Stepping down the nuclear ladder: options for Trident on a path to zero

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A new opportunity is emerging to rethink current nuclear weapons policies and take significant steps towards a nuclear weapons-free world. Britain is in an excellent position to take a major leadership role. This report provides an overview of paths the government could take to further reduce the size and operational status of the Trident system and the challenges involved.

British leadership towards a world free of nuclear weapons

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. This has injected the possibility and urgency of nuclear disarmament with new credibility.[1] 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'.[2] In January 2008 and March 2009 Prime Minister Gordon Brown committed his government to leading "the international campaign to accelerate disarmament amongst possessor states".[3]

Britain can 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 by exploring the challenges of taking further steps towards a nuclear weapons-free world with its own nuclear arsenal.

Yet the government argues that there are only two choices for the UK: unilateral nuclear disarmament or 'business-as-usual' through a like-for-like Trident replacement until a global nuclear disarmament process is well underway. Unilateral nuclear disarmament remains politically unacceptable to the main political parties despite the powerful arguments in its favour leaving only business-as-usual.[4]

This report challenges that assertion. It argues that there are further steps this or the next government could take to further reduce the size and operational status of the British nuclear force, that the prevailing understanding of 'minimum deterrence' based on a continuous-at-sea deterrence operational posture can be reconceptualised, and that the government need not wait for a fully-fledged multilateral nuclear disarmament process to be underway before it takes further steps towards that goal.

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[1] Nunn, Schultz, Kissinger, and Perry, "A World Free of Nuclear Weapons", *Wall Street Journal*, January 7, 2007.

[2] Margaret Beckett, "A World Free of Nuclear Weapons?", Carnegie International Nonproliferation Conference, Keynote Address, June 25, 2007.

[3] Gordon Brown, "Speech to Speech at the Chamber of Commence in Delhi", January 21, 2008; Gordon Brown, "Speech on nuclear energy and proliferation", March 17, 2009.

[4] Nick Ritchie, "Deterrence Dogma: Challenging the Relevance of British Nuclear Weapons", *International Affairs* 85:1, January 2009

Trident

The current Trident nuclear weapons system comprises four Vanguard-class nuclear-powered ballistic missile submarines, 160 operational nuclear warheads and 50 American-designed and built Trident II (D5) submarine-launched ballistic missiles (SLBMs) drawn from a common pool of Trident missiles based in the United States. At least one submarine is at sea at all times in an operational posture labelled 'continuous-at-sea deterrence' (CASD) armed with up to 48 warheads with a loading of perhaps 12-14 missiles carrying 3-4 warheads each. Most of the warheads are thought to have an explosive yield of 100 kilotons (kt) with a few carrying so-called 'sub-strategic' warheads with a yield of around 10kt.[5]

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 the submarines. It includes the centre for British nuclear warhead design, testing, production, assembly and disassembly, in-service maintenance and decommissioning at the Atomic Weapons Establishment (AWE) Aldermaston and Burghfield. The Vanguard submarines undergo a major mid-life Long Overhaul Period (Refueling) (LOP® at HMNB Devonport in Plymouth and the nuclear power plants and nuclear fuel rods that power the Vanguard submarines and designed and manufactured at Rolls Royce's Raynesway plant in Derbyshire. The infrastructure also includes the Nuclear Operations and Targeting Centre the Joint Service Unit Northwood that generates nuclear targeting plans and controls the operation of the Vanguard fleet through the Royal Navy's Commander-in-Chief Fleet operational HQ and MOD's Chief Strategic Systems Executive that manages that overall Trident system.

Political motivations for change

In 2006 the government set out its arguments for business-as-usual in its 2006 White Paper on *The Future of the United Kingdom's Nuclear Deterrent* in which announced its decision to begin the process of replacing the Trident system by procuring a new fleet of 'Successor' submarines to replace the Vanguard fleet, a decision endorsed by parliament in March 2007. The government stated that the procurement process will take 17 years and that a new submarine will be required by 2024 to ensure continuation of the CASD posture when the oldest two Vanguard submarines are scheduled for retirement following a five-year life extension programme. The question can therefore legitimately be asked as to why this policy should change to facilitate further reductions in size and operational readiness of the UK nuclear arsenal. Five political motivations can be identified:

1. To reduce the financial costs of the current operational posture.
2. To sustain and reinforce the Nuclear Non-Proliferation Treaty (NPT) by demonstrating reduced salience of and reliance upon nuclear weapons for national security.
3. To examine the operational obstacles to reduced operational readiness and force size in order to lead and inform comparable steps by other countries.
4. To explore how a 'reduced readiness posture' could be independently verified in order to increase confidence and build trust between nuclear weapon states and with non-nuclear weapon states.

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[5] Nicola Butler and Mark Bromley, "Secrecy and Dependence: The UK Trident System in the 21st Century", BASIC Research Report 2001:3 (BASIC: London) November 2001.

5. To demonstrate international leadership to the electorate and international leaders.

This report acknowledges that any decision to constrain, reduce or give up nuclear weapons is a political decision involving first-order security considerations. These five motivations 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 a positive assessment.

The report first outlines four credible options for the government supported by four precedents in US and NATO nuclear weapons policy. It then explores four conceptual obstacles and two operational obstacles to change that will have to be confronted and overcome.

Options:

Precedents:

Conceptual obstacles:

Operational obstacles:

Potential options (1): 'Trident lite'

The 'Trident lite' option is business-as-usual with smaller nuclear arsenal and SSBN fleet. The government is currently exploring whether CASD can be maintained with three rather than four Trident Successor submarines.[6] The new 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 Devonport. This will increase the operational availability of submarines and may allow CASD to be maintained with three boats. The Core H nuclear reactors are currently being installed in the new Astute-class SNN 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 will have 12 rather than 16 missile launch tubes.[7] 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 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 missiles produce the following combinations:

Table 1: Trident system configuration options

SSBNs in operational cycle	Missile compartment launch tubes	Average warheads per missile	Warheads per boat	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.

[6] See comments by defence secretary Des Browne in "The Future of the UK's Strategic Nuclear Deterrent: The White Paper. Volume II: Oral and Written Evidence", House of Commons Defence Committee report HC 225-II, March 2007 (HMSO: London) p. Ev 69.
[7] Gordon Brown, "Speech on nuclear energy and proliferation", March 17, 2009.

Potential options (2): 'Reduced alert'

The next step beyond 'Trident lite' can be labelled 'reduced alert'. It envisages a fleet of two of 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. 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 100 warheads with fewer missiles and warheads per submarine than are currently deployed reflecting some of the options on the table above.

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 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 the corresponding cost savings. Each Vanguard submarine in the current operational cycle has a Port and a Starboard crew. The government announced in its 1998 Strategic Defence Review its intention to reduce from double to single crews, presumably to reduce costs.[8] 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.[9]

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 repairs.[10] This may require a more advanced reactor pressure vessel that can be 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 25 years.[11] 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. [12] 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.

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[8] Ministry of Defence, *The Strategic Defence Review*, Command 3999, HMSO: London, July 1998, "Supporting Essay 5: Deterrence, Arms Control and Proliferation" (HMSO: London), paragraph 12.
[9] Hansard, July 28, 1998, Column 200 (HMSO: London).
[10] See Rear Admiral Andrew Mathews, "The Future of the UK's Strategic Nuclear Deterrent: The White Paper. Volume II: Oral and Written Evidence", House of Commons Defence Committee report HC 225-II, March 2007 (HMSO: London), p. Ev 70.
[11] Commodore Tim Hare, "The Future of the UK's Strategic Nuclear Deterrent: The Strategic Context", House of Commons Defence Committee report HC 986 (HMSO: London), June 2006, p. Ev 38.
[12] Peter Whitehouse, "The Future of the UK's Strategic Nuclear Deterrent: The Strategic Context", House of Commons Defence Committee report HC 986 (HMSO: London), June 2006, p. Ev 38.

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 the 'reduced alert' posture and a reduced number of un-armed Trident missiles either routinely stored ashore at the Royal Naval Armaments Depot (RNAD) Coulport or aboard SSBNs. 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".[13]

Under this option a small stockpile of Trident warheads would be routinely stored ashore at Coulport. This might number 20-40. 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 may revolve around a redeployment timeline measured in months rather than weeks. These procedures may be tested during annual exercises to re-mate warheads with missiles and redeploy a Successor submarine.

Measures may be developed and enacted to verify the absence of nuclear warheads and/or missiles from submarines 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.[14]

This alert posture does not envisage moth-balling the SSBN fleet. Instead the two or three Vanguard-replacement submarines would routinely engage in other non-nuclear activities and operational missions facilitated by a new Common Missile Compartment 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 vehicles. 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 securely storing them some distance away in facilities open to external inspection to monitor warhead movements in and out of the facilities such that eventually there would be no weapons immediately ready to fire.[15]

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[13] *Hansard*, December 18, 2006, Column 1478W.

[14] Ministry of Defence, *The United Kingdom's Defence Nuclear Weapons Programme*, <www.mod.uk/NR/rdonlyres/3B3D7417-EAE1-487F-A0BB-891E841FA973/0/nuclearweaponsverification.pdf> (MoD: London); "Nuclear disarmament: swords and ploughshares", *The Economist*, April 14, 2008.

[15] Adm. Stansfield Turner, *Caging the Nuclear Genie, An American Challenge for Global Security* (Westview Press: Boulder, CO), 1997.

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 possibly 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 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 months based on removal of limited life components from warheads, such as neutron generators and tritium reservoirs, and other components leaving the nuclear warhead physics package intact. A further step would be to disassemble the physics package such that the 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 physics package.

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.

Further 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.[16] Further steps may have to be taken to render nuclear facilities at Faslane, Coulport, and AWE Aldermaston capable of surviving 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 international tension.

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[16] Michael Mazarr, "Virtual Nuclear Arsenals", *Survival* 37:3, Autumn 1995; Michael Mazarr, "The Notion of Virtual Arsenals" in Michael Mazarr (ed), *Nuclear Weapons in a transformed World: The Challenge of Virtual Nuclear Arsenals* (St. Martin's Press: New York), 1997, p. 15.

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 UK's new Astute-class SSN attack submarines. 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 F-35 Joint Strike Fighter/Joint Combat Aircraft or a new long-range bomber. Air-delivered options, however, present increased technological and financial risk and are not considered here.[17]

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 deployed aboard Astute submarines, has a range of 1,600km). It is likely that the United States will retire this weapon after the forthcoming 2009 Nuclear Posture Review. It has no other nuclear-armed submarine-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. This would be expensive, unproven and 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 a small number of these warheads to existing Tomahawk missiles and configure some of the Astute-class SSNs with fire control systems for targeting and launching nuclear- as opposed to conventionally-armed Tomahawk missiles. The UK would also have to be certain of continued 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 an credible alternative 'emergency alert' nuclear 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 easily intercepted with surface-to-air missiles. They are also of much shorter range and may require a longer period for a submarine at sea to be in a position to fire the missiles and can only deliver a single warhead compared to the multiple and independently-targetable warhead and decoy deployment capability of the Trident missiles.

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[17] For an overview see Rebecca Johnson, Nicola Butler and Stephen Pullinger, *Worse than Irrelevant: British Nuclear Weapons in the 21st Century* (Acronym Institute: London), 2006, pp. 36-37.

Precedents (1): SSGNs

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 missile 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.

Conventional Trident submarines

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, 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.[18]

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 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.[19] 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 with the possibility of substituting the conventional warhead for a nuclear warhead if required. Nuclear warheads are routinely removed from Trident missiles still aboard 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.[20] The US Navy began research in 2003 for its 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.[21] Full operational capability was planned for 2012 but Congress cut funding due to concern that other countries' 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.[22]

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[18] Ronald O'Rourke, "Navy Trident Submarine Conversion (SSGN) Program: Background and Issues for Congress", CRS Report for Congress (Congressional Research Service, Washington, D.C.), May 2008.
[19] "SSGN "Tactical Trident" Subs: Special Forces and Super Strike", *Defense Industry Daily*, October 28, 2008.
[20] Nick Ritchie, *US Nuclear Weapons Policy Since the End of the Cold War* (Routledge: Abingdon), 2008.
[21] *Conventional Prompt Global Strike Capability: Letter Report* (National Academy Press, Washington, D.C.), 2007; Amy Woolf, "Conventional Warheads for Long-Range Ballistic Missiles", CRS Report for Congress (Congressional Research Service, Washington, D.C.), February 2009.
[22] Richard Sokolsky, "Demystifying the U.S. Nuclear Posture Review", *Survival* 44:3, Autumn 2002, p. 139.

Precedents (2): Tomahawk Land-Attack Missile-Nuclear

The US Navy produced around 360 nuclear-armed TLAM-N missiles in the 1980s with 100 deployed at sea at a time aboard its SSN nuclear attack submarines.[23] 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 and 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.[24]

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 Pacific and Atlantic fleets and a Quality Assurance and Surveillance Test (QAST) that can involve a live test firing of an unarmed TLAM-N to ensure they 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.[25]

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."[26] 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.[27]

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 handful of nuclear-armed Trident missiles within a specific period of time from weeks to months 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.

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[23] Joshua Handler, "PNIs and TNW Elimination, Storage and Security", in Brian Alexander and Alistair Millar (eds), *Tactical Nuclear Weapons* (Brassey's, Inc: Dulles, VA), 2003, p. 22; Robert Norris and William Arkin, "U.S. Nuclear Weapons Stockpile, July 1996", *Bulletin of the Atomic Scientists*, July-August 1996, p. 63
[24] Handler, "PNIs and TNW Elimination, Storage and Security", p. 23.
[25] Robert Norris, William Arkin, Hans Kristensen and Joshua Handler, "U.S. Nuclear Forces, 2001", *Bulletin of the Atomic Scientists*, March-April 2001.
[26] *Nuclear Weapons Systems Sustainment Programs*, Office the Secretary of Defense (US Department of Defense: Washington, D.C.), May 1997.
[27] Defense Science Board, *Report of the Defense Science Board Task Force on Nuclear Deterrence*, (US Department of Defense: Washington, D.C.), October 1998, p. 30; Robert Norris, William Arkin, Hans Kristensen and Joshua Handler, "U.S. Nuclear Forces, 2002", *Bulletin of the Atomic Scientists*, May-June 2002, p. 74.

Precedents (3): NATO Nuclear Capable Aircraft

Nuclear deterrence remains a key part of NATO's military posture[28] and the United States still 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).[29]

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".[30] 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 weapons were withdrawn from RAF Lakenheath in 2008.[31]

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".[32] 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".[33]

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.[34] John Ainslie argues that NATO probably stopped maintaining standing nuclear plans between 1995 and 1998.[35] 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).[36]

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.

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[28] See "The Alliance's Strategic Concept" (NATO: Brussels), April 1999. Available at <http://www.nato.int/docu/pr/1999/p99-065e.htm>.

[29] Hans Kristensen, *U.S. Nuclear Forces in Europe* (Natural Resources Defense Council: Washington, D.C.), February 2005, p. 11.

[30] "The Alliance's Strategic Concept", April 1999.

[31] Hans Kristensen, "The Minot Investigations: From Fixing Problems to Nuclear Advocacy", FAS Security Blog, January 14, 2009. Available at <http://www.fas.org/blog/ssp/2009/01/schlesingerreport.php#more-669>; Hans Kristensen, "U.S. Nuclear Weapons Withdrawn from the United Kingdom", FAS Security Blog, June 26, 2008. Available at <http://www.fas.org/blog/ssp/2008/06/us-nuclear-weapons-withdrawn-from-the-united-kingdom.php>.

[32] "NATO's Nuclear Forces in the New Security Environment", NATO, 1995. Available at <http://www.nato.int/issues/nuclear/sec-environment.html>.

[33] Kristensen, *U.S. Nuclear Forces in Europe*, p. 68.

[34] "The Alliance's Strategic Concept", April 1999; "Final Communiqué of the Meeting of the Defence Planning Committee in Ministerial Session" (NATO: Brussels) June 13, 1996. Available at <http://www.nato.int/docu/pr/1996/p96-088e.htm>.

[35] John Ainslie, *The Future of the British Bomb* (Scottish CND: Glasgow), 2005, p. 67.

[36] Kristensen, *U.S. Nuclear Forces in Europe*, p. 64; Ainslie, *The Future of the British Bomb*, p. 68.

Precedents (4): US disassembled warheads

The US has maintained over several thousand nuclear weapons in various states of readiness for many years.[37] 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.[38]

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 at King's Bay, Georgia and the Strategic Weapons Facility Pacific at Bangor, Maine.[39] The US has approximately 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.[40]

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.[41]

When nuclear weapons are dissembled at the Pantex nuclear warhead assembly and disassembly plant in Texas, 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.[42]

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

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[37] *Faking Nuclear Restraint: The Bush Administration's Secret Plan For Strengthening U.S. Nuclear Forces* (National Resources Defense Council: Washington, D.C.), February 2002.
[38] *Nuclear Posture Review (Excerpts)* available at <http://www.globalsecurity.org/wmd/library/policy/dod/npr.htm> (Globalsecurity.org: Washington, D.C.), 2002; Amy Woolf, *U.S. Nuclear Weapons: Changes in Policy and Force Structure* (Congressional Research Service: Washington, D.C.), January 2006, p. 25.
[39] Robert Norris & Hans Kristensen, "Where the Bombs are, 2006", *Bulletin of the Atomic Scientist,* December 2006.
[40] Hans Kristensen & Robert Norris, "U.S. Nuclear Forces, 2009", *Bulletin of the Atomic Scientists*, March 2009.
[41] Center for Counterproliferation Research (National Defense University) and Center for Global Security Research (Lawrence Livermore National Laboratory), *U.S. Nuclear Policy in the 21st Century: A Fresh Look at National Strategy and Requirements*, Final Report (GPO: Washington), 1998, p. 5.4.
[42] Stephen Schwartz (ed), *Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons* (Brookings Institution Press: Washington, D.C.), 1998, pp. 92, 331 and. 465.

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 obstacles. 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 concepts of 'assured retaliation', survivability and continuous-at-sea deterrence (CASD). This states that an effective nuclear deterrent threat requires an assured capability, to deliver a devastating retaliatory blow to an aggressor. An assured capability to retaliate requires a survivable nuclear weapon system, i.e. one that is invulnerable to a surprise nuclear 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, i.e. a CASD operational posture.

These three 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 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 induce an aggressor to calculate that it could credibility threaten to, or actually execute, a disarming nuclear first-strike against the UK thereby exposing the country to nuclear blackmail or a 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 creates an incentive for coercion or attack.[43]

These three concepts of assured retaliation, survivability/invulnerability and CASD form the heart of the conceptual apparatus governing the operation of the UK's Trident system. A vital prerequisite for reducing the system's 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.[44] Nearly 20 years since the end of the Cold War and 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 first-strike has dissipated.

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[43] Des Browne, "The Future of the UK's Strategic Nuclear Deterrent: The White Paper. Volume II: Oral and Written Evidence", House of Commons Defence Committee report HC 225-II (HMSO: London), March 2007, p. Ev 68.
[44] "Joint Declaration by the President of the Russian Federation and the Prime Minister of the United Kingdom of Great Britain and Northern Ireland", Moscow, February 15, 1994.

Conceptual obstacles (2): Crisis stability

A fourth concept of 'crisis stability' is also regularly invoked to support this posture. Crisis stability/instability refers to the mutual interaction of processes for mobilising and heightening the alert-status of opposing forces during a crisis that could be interpreted by one or more sides as aggressive, escalatory and a preclude to an attack.

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 opposing forces 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.[45]

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 risks of conflict by changing the strategic calculations of the opposing side.[46] Sailing a Trident submarine in a crisis could therefore becalm or stoke the situation depending upon the political context.[47]

Furthermore, in a crisis where the use of nuclear weapons was a real possibility any decision to sail a Trident submarine would 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 ready 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.[48] These, plus political statements testifying to the seriousness of the crisis, have the potential to destabilise a crisis even with 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.

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[45] Ministry of Defence, *The Strategic Defence Review*, paragraph 13.

[46] Owen Price, "Preparing for the Inevitable: Nuclear Signalling for Regional Nuclear Crises", *Comparative Strategy*, 26:2, 2007, p. 105.

[47] Nuclear activities can also be misinterpreted absent a crisis – the manner in which the 1983 NATO Exercise Able Archer to simulate release of nuclear weapons against Soviet targets reinforced Soviet fears of a surprise nuclear attack by West is perhaps the most serious case. The NATO exercise was initially interpreted by Moscow as the real thing and Soviet nuclear and conventional forces were mobilised in response.

[48] "We wouldn't necessarily use the deployed submarine as the sub-strategic boat. We may sail another specifically in that role, so we have the flexibility of doing either or both." Commander Tom Herman, 1 Submarine Squadron, Navy News Clyde Supplement, May 1996, cited in John Ainslie, *Trident: Britain's Weapons of Mass Destruction* (Scottish CND: Glasgow), March 1999.

Conceptual obstacles (3): Nuclear targeting

Further British nuclear force reductions will be governed in part by prevailing understandings of the quantity and type of 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 to deter attack.

The size and capability of the British nuclear arsenal was governed for much of the Cold War by the 'Moscow Criterion' that stipulated Britain must be able to destroy Moscow and a number of other major Soviet/Russian cities in a retaliatory 'counter-value' nuclear attack.[49] During the 1980s and 1990s there seems to have been a shift away from targeting 5-10 Soviet/Russian cities, including Moscow, and towards a more specific focus on the Soviet and Russian command and control infrastructure. This did not constitute a radical departure from the Moscow Criterion since the Soviet command and control system was centralised in and around Moscow.[50]

Since the end of the Cold War 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."[51]

The steady reduction 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[52] and in the post-Cold War from an estimated 500 strategic nuclear warheads for Trident[53] to 300 under the Conservative government with 60 per submarine[54], to 200 announced in Labour's 1998 Strategic Defence Review with 48 per submarine,[55] and finally to 160 announced in Labour's 2006 White Paper[56] demonstrates that 'minimum deterrence' is a moveable feast.[57]

For illustrative purposes a basic calculation of 'minimum deterrence' warhead numbers based on the capability to destroy the three biggest Russian cities by population (Moscow, St. Petersburg and Novosibirsk) can be made using figures from Geoffrey Kemp's two 1974 *Adelphi Papers* on nuclear targeting.[58] Kemp argues that the capacity to cover an urban area with a blast overpressure of 5 psi or more will be sufficient "to threaten with a high degree of reliability the destruction of most major facilities in cities and to cause about 50 per cent

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49 Kristan Stoddart, "Maintaining the 'Moscow Criterion': British Strategic Nuclear Targeting 1974–1979", *Journal of Strategic Studies,* 31:6 December 2008, p. 920.
50 Ainslie, *Trident: Britain's Weapon of Mass Destruction.*
51 Michael Quinlan, "The British Experience", in Henry Sokolski (ed), *Getting MAD: mutual assured destruction, its origins and practice*, Strategic Studies Institute (Army War College, Carlisle, PA), November 2004, p. 265..
52 Quinlan, "The British Experience", p. 274; Stoddart, "Maintaining the 'Moscow Criterion", p. 901.
53 Nicholas Whitney, *The British Nuclear Deterrent after the Cold War* (RAND: Santa Monica, CA), 1995, p. 36.
54 *Hansard,* July 16, 1998, Column 237
55 Ministry of Defence, *The Strategic Defence Review*, paragraph 64.
56 Ministry of Defence (MoD) and Foreign & Commonwealth Office (FCO), *The Future of the United Kingdom's Nuclear Deterrent*, Command 6994 (HMSO: London), December 2006, p. 5.
57 Stoddart, "Maintaining the 'Moscow Criterion", p. 923.
58 Geoffrey Kemp, "Nuclear forces for medium powers part I: Targets and weapons systems", *Adelphi paper 106* (International Institute for Strategic Studies: London), 1974 and Geoffrey, *Adelphi paper 107* (International Institute for Strategic Studies: London), 1974

immediate fatalities".[59] He calculates that a 100kt blast (the yield of a single UK Trident warhead) will cause 5 psi over 13.6 miles^2.[60] He also states that a 90% reliability figure for each missile and each warhead gives 81% reliability for each warhead reaching its destination. This yields the following figures:

Table 2: Trident warhead numbers to destroy three largest Russian cities

City	Area (miles^{2})	Population (millions)	100kt Warheads needed with 0.81 success rate
Moscow	350	10.38	32
St. Petersburg	240	4.66	22
Novosibirsk	190	1.42	19

This gives a total of 73 warheads. The figure for Moscow is complicated by its ABM system of 100 interceptors. The capability of this system against modern Trident warheads and sophisticated missile defence penetration aids stemming from the Chevaline programme developed for the UK Polaris system is unknown. If, for sake of argument, we add a further 20% to the Moscow total taking it to 39, the total is 80 warheads. A further reserve of 20% gives a total UK arsenal of 96 warheads to utterly destroy Russia's three largest cities including its military command and control system in Moscow and cause many, many millions of deaths.

[59] Kemp, "Part II: Strategic requirements and options", p. 5.
[60] Kemp, "Part I: Targets and weapons systems", p. 18.

Conceptual obstacles (4): the 'special relationship'

The UK is heavily dependent upon the US for the provision and operation of Trident.[61] 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.[62]

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, the Royal Navy uses American software for target planning and data processing, and British and American Trident submarine operations are coordinated together.[63]

Britain enjoys substantial nuclear weapon cooperation 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 new Successor submarines.[64]

Furthermore, Britain's nuclear capability is a central plank of its 'special relationship' with the US and is considered an important function of the closeness of the broader military and political relationship.[65] A very high value is placed in the UK on maintaining political and military credibility in Washington.[66] This is judged to require a significant 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.[67] Policy-makers in Whitehall will be anxious to avoid destabilising the precious nuclear relations with the United States in any way by moving away from the current CASD posture to a reduced readiness posture.

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 decommissioning, verification and stockpile stewardship.[68] Concerns centred on the 'special relationship' are not sufficient to preclude a reduced operational readiness posture.

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[61] For a full account of British dependence on the United States see Butler Mark Bromley, *Secrecy and Dependence*.
[62] See Ainslie, *The Future of the British Bomb*.
[63] See Ainslie, *The Future of the British Bomb*.
[64] MoD and FCO, *The Future of the United Kingdom's Nuclear Deterrent*, p. 31.
[65] See John Dumbrell, *A Special Relationship: Anglo-American Relations in the Cold War and After* (Macmillan: Basingstoke), 2001, chapter 6 'Nuclear and Intelligence Cooperation; Jeremy Stocker, *The United Kingdom and Nuclear Deterrence,* Adelphi Paper 386 (International Institute for Strategic Studies: London), 2007, p. 34.
[66] Ministry of Defence, *Delivering Security in a Changing World*, Cm 6041-I (HMSO: London), December 2003, p. 8.
[67] Lawrence Freedman, *The politics of British defence, 1979-98* (Basingstoke: Macmillan, 1999), p. 98; *The Future of the UK's Strategic Nuclear Deterrent: the Strategic Context*, House of Commons Defence Committee report HC 986 (HMSO: London), June 2006, p. Ev 101.
[68] See John Simpson in *The Future of the UK's Strategic Nuclear Deterrent: The Strategic Context*, House of Commons Defence Committee report HC 986, The Stationary Office: London, June 2006, Ev. 27.

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 outlined above. The most serious operational obstacle is the ability to maintain a high-level of submarine crew training and morale for the operation of the Trident weapon system and an assured firing chain in the event of a decision to use nuclear weapons against an adversary.

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.[69] 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 ...".[70]

Nevertheless, the SSBN scenarios outlined above envisage regular operation of two or three Successor submarines. A sufficient level of operational readiness could be maintained under a reduced readiness posture through regular operation of SSBN/SSGN boats, onshore simulation and intensive training before, during and after operational patrols, regular redeployment drills and annual/bi-annual 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 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 in 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 nuclear command, control and communication system; and to ensure training and readiness for warhead delivery vehicles, maintenance crews and other logistics and support elements.[71]

The United States has had to face 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.[72] Nevertheless, 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.

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[69] "The Future of the UK's Strategic Nuclear Deterrent: The White Paper. Volume II: Oral and Written Evidence", House of Commons Defence Committee report HC 225-II, (HMSO: London) March 2007, p. Ev 69.

[70] Des Browne, Statement at RUSI seminar on "Renewing the UK's Independent Strategic Nuclear Deterrent: A Debate", Royal United Service Institute, March 7,2007.

[71] Michael Wheeler, "Reconstitution and Reassembly of a Virtual Nuclear Arsenal", in Mazarr (ed), *Nuclear Weapons in a Transformed World* (St. Martin's Press: New York), 1997, p. 127.

[72] See Ritchie, *US nuclear weapons policy since the end of the Cold War*, chapter 8; Defense Science Board, *Report of the Defense Science Board Task Force on Nuclear Capabilities* (US Department of Defense: Washington, D.C.), December 2006, p. 33.

Operational obstacles (2): regenerating 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 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 (in fact this is currently the case with HMS Vigilant in mid-life overhaul and HMS Vanguard undergoing repairs at Faslane following the collision with the French SSBN Le Triomphant in February 2009). A return to CASD would require generating a third or fourth crew as soon as possible whilst training a further two or three crews to enable a third submarine to enter the operational cycle.

The 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 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 weapons systems, particularly the Trident missiles. This can be addressed through onshore simulation and training at the Trident Training Facility in Faslane and through 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 simply '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 that [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."[73] It is also maintained that harmony of crews is very important for morale aboard SSNs and SSBNs and sudden changes to crews and missions could undermine the smooth operation of the nuclear mission. In addition, there may not be sufficient slack in the SSN crews to switch some to SSBN operations, particularly if SSNs are required to protect the SSBNs.

In addition 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 and ensure successful operation for their projected service life.

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[73] "The Future of the UK's Strategic Nuclear Deterrent: The White Paper. Volume II: Oral and Written Evidence", House of Commons Defence Committee report HC 225-II (HMSO: London), March 2007, p. Ev 69.

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 and Baroness Shirley Williams' (Brown's advisor on nuclear proliferation) recent statement that warhead numbers could be reduced from 160 to 120 indicate that this option is being pursued.[74]

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 proicuremnt and operational costs of the Trident system and develop robust nuclear disarmament verification measures of international significance.

Ending CASD will require a rethinking of 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 and cooperative 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 the nuclear arsenal within a specified period of time if required to do so in a period of international tension.

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 and support expertise and as well as expertise, capabilities and specialised procedures at AWE aldermaston for ensuring the safety and reliability of nuclear stockpile. The new submarines ay also have considerably 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 totally 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.

Key components of this exploratory analysis will be subject to further detailed study over 2009 and presented to policy-makers in the hope of encouraging the government to undertake its own thorough examination of these options.

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[74] *Hansard*, Column 791 (HMSO: London), March 26, 2009. This reflects the 5th option in Table 1 above.