Disarming Trident

A practical guide to the steps required to verifiably de-activate and dismantle the Scottish-based Trident nuclear weapon system.

John Ainslie, Scottish CND June 2012

Fifty years after the Cuban Missile Crisis, Britain still has large numbers of nuclear weapons poised to destroy Moscow, or any other target chosen by the Ministry of Defence. Moving away from this, towards disarmament is not an impossible dream. There are practical steps that can be taken and they don't all need to take years to implement.

Within the UK context, it would be possible to carry out a number of actions which would mean that British nuclear weapons could not be used in anger. The recent UK-Norway Initiative demonstrates how Non Nuclear Weapon States could play an important role in verifying that Trident had been de-activated. Final dismantlement of the nuclear arsenal could also be verified using similar procedures.

In the event of independence, a sovereign Scottish government could insist that steps were taken within days and weeks to de-activate the Trident system. They could also present London with a timeline setting out how all nuclear warheads should be removed within one to three years. The Scottish government could verify that this plan was being implemented.

The proposed stages are:

1. End Deployment
2. Remove keys and triggers
3. De-activate missiles
4. Remove nuclear warheads from submarines
5. Remove missiles from submarines
6. De-activate nuclear warheads
7. Remove nuclear warheads from Scotland
8. Dismantle nuclear warheads

Starting point

The Royal Navy has four Vanguard class nuclear submarines. There is always one submarine undergoing refit at Devonport. The remaining three vessels are normally armed with Trident missiles and nuclear warheads.[1] One submarine is deployed on patrol. This study assumes a starting point where one vessel is on patrol, the second is on trials and the third is berthed at Faslane.

Phase One – End deployment

The submarine on patrol could return to Faslane within 4-7 days. Patrol changeovers can take longer, but these involve one submarine travelling to its station before the other can stand down. Vanguard class submarines can travel long distances at speeds greater than 20 knots.

Phase Two – Remove keys and triggers

The launch of Trident missiles involves the operation of a key, which is in the custody of the Captain, and a trigger, which is held by the Weapons Engineering Officer (WEO). There are strict arrangements for the storage and handling of these keys and triggers. As an initial disarmament step, these keys and triggers could be identified, removed from all submarines and stored in a secure site on shore. This could be carried out within a few hours for the submarine berthed at Faslane, and within a few hours of each of the other two vessels returning to port.[2]

Inspectors could place seals on the appropriate parts of the Fire Control System and the storage site. Continuous monitoring could be established at the storage site.

Trident launch trigger on HMS Victorious

Phase Three – De-activate missiles

There is a hatch in each missile tube which enables technicians to replace certain components on the missile while it is on the submarine. These parts include the guidance system and flight control system. Spare guidance and flight control components are stored in the Strategic Weapon System (SWS) building at Faslane. If these parts are removed then the missile can no longer be deliberately launched at any target.

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[1] There is a gap of up to 12 months between when a submarine leaves refit and when it becomes operational. During this time there are only 2 operational submarines.

[2] It would be possible to accelerate this process if keys and triggers were offloaded by helicopter before the submarines berthed.

These components are replaced on a routine basis. Following the Strategic Defence and Security Review of 2010, each Vanguard class submarine will only carry eight Trident missiles. The removal of vital components from one missile takes around 90 minutes.[3] Eight missiles could probably be de-activated within one day.

Similar components could be removed from any spare missiles stored in the Ready Issue Magazines.

Inspectors could set up seals on the missile access hatches. The components could either be stored in the existing room within the SWS building or at another suitable site. Seals and continuous monitoring could be set up at the store.

Removable Mk6 Guidance Unit for a Trident D5 missile

Phase Four – Remove nuclear warheads from submarines

RNAD Coulport has the facilities and equipment required to load and unload nuclear warheads from Trident missiles. It retains a team of specially trained and experienced personnel to carry out this work. To remove the warheads, each submarine would be taken, in turn, to the Explosives Handling Jetty (EHJ). Once securely berthed in the jetty, the warheads would be removed from the missiles while the missiles were on the submarine.

Current practice is that the unloading of all the warheads on a submarine takes place once every three years, in the pre-refit period. Complete loading also takes place once every three years, at the end of the post-refit work up. In addition, small numbers of warheads are removed from one or two missiles several times each year, when operational submarines dock in the EHJ.

The removal of all warheads from one submarine would take between 7 and 10 days.[4] In theory warheads could be removed from all submarines within one month. In practice this may take longer. There are detailed safety and security procedures for de-mating warheads from missiles and for moving warheads between the EHJ and the Reentry Body Magazines (RBMs) at Coulport. Additional preparation and training may be required prior to conducting unloading on the scale required. This could increase the total time required to 6 - 8 weeks.

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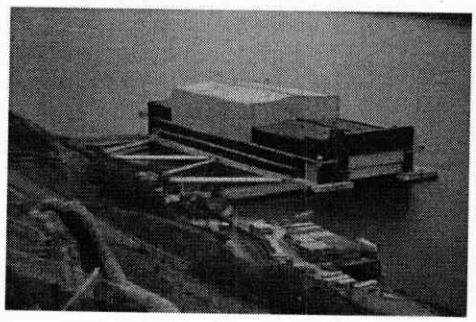
[3] Beyond the Nuclear Shadow, RAND, 2003, http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA416560; Bruce G. Blair, Global Zero Alertfor Nuclear Forces (Washington, DC: Brookings Institution), 1995, pp. 88-89.

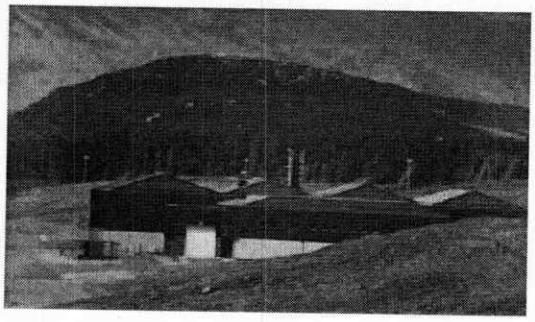
[4] Based on the time taken to initially load warheads on HMS Vanguard in December 1994, prior to its first patrol.

When the RBMs were built in the 1980s it was intended that the Navy would deploy several hundred Trident nuclear warheads. The magazines will be able to store the entire current stockpile of less than 225 warheads.

Inspectors could monitor the unloading process and establish seals and monitors in the RBMs.



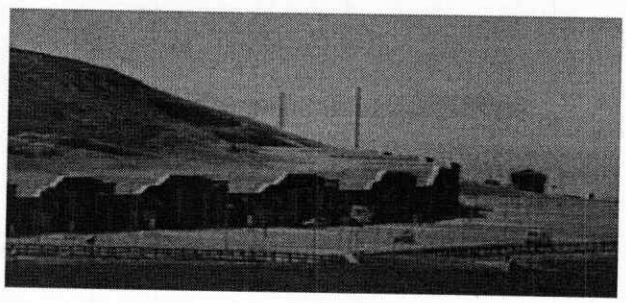
Explosives Handling Jetty (EHJ)



Reentry Body Magazines (RBM)

Phase Five - Remove missiles from submarines

Missiles can be removed from submarines in the EHJ. The Ready Issue Magazines (RIMs) at Coulport can only store 16 missiles. While it would be possible to store two-thirds of the missile stockpile, separately from the nuclear warheads, on-shore at Coulport, around 8 missiles would remain on a submarine.



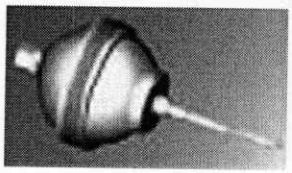
Ready Issue Magazines (RIM)

Inspectors could seal and monitor the 16 missiles which had been moved into the RIMs. Monitoring the remaining unarmed missiles on the submarine would be more difficult.

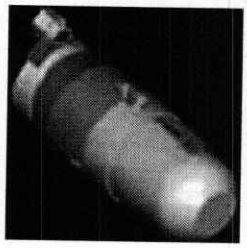
Phase Six – De-activate nuclear warheads

US practice is that three Limited Life Components (LLCs) of nuclear warheads are routinely replaced at operating bases. These are the Arming Fuzing and Firing System (AF&F), Gas Transfer System (GTS) and Neutron Generator (NG). In the case of the UK Trident warhead, all three of these components are purchased from the United States. The Re-entry Body Process Building (RBPB) at Coulport is almost certainly able to remove these components from UK Trident warheads.

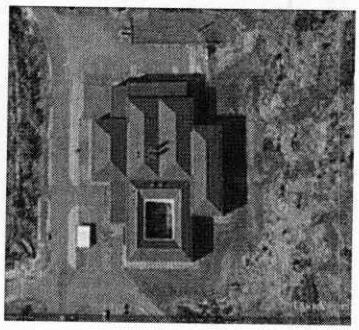
AF&F



Gas Transfer System



Neutron Generator



Reentry Body Process Building

Following the Strategic Defence and Security Review the number of operationally-available nuclear warheads is being reduced from "less than 160" to "less than 120". These operationally-available warheads will be fitted with their LLCs. There are 65-105 additional (spare) warheads, making a total stockpile of less than 225.[5] Most of these spare warheads are stored in the RBM at Coulport. In line with US practice, it is likely that some of these spare warheads are stored without LLCs fitted.

Removal of the AF&F from the warhead would be a clear step which could be taken to de-activate it. This would separate the AF&F, which includes the firing system, from the Nuclear Explosives Package. The GTS and NG could also be removed. The removal of these LLCs may be a time-consuming process, because of safety considerations. The removal of all LLCs from more than 120 warheads might take Coulport between 6 and 18 months.

The most hazardous part of the warhead is the Nuclear Explosives Package. The LLCs are less dangerous and so easier to transport. The GTS contains radioactive tritium and the NG holds a smaller amount of the same material. The AF&F does not contain radioactive material. Although removing LLCs may be time consuming, transporting these components out of Scotland could be carried out quickly.

The RBPB at Coulport is not designed for disassembling the Nuclear Explosives Package. This specialised task can only be carried out at AWE Burghfield in Berkshire.

Inspectors could monitor and verify the removal and storage of LLCs and their transport out of Scotland.

Phase Seven – Remove nuclear warheads from Scotland

The clearest and most significant step would be the physical removal of nuclear warheads, in particular their Nuclear Explosive Packages, from Coulport.

When Chevaline warheads were withdrawn from service in the 1990s they were initially stored at RAF Honington, prior to being dismantled at Burghfield. Adopting the same approach for Trident would speed up the removal of warheads from Scotland.

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[5] In 2010 the SDSR said that while the number of operationally available warheads would be reduced from less than 160 to less than 120 over the next few years, the total stockpile would only be reduced from less than 225 to less than 180 by the mid 2020s.

RAF Honington

RAF Honington has 25 separate bunkers in its former nuclear weapons storage area. It is not clear how many warheads can be stored in each bunker. Honington is not longer a base for fixed-wing aircraft. It is a major centre for the RAF Regiment. It retains a significant nuclear role as the home of the Defence Chemical Biological, Radiological and Nuclear (CBRN) Wing (20 Wing of the RAF Regiment). The Defence CBRN Wing is the MOD's lead CBRN organisation. It provides experts who can monitor the effects of a radiation incident and it supports the UK Nuclear Event Response Organisation.[6]

Nuclear weapon storage area at RAF Honington

Assuming the nuclear store at Honington is not currently operational, a number of steps would be required to re-activate it. These would include reviews of safety and security, improved security measures and the deployment of a small team of warhead experts from Coulport and Aldermaston/Burghfield.

Nuclear weapon transport convoys

In recent years nuclear weapons convoys have contained between 3 and 5 lorries. Each lorry can carry two Trident warheads, but sometimes they contain only one. Convoys may include one empty lorry. The maximum number of warheads which can be transported by each convoy is probably between 8 and 10. This would suggest that moving the entire stockpile of warheads out of Scotland could require between 20 and 30 convoys. In some years during the 1980s and 1990s convoys were travelling regularly to Scotland, once every four to six weeks. During this time additional convoys were transporting nuclear weapons around England. In theory convoys could possibly operate once every two weeks, but in practice once every three to six weeks is probably more realistic. On this basis, removing all warheads from Scotland would take more than one year, and possibly as long as three years.

Inspectors could monitor and verify the removal of nuclear warheads from Scotland.

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[6] http://rusi.org/downloads/assets/201203_RDS_Michell.pdf

Nuclear Weapons Convoy

Phase Eight Dismantle nuclear warheads

The only site in the UK that can disassemble nuclear warheads, including their Nuclear Explosives Package, is AWE Burghfield. Dismantling a Trident warhead at Burghfield would involve the following steps:[7]

a. Preparate cells for disassembly
b. Inspect warhead
c. Remove RV shroud
d. Cut and disconnect detonator cables
e. Remove firing set and neutron generator (if not removed at Coulport)
f. Cut open and remove radiation case
g. Remove the primary
h. Remove the secondary, for dismantlement separately
i. Prepare for removal of High Explosive (primary)
j. Remove High Explosive (primary)
k. Package plutonium pit (primary)
l. Dismantle secondary

In the United States, steps a to j are carried out at Pantex, while step k takes places at Y-12. Initial dismantlement of UK secondaries probably takes place at Burghfield, with follow-up work in facility A45 at Aldermaston.

AWE Burghfield has four cells which are designed to limit the effect of the detonation of conventional explosives in the event of an accident while high explosive is attached to, or removed from the plutonium pit. AWE are currently building a new warhead assembly/disassembly facility, Project Mensa, at Burghfield. This is due to enter service in 2016. The new facility will have a similar capability to the old buildings and will probably have four assembly cells.[8]

WE-177 nuclear bombs were initially produced at annual rates of between 24 and 36 per year. In 1981 it was assumed that Trident warheads would be manufactured at a rate of up to 60 per year.

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[7] This is a simplified version of the procedures detailed in the US Department of Energy 1996/97 study, http://www.fas.org/sgp/othergov/doe/dis/

[8] The planning application documents for Project Mensa refer to Cells A and C. The design is symmetrical and so there are probably four identical cells.

Actually assembly probably peaked at around 40 Trident warheads per year. WE-177 and Chevaline warheads were all dismantled by 1998 and 2002 respectively. Disassembly rates for these two weapons were probably between 20 and 40 per year.

These assembly and disassembly rates were achieved while Burghfield was carrying out a number of tasks simultaneously – assembling, refurbishing and disassembling more than one type of warhead. If all four cells were set up for disassembly then higher rates could be achieved. Annual disassembly rate of 50-70 warheads per year should be possible. This would indicate that it would take between 3 and 5 years to dismantle the current stockpile of less than 225 warheads.

The output from disassembly at Burghfield would be the separated components of a nuclear warhead, including the plutonium pit. Further work would be required to convert the pit into a form where it could not be reconstituted into a nuclear weapon.

Summary of timescale

Phase	Measure	Time to complete from day 1
1	End Deployment	4 - 7 days
2	Remove all keys and triggers	5 - 8 days
3	De-activate all missiles	5 - 9 days
4	Remove all warheads from submarines	6 - 8 weeks
5	Remove 16 of the 24 missiles from submarines	8 - 12 weeks
6	De-activate nuclear warheads and remove LLCs from Scotland	6 - 18 months
7	Remove nuclear warheads from Scotland	1 – 3 years
8	Dismantle nuclear warheads	3 - 5 years

Additional Steps

Two further measures could also be taken

a. Return of Trident missiles to the US

The D5 missiles were initially loaded onto British submarines at the US Navy Trident facility at Kings Bay, Georgia. They would have to be returned to this site, or possibly the US Navy's other Trident base at Bangor in the Pacific. Currently the only means of transporting D5 missiles between the UK and US is onboard British Vanguard class submarines or American Ohio class submarines.

b. Dismantling Vanguard class submarines

Maintenance of Vanguard class submarines is carried out at Faslane. Some of the Trident-related equipment on the submarines could be dismantled while the vessels were at this Clyde base. For example, much of the Fire Control System and replaceable elements of the launch system could be removed.

The fuel core in the reactor of a Vanguard class submarine reactor can only be removed at 9 Dock in Devonport dockyard. The fourth Trident submarine HMS Vengeance is in 9 Dock for a three year refit and refuelling which began in 2012. After this, the MOD plan to carry out refits, without refuelling, on some of the other Trident submarines. This refit programme could be replaced with the defueling and decommissioning of these vessels.

Questions of where and how the final dismantlement of nuclear submarines should be carried out are the subject of a long-running investigation by the Ministry of Defence.

Verification

Work has been done by several countries, the IAEA and NGOs into how to verify that nuclear disarmament has taken place. Most of this has focused on Phase 8 (dismantle nuclear warheads). The principles which have been established can also be applied to the other steps.

Non Nuclear Weapon States (NNWS) can play an important part in verifying disarmament. This was recognised in the recent UK-Norway Initiative. During this Initiative, from 2007 to 2012, three exercises were conducted which simulated an NNWS verifying the dismantlement of nuclear weapons.

In the event of Scottish independence, Scotland could play the role of the NNWS verifying the de-activation of the Trident system and the removal of nuclear weapons.

An underlying conflict is between the NNWS's requirement for evidence and the Nuclear Weapons State's desire to keep information secret, partly to prevent the proliferation of nuclear weapon's technology. In the case of the UK Trident system, the issue is complicated by the fact that many of the classified components are of US origin.

With regard to ending the deployment at sea of Trident submarines (phase 1), it is easy to monitor the movement of Trident submarines in and out of Faslane and Coulport. This would provide a basis for establishing that continuous patrols had ended. It would be harder to prove that vessels were not carrying out occasional ad-hoc patrols.

Verification of the initial de-activation steps, removal of keys/triggers and missile components (phases 2 and 3), would be difficult. The components are classified and so detailed inspection of each item by an NNWS inspector would be problematic. As they do not contain nuclear material, radioactive monitoring would not be effective. This does not mean that these measures should not be carried out, just that the level of confidence of the inspecting NNWS would be lower than with other steps.

UK Trident missiles carry a mixture of actual warheads and inert Re-entry Vehicles.[9] The latter are added to swamp the Moscow ABM system. The inert RVs look very similar to a warhead.

With regard to the US Trident system, the START agreement allowed Russia to occasionally inspect a sample of submarines and to check whether there were missiles in their launch tubes. The agreement did not, however, provide an accurate way that Russian inspectors could check how many warheads were on each missile.

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[9] Current loading is possibly 5 warheads and 7 inert RVs per missile.

In the same way, it would be difficult for an external inspector to count the warheads on a UK Trident missile. However, an inspector could verify that all warheads and inert RVs had been removed (phase 4). To do this, the nose-cone of the missile would be removed and shrouds placed over the third stage and the Release Assembly fittings. In this way, it would be possible to show that there were no warheads or inert RVs present, without disclosing classified information about the missile's design.

There is a second way in which the removal of warheads from a submarine could be verified. The measures developed in the UK-Norway Initiative could be used to confirm that warheads have been moved out of the Explosives Handling Jetty, after unloading. Mutually-agreed radiation monitoring equipment could verify the presence of a warhead without revealing classified information. This technology would enable the NNWS (Scotland) to discriminate between nuclear warheads and inert RVs without inspecting them visually.

Removal of missiles from submarines into the Ready Issue Magazines (phase 5) would only require a level of access similar to that which the United States gave to Russian inspectors under the START agreement.

Monitoring the removal of the Tritium Reservoir, one of the Limited Life Components (phase 6) should be possible, because it contains radioactive material. An external inspector should be able to distinguish between a box containing a real tritium reservoir and a similar box which does not, without seeing the reservoir itself. This process could also be used to monitor the transport of Tritium Reservoirs out of Scotland. The Neutron Generator contains a small amount of tritium and so the same approach might be possible. Identifying Arming, Fuzing and Firing systems, without classified access, would be more difficult.

The removal of nuclear warheads from Scotland (phase 7) could be verified using a form of Information Barrier system, as investigated in the UK-Norway Initiative. This would allow an NNWS (Scottish) inspector to verify whether or not a warhead was in a container before the container was placed in a lorry.

The verification of warhead disassembly (phase 8) has been the focus of significant research.

Scottish independence scenario

The Government of an independent Scotland could set out a plan for disarmament. The steps above provide an example of what could be stipulated. The Scottish Government would be able monitor whether these steps had been verifiably implemented. Practical implementation of the steps would largely be the responsibility of the Remainder of the United Kingdom (RUK).

In the event of a decision by an independent Scottish Government to call for the removal of nuclear weapons there would be no reason for them to delay. There is nowhere for Trident to be moved to.[10] Any postponement would encourage the RUK to put pressure on the Scottish Government in the hope that their policy would change.

The Government of an independent Scotland would be keen to establish positive relations with countries around the world and with RUK. Calling for the rapid de-activation and removal of nuclear weapons is not inconsistent with this. It would be a clear signal that Scotland intended to position itself as a forward-looking progressive member of international society, actively seeking to help the international community to achieve one of its objectives, the elimination of Weapons of Mass Destruction.

Verification

Establishing and deploying an international inspection team could take some time. However, some of the preparatory steps might be taken in advance.

Between 2007 and 2012 the UK and Norway collaborated in joint research into disarmament verification.[11] An underlying principle was the recognition that Non Nuclear Weapon States have a role to play in verifying nuclear disarmament. The scenario in each of the three exercises was the dismantlement of nuclear weapons, similar to what can be carried out at Burghfield. Most of The issues which were addressed during the UK-Norway Initiative would also apply to the earlier steps of dismantling Trident.

If the government of an independent Scotland, or another Non Nuclear Weapon State, wanted to verify disarmament steps, they would require Managed Access. Inspectors, who did not have the appropriate security clearance, would be given limited physical access to the necessary facilities in order to verify that the appropriate measures had been taken. Agreed Information Barriers would be

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[10] Trident: Nowhere to Go, John Ainslie, CND/Scottish CND, 2012.

[11] http://www.mod.uk/DefenceInternet/AboutDefence/CorporatePublications/SecurityandIntelligencePublications/InternationalSecurity/UkNorwayInitiativeOnNuclearWarheadDismantlementVerification.htm

established to protect sensitive information. Security measures and Health and Safety requirements would restrict the inspectors' ability to carry out their work. 100% confidence in verification could not be achieved. The level of confidence achieved would reflect the degree of collaboration between the two sides. This was evident from the third UK-Norway exercise which assumed a level of hostility that had been absent in the first two exercises.