen reports that at the end of the Cold War there were approximately 1,400 forward-deployed nuclear bombs that were reduced to around 700 by 1992, 480 by the mid-1990s and is now estimated at between 150 and 240. All B61 nuclear weapons were withdrawn from RAF Lakenheath in 2008.[49]

Readiness of DCA has also been reduced significantly. NATO reports that "In 1995, in a first major step of relaxation, the readiness posture of dual-capable aircraft was greatly reduced, so that nuclear readiness was measured in weeks rather than in minutes. In 2002… the readiness requirements for these aircraft were further reduced and are now being measured in months".[50] Kristensen argues that "a readiness level of 'months' suggests that some of the mechanical and electronic equipment on the fighter aircraft needed to arm and deliver the nuclear bombs may have been removed and placed in storage".[51]

The circumstances in which NATO Allies might contemplate use of nuclear weapons are described as "extremely remote" and its nuclear weapons are no longer targeted at anyone.[52] John Ainslie argues that NATO probably stopped maintaining standing nuclear plans between 1995 and 1998.[53] The NATO nuclear mission in Europe is maintained, however, through regular training missions where US and NATO pilots practice their skills in dropping nuclear bombs, through regular Nuclear Surety Inspections, and through NATO Tactical Evaluations. This includes annual ABLE ALLY and ABLE TEAM war game exercises to plan for the use of DCA nuclear weapons and test the NATO Nuclear Planning System (NNPS).[54]

This demonstrates that the forward-deployed NATO nuclear arsenal operates under a different conception of 'minimum deterrence' than the UK Trident arsenal and again demonstrates how a nuclear force can be maintained at much lower levels of readiness for a long period of time.



Graph taken from "NATO's Nuclear Forces in the New Security Environment" at <http://www.nato.int/issues/nuclear/sec-environment.html>.

Precedents (4): Disassembled US nuclear warheads

The US has maintained several thousand nuclear weapons in various states of readiness for many years.[55] Its nuclear stockpile is divided into operational, active reserve and inactive reserve categories. Warheads in the active reserve are "maintained in a ready-for-use configuration with tritium and other limited life components installed. They incorporate the latest warhead modifications" and can augment operationally deployed nuclear forces over a period of weeks, months and years if required. Warheads in the inactive reserve "do not have limited life components installed, and may not have the latest warhead modifications." They serve as a source of replacements for warheads used in quality assurance and reliability testing and as a hedge against of the discovery of a problem with a large number of active warheads.[56]

The stockpile of *assembled* active and inactive nuclear warheads is stored at a number of facilities and includes a huge stockpile of W76 Trident missile warheads stored at the Strategic Weapons Facility Atlantic in Georgia and the Strategic Weapons Facility Pacific in Maine.[57] The US is estimated to have 3,200 W76 warheads of which approximately 1,200 are counted as part of the operationally deployed nuclear arsenal, leaving 2,000 in the active stockpile.[58]

The inactive stockpile also includes the key component parts of *disassembled* nuclear warheads, including plutonium 'pits' (the 'primary stage' for a thermonuclear weapon that generates the initial nuclear fission explosion), 'canned subassemblies' (the 'secondary stage' containing highly-enriched uranium that generates a nuclear fusion explosion), tritium reservoirs, and other key components.[59] The Kirtland Underground Munitions Storage Complex at Kirtland Air Force Base in Albuquerque, New Mexico, reportedly stores more than 1,900 warheads that are either part of the inactive reserve stockpile or awaiting shipment to the US nuclear warhead assembly and disassembly Pantex Plant in Texas for dismantlement.[60]

When nuclear weapons are dissembled at the Pantex Plant, either for retirement or quality assurance testing, the components parts are returned to their point of origin. Plutonium pits are returned to the Los Alamos Nuclear Laboratory in New Mexico, highly-enriched uranium components and secondaries are transferred to the Y-12 Oak Ridge plant in Tennessee for further processing and storage, tritium reservoirs are sent to the Savannah River Site (SRS) tritium facility in South Carolina, and other non-nuclear components to the Kansas City Plant. A reserve of many thousands of plutonium pits is stored in protected concrete 'igloo' bunkers at the Pantex Plant.[61]

This demonstrates that it is possible to store and manage assembled active and inactive Trident warheads or the key components of disassembled Trident warheads for long periods of time with processes in place for re-assembly and redeployment as envisaged in the 'emergency alert' option above.

Conceptual obstacles (1): Assured retaliation

Obstacles to further reducing the size and operational posture of the UK nuclear arsenal can be divided into conceptual and operational categories. Conceptual obstacles refer to prevailing understandings of core concepts affecting the commitment to and operation of the UK nuclear arsenal that would have to be overcome or reconceptualised to enable further reductions and reduced readiness. Operational obstacles refer to a number of issues affecting the technical feasibility and practicality of different options.

The main conceptual obstacles revolve around the prevailing understanding of the concept of nuclear deterrence in the UK, in particular the linked concepts of 'assured retaliation', survivability and continuous-at-sea deterrence (CASD). The concept of 'assured retaliation' states that an effective nuclear deterrent threat requires an assured capability to deliver a devastating retaliatory blow against an aggressor. An assured capability to retaliate in turn requires a survivable nuclear weapon system, i.e. one that is invulnerable to a surprise attack, such as stealthy nuclear-powered submarines that can fire nuclear-armed ballistic missiles across the globe. Assured retaliation and survivability are judged to require at least one submarine at sea ready to fire a short notice at all times, i.e. a CASD operational posture.

These three linked concepts are based on a perceived need to counter the threat of a surprise 'bolt from the blue' nuclear first-strike in which the UK's nuclear weapons, support infrastructure and command and control systems are destroyed in a no-notice nuclear attack leaving the country unable to deliver a retaliatory nuclear counter-blow. According to the logic of deterrence established during the Cold War, the absence of an invulnerable retaliatory capability could cause an aggressor to calculate that it could credibly threaten to, or actually execute, a disarming nuclear first-strike against the UK thereby exposing the country to nuclear blackmail or the possibility of a crippling surprise attack.

The solution to the 'bolt from the blue' scenario is a nuclear posture that provides 100% assurance that a retaliatory blow can be delivered via an invulnerable delivery platform. For many in the UK defence establishment the concept of deterrence is *defined* by a 100% assured retaliation capability and anything less will establish a clear incentive for coercion or attack.[62] These three concepts of assured retaliation, invulnerability and CASD form the heart of the conceptual apparatus governing the operation of the UK's Trident system. A vital prerequisite for reducing operational readiness is acceptance by the policy-elite that an assured capability to retaliate against a surprise nuclear attack is no longer necessary for UK national security.

The strategic case for such an acceptance is compelling. The primary strategic justification for a CASD posture was to deter the prospect of a surprise nuclear attack by the Soviet Union. Such a posture is no longer necessary. By the mid-1990s it was acknowledged by the policy-elite in Britain that the Cold War was truly over and that the possibility of a surprise Russian nuclear first-strike was so low as to be near zero.[63] Nearly 20 years since the end of the Cold War there is very little prospect of a revival of a surprise nuclear first-strike threat to the country. The strategic imperative for a British nuclear force to be 100% capable of surviving a surprise no-notice first-strike has dissipated. Furthermore, the asserted causal relationship between 100% assurance of retaliation and successful deterrence of aggressive nuclear threats or attack is spurious. A calculation by an aggressor that the UK had an 80%, or 50% or 20% chance of successfully delivering even a handful of nuclear warheads would, according to the logic of nuclear deterrence, be sufficient to deter. As the late Sir Michael Quinlan noted, 'even a modest chance of a huge penalty can have great deterrent force'.[64]

Conceptual obstacles (2): Crisis stability

The concept of 'crisis stability' is also regularly invoked to support a CASD posture. Crisis stability/instability refers to the mutual interaction of processes for mobilising and heightening the alert-status of military forces during a crisis that could be interpreted by one or more sides as aggressive, escalatory and a prelude to an attack such that the risks of not firing first become unacceptable.[65]

A decision to step back from a CASD posture could mean that in the event of a sudden crisis in which British nuclear weapons were deemed to be relevant the government may not have a Trident submarine at sea. This could limit the government's options because a decision to sail a Trident submarine could be interpreted by an adversary as an escalatory move signalling an intention to use, or threaten to use, nuclear weapons. This could be met with a bellicose response that destabilises the crisis and increases the risk of conflict or even a pre-emptive attack. Far better, it is argued, to maintain CASD and avoid this hypothetical scenario altogether.[66]

Research on nuclear weapons 'signalling' during a crisis and crisis stability is less conclusive. Certainly a nuclear 'signal' like sailing a Trident submarine during a crisis could be misinterpreted and lead to inadvertent escalation but such signals can also send a clear, credible and verifiable message that a crisis is serious enough to warrant recourse to implicit or explicit nuclear deterrent threats. This can reinforce deterrence and reduce the risk of conflict by changing an adversary's strategic calculations.[67] Sailing a Trident submarine in a crisis could therefore becalm or stoke the situation depending upon the political context.[68]

The British government has stated that it would only ever use nuclear weapons in "extreme circumstances of self-defence."[69] This phrase is borrowed from the 1996 International Court of Justice (ICJ) Advisory Opinion on the "Legality of the Threat or Use of Nuclear Weapons". The Court concluded that "the threat or use of nuclear weapons would generally be contrary to the rules of international law applicable in armed conflict, and in particular the principles and rules of humanitarian law" applicable in armed conflict because the destructive blast, incendiary and radiation effects of nuclear weapons cannot be contained either in space or time. It could not, however, "conclude definitively whether the threat or use of nuclear weapons would be lawful or unlawful in an *extreme circumstance of self-defence, in which the very survival of a State would be at stake*" (emphasis added).[70]

In a crisis where the use of nuclear weapons is considered a genuine possibility any decision to sail a Trident submarine will likely be part of a wider and observable mobilisation of armed forces rather than singular event. It is also quite possible that the government would prepare a second Trident submarine for operational deployment to complement the single submarine routinely on operational patrol in a CASD posture, particularly if use of lower-yield 'sub-strategic' warheads were envisaged that were not deployed on the submarine at sea.[71] These, plus political statements testifying to the seriousness of the crisis, have the potential to destabilise a crisis even under a CASD regime.

Trident submarines are also thought to be capable of firing their missiles alongside docked at port in a national emergency. To relieve any pressure the government might feel to launch a nuclear attack first, however, under a non-CASD posture a Trident submarine could be readied for short-notice deployment during a crisis and maintained at that level for a period of time. Crisis stability is not a compelling reason to preclude a reduced operational readiness posture.

Conceptual obstacles (3): Nuclear targeting

Further British nuclear force reductions will be governed in part by prevailing understandings of the quantity and type of enemy targets that must be held at risk by British nuclear weapons and the degree of destruction that must be inflicted upon an adversary in order to constitute a 'minimum deterrent' force designed to deter attack.

The size and capability of the British nuclear arsenal was governed during the Cold War by the need to have the ability to threaten key elements of Soviet power.[72] This was often interpreted as a 'Moscow Criterion' that stipulated Britain had to be able to destroy Moscow and the Soviet command and control system centralised in and around the city, plus a number of other major Soviet/Russian cities, in a retaliatory nuclear attack.[73] Nuclear planning in the 1950s was initially based on the ability to destroy 50% of 30-40 Soviet cities. By the 1960s this had been reduced to 15.[74] During the 1980s and 1990s targeting strategy shifted away from targeting a reduced number of 5-10 Soviet/Russian cities, including Moscow, and towards a more specific focus on the Soviet and Russian command and control infrastructure.[75]

A key issue was maintaining the ability to overcome Soviet anti-ballistic missile (ABM) systems deployed around Moscow. The Chevaline upgrade of Trident's predecessor, the Polaris system, and in part the purchase of Trident itself were driven by the need to maintain the capability to overcome current and projected Soviet ABM deployments and inflict nuclear devastation upon Moscow.[76] When the purchase of Trident was under consideration in the late 1970s consideration was given to alternative targeting baselines that did not involve the destruction of Moscow but these were subsequently rejected.[77]

Since the end of the Cold War the criteria for specifying the quantity and type of targets that must be held at risk and level of destruction required for a 'minimum deterrent' have not been articulated. It is therefore unclear how 'minimum deterrence' is calculated beyond a subjective set of general guidelines for the deterrence of 'strategic threats' set out in successive government documents. Sir Michael Quinlan argues that "It is possible, given now the very general 'to-whom-it-may-concern' character of UK nuclear deterrence, that there is currently little or no such planning in specific terms."[78]

The evolution of the concept of 'minimum deterrence' during the Cold War from an assured capability to destroy 30-40 Soviet cities, to 20, to 10 and then to 5[79] and in the post-Cold War from an estimated 500 strategic nuclear warheads for Trident[80] to 300 under the Conservative government with 60 per submarine[81], to 200 announced in Labour's 1998 Strategic Defence Review with 48 per submarine,[82] and finally to 160 announced in Labour's 2006 White Paper[83] demonstrates that 'minimum deterrence' is a moveable feast.[84]

Without a clearer understanding of current nuclear doctrine and the minimum level of destruction the UK may wish to visit upon potential adversaries in terms of destruction of command and control centres, destruction of one or more major cities, destruction of primary industrial centres, ABM technologies and systems that must be overcome etc. as part of a NATO/US attack or an independent British attack, it is difficult to quantify the minimum number of Trident warheads required.

Conceptual obstacles (4): The 'special relationship'

The UK is heavily dependent upon the US for the provision and operation of Trident.[85] Britain purchased its Trident missiles directly from America, test fires its missiles near Cape Canaveral under American supervision, and received substantial design assistance with the Vanguard submarines. The UK's Trident warhead is based on America's W76 Trident warhead design, uses key components bought off-the-shelf from American nuclear weapons laboratories, and was tested at America's Nevada Test Site.[86]

British warheads can be integrated into American nuclear war plans and there is a UK Liaison Cell at the headquarters of US Strategic Command (STRATCOM) responsible for American plans. America also supplies important aspects of nuclear targeting data to UK submarines and the Royal Navy uses American software for target planning and data processing. American officers are stationed at the Permanent Joint Headquarters at Northwood in London from where UK submarine operations are controlled in order to coordinate British and American Trident submarine operations. Under the Polaris Sales Agreement UK nuclear forces are formally committed to NATO and targeted in accordance with Alliance policy. John Ainslie argues that NATO's Nuclear Planning System is linked to STRATCOM and probably MoD and is dominated by US nuclear planning.[87]

Britain enjoys substantial cooperation on nuclear weapons with America under the terms of the 1958 Mutual Defence Agreement that allows cooperation on all aspects of nuclear warhead development. Britain will look to the US for political and technical support in replacing the four Vanguard submarines and has sought assurances that any new missile procured by the US to replace the Trident II (D5) will be compatible with the planned Successor submarines.[88]

Furthermore, Britain's nuclear capability is considered a central plank of its 'special relationship' with the US and an important function of the closeness of the broader military and political relationship.[89] A very high value is placed in the UK on maintaining political and military credibility in Washington.[90] This is judged to require a significant military power projection capability in order to be able to undertake a range of military tasks in support of US-led intervention operations and thereby ensure a degree of influence in White House decision-making. This includes a nuclear weapon capability.[91] Policy-makers in Whitehall will be anxious to avoid destabilising the precious nuclear relationship with the United States by moving towards a reduced readiness posture.

Nevertheless, a strong case can be made that a UK decision to pursue a reduced readiness nuclear posture will not unduly affect its relationship with the US and may well be encouraged by the Obama administration that has placed a strong emphasis on steps towards a nuclear weapons free world. Cooperation on many aspects of nuclear weaponry will continue for the foreseeable future, not least in nuclear targeting, warhead decommissioning, verification and stockpile stewardship.[92] Concerns centred on the 'special relationship' are not sufficient to preclude a reduced operational readiness posture.

Operational obstacles (1): Maintaining operational readiness

There are a number of operational obstacles affecting the options outlined above that would have to be overcome in addition to the four conceptual obstacles. The most serious operational obstacles are the ability to maintain a high-level of submarine crew training and morale for the operation of the Trident weapon system, an assured firing chain (absolute certainty that missiles will be launched by the submarine in the event of a decision by the Prime Minister to use nuclear weapons against an adversary), and the major support infrastructure required to generate a nuclear capability.

It is argued that required standards of operational readiness, crew training and morale will inevitably decline if the nuclear deterrence mission is 'downgraded' through a reduced readiness posture and the ability to deploy Trident at sea with absolute confidence in the firing chain will degrade. This reflects an 'all or nothing' view in which deployment of Trident must treated as a priority elite mission requiring high-tempo continuous-at-sea deterrence or it must not be done at all.[93] Defence secretary Des Browne stated in 2007 that "The people who have experienced [this] tell me 'don't play around with this: if you don't intend to maintain this system continuously and maintain that skills set, bring them home and stop doing it, because you cannot play around with this, this is a deeply dangerous thing to do.' … I am persuaded by that …".[94]

Nevertheless, the scenarios outlined above envisage regular operation of two or three Successor submarines. A sufficient level of operational readiness and technological, industrial and military expertise could be maintained under a reduced readiness posture through regular operation of the submarines, onshore simulation and intensive training before, during and after operational patrols, regular redeployment drills and war games to exercise the redeployment option and nuclear targeting and war planning operations in a crisis scenario, all overseen by the current or modified stringent assessment and examination process.

This will require robust training procedures to execute the steps needed to redeploy nuclear weapons, including steps to: enable and arm nuclear weapons depending on whether they are maintained fully configured or disassembled; to re-mate active warheads to well-serviced Trident missiles either stored at RNAD Coulport or aboard submarines; to configure the submarines' fire control systems to launch the missiles to their targets if required; to ensure a fully operational and integrated nuclear command, control and communication system; and to ensure training and readiness for warhead delivery vehicles, maintenance crews and equipment and other logistics and support elements.[95]

The United States has faced and overcome problems associated with neglect of some aspects of its national nuclear mission over the post-Cold War period and some of the challenges faced by the US are relevant to operation of a reduced readiness British nuclear posture.[96] The UK has a substantial submarine training and assessment programme and facilities including HMS Raleigh Royal Naval Submarine School in Cornwall, the Trident Training Facility at Faslane that houses a full size inert Trident II (D5) missile in its launch tube and associated control system, and the Vanguard simulator that replicates the machinery control room system in the Vanguard submarines.[97] It is entirely conceivable that a robust training and operational regime can be devised that enables the Navy and Ministry of Defence to manage all aspects of the Trident capability to the required standard.

Operational obstacles (2): Generating submarine crews

A second related issue is the difficulty of regenerating SSBN crews even at several months notice in a situation in which the government opts to return to a CASD posture for a limited period during a period of international tension or crisis. The Vanguard fleet currently has two crews for each of the two submarines in the operational cycle on operational patrol and preparing for operational patrol. The submarine undergoing its major mid-life overhaul has a minimal single crew and the submarine in post-overhaul sea trials has one crew, giving a total of six crews for the four-boat Vanguard fleet.

A fleet of two or three SSBNs operating with single crews would likely have a total of two or three crews. A CASD posture can be achieved with two submarines operating back to back for a short period measured in months and would require four crews, or possibly two 'augmented' crews. This was the case in February and March 2009 when HMS Vigilant was in mid-life overhaul and HMS Vanguard was undergoing repairs at Faslane following its collision with the French SSBN Le Triomphant in February 2009. A return to a CASD posture would therefore require generating two additional crews or augmenting two existing crews as soon as possible whilst training a further one or two crews to enable a third submarine to enter the operational cycle.

A training programme to ensure the requisite level of high-levels skills commensurate to a reduced operational posture would therefore have to include procedures for a crash training programme over 6-18 months if required (for example, it takes up to a year to train a weapons officer to operate in a Vanguard SSBN). The key variable will be how many fully trained crews need to be generated within a period of time and how many positions will require senior ranking. This might entail seconding SSN submariners since much of the expertise and training required to operate an SSN is the same as that required to operate an SSBN, the key difference being operation of the weapon systems, particularly the Trident missiles. This can be addressed through onshore simulation and training at the Trident Training Facility in Faslane and exercises at sea. In addition, it is highly likely that the new Successor submarines will have considerable commonality with the new Astute SSN fleet to capitalise on the investment and technology development for the Astute programme.

Arguments against reduced readiness insist that it will be difficult, if not impossible, to 'regenerate' two or three SSBNs crews of 140 people or single 'augmented' crews of 200 over 12-18 months whilst maintaining a regular (if not continuous) nuclear presence at sea during that training period. Des Browne stated in 2007 that "I believe that if we did not continue [CASD] we could not be certain that we could recreate it, that we could step it up in the timescale that we might need to if the need arose at some time in the future."[98] In addition, maintaining the harmony of crews is crucial for morale aboard SSNs and SSBNs and sudden changes to crews and missions could undermine the smooth operation of the nuclear mission. Furthermore, there may not be enough slack in the SSN crew pool to switch some to SSBN operations, particularly if SSNs are required to protect the SSBNs.

Beyond the skills needed to operate Trident missiles and SSBNs a range of support skills would need to be enhanced over a period of time to cope with an increased operational tempo, in particular military and industrial submarine, missile, warhead and reactor maintenance expertise necessary to re-establish and maintain a CASD posture, prepare submarines for operational patrol within weeks of returning from patrol, protect outgoing and returning submarines, and ensure successful operation for their projected service life.

Conclusion

The government's argument that it can make no significant further changes to UK nuclear weapons posture until a global nuclear disarmament process is well underway can be robustly challenged. The government has repeatedly expressed its international leadership on progress towards a world free of nuclear weapons. There is ample opportunity for the government to demonstrate such leadership with its own nuclear arsenal without recourse to unilateral nuclear disarmament that remains politically unacceptable at the present time.

At the very minimum the government can pursue a 'Trident lite' option based on three submarines with a reduced number of missiles tubes and warheads. Prime Minister Gordon Brown's announcement that the Successor submarine will have 12 tubes, that the government is looking at a fleet of three SSBNs indicate that this option is being explored.

The government can also pursue further measures based on ending a CASD operational posture from a 'reduced alert' to a 'de-mated alert or an 'emergency alert' posture based on the current Trident system or alternatively a nuclear-armed cruise missile system for SSN attack submarines. The practicability of these options is evidenced in a number of nuclear operational practices in the US and NATO. These options also present important opportunities to reduce the procurement and operational costs of the Trident system and develop robust nuclear disarmament verification measures of international significance.

Ending CASD will require rethinking the necessity of assured retaliation and invulnerability, a realistic assessment of the impact of a reduced readiness posture on 'crisis stability', a clearer sense of the level of destructiveness required to constitute a 'minimum deterrent' and confidence in the strength of the close relationship with the United States on nuclear matters. It will also require detailed analysis of the training and capability management structures necessary to operate the Trident system at various levels of reduced readiness over a long period of time and reconstitute a deliverable nuclear arsenal within a specified period of time if required to do so.

These options do not propose mothballing the Trident system for months or years for reactivation in a crisis. They involve procuring two or perhaps three new Successor submarines that will enable retention of key submarine operation, support, protection, and targeting capabilities and expertise as well as expertise, capabilities and specialised procedures at AWE Aldermaston for ensuring the safety and reliability of the nuclear stockpile. The new submarines may also have considerable conventional military utility. With major pressure on the defence budget the armed services are increasingly opting for flexible, multi-use capabilities. Whilst there is a strong desire to keep the Trident system as a separate capability it is clear from the operation of dual-use strike aircraft capable of delivering nuclear and conventional munitions for many years that the Ministry of Defence is comfortable with dual-use military capabilities. This increases the attractiveness of a new fleet of two or three Successor submarines that could take on some of the roles of an SSN attack submarine.

British security (and the exchequer) does not require a 'Rolls Royce' nuclear system.[99] If the government continues to insist that terminating the Trident replacement process and relinquishing Britain's nuclear weapons capability is strategically and politically out of bounds then at the very least it should seriously explore some of these options for reducing the size and readiness of the future Trident system and demonstrate genuine international leadership and a 'disarmament laboratory' ethic by stepping back from continuous alert and further reducing the nuclear arsenal.

Acronyms

ABM	Anti-Ballistic Missile
AWE	Atomic Weapons Establishment
CASD	Continuous at-sea Deterrence
DCA	Dual Capable Aircraft
HEU	Highly Enriched Uranium
HMNB	Her Majesty's Naval Base
LOP(R)	Long Overhaul Period (Refuel)
NGNPP	Next Generational Nuclear Power Plant
NSRP	Nuclear Steam Raising Plant
PWR	Pressurised Water Reactor
QAST	Quality Assurance and Surveillance Test
RNAD	Royal Naval Armament Depot
SLBM	Submarine-Launched Ballistic Missile
SLCM	Sea-Launched Cruise Missile
SSBN	Ship Submersible Ballistic Nuclear (nuclear powered ballistic missile submarine)
SSGN	Ship Submersible Guided Nuclear (nuclear powered guided missile submarine)
SSN	Ship Submersible Nuclear (nuclear powered attack submarine)
TLAM-N	Tomahawk Land Attack Missile-Nuclear
UUV	Unmanned Underwater Vehicle
UAV	Unmanned Aerial Vehicle

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STEPPING DOWN THE NUCLEAR LADDER:

OPTIONS FOR TRIDENT ON A PATH TO ZERO

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