UK Trident targeting and the vulnerability to a US cyber attack

UK targeting and fire control

Key Sites

United Kingdom Software Facility

One of the least well-known, but most important parts of the British Trident system is the United Kingdom Software Facility (UKSF). This is located in an underground bunker at Corsham in Wiltshire. It is the one remaining fragment of what was once a massive underground complex in which the Prime Minister and Queen would have taken refuge in the event of nuclear war. The Ministry of Defence avoids revealing the location of UKSF, although the site was clearly identified several years ago.

UKSF is run by the Strategic Weapons Project Team (SWPT) with support from Mass Consultants. Mass Consultants employ mathematicians and computer programmers at UKSF. The Project Manager for Mass Consultants at UKSF is a former Trident missile officer.

The information which programmes missiles to attack specific targets is generated in the UK Strategic Weapons Targeting System (SWTS) and would be implemented by the Fire Control System on a Trident submarine. UKSF is a critical part of SWTS. It produces the software for the targeting system, using a mix of UK and US components, and it coordinates the computer network over which targeting is carried out.

UKSF also tests the US-supplied software for the Fire Control System and issues it to submarines. UKSF has a Mk98 Fire Control System. This hardware is identical to that on a Trident submarine. Like the submarine hardware, it is purchased from the US. When the Navy is introducing a hardware upgrade, UKSF operates both the old and the new modifications of the system. Personnel at UKSF who work on the Fire Control System software visit the US Navy site at Dahlgren, Virginia, where this software is produced. American technicians from Dahlgren are seconded to UKSF when required.

UKSF are involved in assessing the performance of Trident, including analysing data from missile tests and the detailed electronic logs from each submarine patrol. Personnel involved in this work visit the Applied Physics Laboratory (APL) at John Hopkins University in Maryland. APL has unique expertise in analysing and modelling the performance of Trident missiles. Much of the analysis of the performance of UK Trident is carried out by APL. APL created the Trident Weapon System Accuracy Model which is likely to be a critical component of the UK Strategic Weapons Targeting System and the Fire Control System software on Royal Navy submarines. APL analyse the detailed data logged on each US Navy Trident patrol. They are almost certain to assist the UK in doing the same for Royal Navy patrols.

Nuclear Operations and Targeting Centre

The Nuclear Operations and Targeting Centre (NOTC) is located within the Ministry of Defence.

United Kingdom Liaison Office

At the core of SWTS is a computerised network between UKSF (Corsham), NOTC (London) and UKLO (Omaha). The recent upgrade to SWTS is called the Common Planning System. The term "common" may refer to how it functions across these three sites.

Nuclear weapons effects, performance and effectiveness

The people associated with UKSF have been described as the "CSSE Corsham User Community".[5] Some of those in the Corsham Users Community are expected to have knowledge of three specific aspects of Trident: nuclear weapons effects, performance and effectiveness.[6]

The UK has developed some of its own models of the effects of nuclear weapons, but it also works closely with the US in this area. Research is shared through Joint Operating Working Group 43 (JOWOG 43).

The Corsham personnel with expertise in "performance" are expected to be familiar with the accuracy, reliability and yield of Trident and with nuclear weapon system information. These are areas in which the UK is almost wholly dependent on models and data provided by the US.

Those with expertise in "effectiveness" are expected to know about battle modelling, fratricide and how nuclear weapons interact with their targets and collateral infrastructure. This is another area where UK expertise is limited and the personnel will be largely reliant on US information.

The staff who are "practitioners" in performance or effectiveness produce data files for use in operational planning and studies. Those who are "experts" in these areas certify and approve data files for operational use and studies.

Fire Control System

The Fire Control System (FCS) on a UK Trident submarine processes targeting information and sends instructions to Trident D5 missiles and their nuclear warheads. The FCS handles information on targets and the submarine's location as well as bathymetric, gravity and metrological data. The hardware and software for the FCS on UK Trident submarines is produced by General Dynamics Advanced Information Systems (GDAIS) at the Naval Surface Warfare Center Dahlgren Division (NSWCDD) in Virginia, US. There have been several complete upgrades of the hardware since the FCS was introduced and there are regular software modifications. There are numerous references in US Navy contracts to providing software and hardware for the Trident Fire Control System on UK submarines, including several references to UKSF.

Media Generation System

The US Navy has a Media Generation System (SMGS) at Dahlgren.[7] This formats software and data on shore prior to it being installed in the Fire Control System on a submarine. There is a similar SMGS

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[5] Nuclear Weapons Functional Competence, MOD, 2006. This document is no longer available online. The revised version which is online (Nuclear Competence Framework, MOD, 2012) provides less detail.
[6] These people are described as the "Corsham user community".

The United Kingdom Liaison Office (UKLO) is within the United States Strategic Command (USSTRATCOM) headquarters at Offutt Air Force Base, Nebraska. It provides an interface between the UK and US nuclear targeting systems.

Target planning

In Autumn 2015 an updated UK Trident targeting system entered service. In describing this development, Desider (the internal magazine of Defence Equipment and Support) said that this targeting system was one area "where we have to go it alone". This is very misleading.

The article says that a similar area, where the UK goes it alone, is the nuclear warhead. Far from being an isolated British development, the current UK Trident warhead is very much the product of collaboration over decades between the US and UK. A senior US official described it as a variant of the UK W76 warhead.[1] The MOD has reluctantly admitted that the UK warhead contains at least three components manufactured in the US. Comparing the targeting system with the warhead only serves to illustrate how it is heavily reliant on US support.

While the overall UK Strategic Weapon Targeting System has been pulled together in Britain, it contains vital components which are of US origin. Its development has only been possible because of US support and there is a formal interface with the US targeting system.

In 2006 the junior defence minister Adam Ingram admitted, "The UK shore-based target planning system for Trident is validated through a range of UK and US research programmes".[2]

Soon after the UK decided to move from Polaris to Trident D5, the MOD realised that the complexity of planning attacks with Multiple Independently Targeted Reentry Vehicles (MIRVs) meant that there would need to be closer cooperation with the US on the technical details of target planning. [3]

At the heart of the UK target planning system are a number of complex mathematical models which have been acquired from the US nuclear planning system. These models and the systems that use them are not static, but are subject to regular upgrades. The description of these upgrades reveals the dependence on US software. For example, the US rewrote some of its models into a new computer language, C++ rather than Fortran. Computer programmers at UKSF then had to modify the UK system to accommodate the change.

In the 1980s the US supplied the UK with the footprinting model which calculates the area within which nuclear warheads on a specific Trident missile can be targeted, taking account of range and trajectory.[4] Since 2005 the US Navy has been using a footprinting model which is part of the SLBM Integrated Planning System (SIPS). It is likely that the UK SWTS is based on this and the other modules in SIPS.

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[1] Project On Nuclear Issues interview with Franklin Miller KGB, Special Advisor to President George W Bush & Senior Director for Defense Policy and Arms Control.
[2] Written Answer by Adam Ingram, Hansard 12/10/2006.
[3] Project On Nuclear Issues interview with Franklin Miller KGB,
[4] Project On Nuclear Issues interview with Franklin Miller KGB,

system at the UKSF in Corsham. The US Navy has issued several contracts for work on this UK Media Generation System.

NATO and independent targeting

The British Trident system is designed to be used either as part of a larger NATO nuclear attack plan or independently. Both sets of plans are created within the SWTS system.

NATO plans are deconflicted at STRATCOM in Ohama, Nebraska This is a process which adjusts the use of US and UK forces to reduce mutual interference. For example, the timing of attacks with British and American warheads on targets in the same area will be adjusted to minimise fratricide.

An insight into the integration of US and UK nuclear target planning is provided in two guidance documents from the Chairman of the Joint Chiefs of Staff.

CJCSI 3231.04E shows that, in the case of the use of British Trident in a NATO attack plan, the key targeting data is lifted from STRATCOM's "Sortie Data Manual (NATO)".[8] The information is passed by STRATCOM to the UKLO at Omaha who forward it to UKSF (Corsham) and NOTC (London). The UK has access to this data on a "daily and continuing basis".

This US nuclear planning data has a very high security classification - Nuclear Command and Control Extremely Sensitive Information (NC2 ESI). Information which is classified as NC2 ESI should normally only be handled by US personnel. CJCSI 3231.04E outlines how a sanitized form of this information can be passed to the three locations in the British targeting system.

CJCSI 5220.01A says that the normal restrictions on US nuclear planning information are modified "to permit the release of information to United Kingdom (UK) operational personnel assigned to USSTRATCOM".[9] But the extent of disclosure is controlled – "The number of personnel authorized access to this sensitive information should be limited to those absolutely necessary to carry out the USSTRATCOM mission, including exercises and increased DEFCONs. Briefing and debriefing procedures should be followed for UK personnel being assigned to or leaving these need to know positions."[10]

In the case of a NATO nuclear attack plan, the UK force is heavily dependent on support from STRATCOM. This dependence also has implications for any independent attack. The requirement to process NC2 ESI information will mean that the UK has to be transparent about the SWTS targeting system. So the US will be fully aware of all aspects of the system which Britain might use in an independent attack.

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[7] The S in SMGS is for SCSI (Small Computer System Interface) is most Trident contracts, however in two cases, including one referring to the UK, the S is for Software. Inconsistent use of abbreviations is commonplace in US contract summaries.

[8] Guidance for the sanitization and distribution of information pertaining to nuclear command and control to Supreme Headquarters Allied Powers Europe (SHAPE); United Kingdom (UK) Liaison Office; UK Strategic Weapons Integrated Project Team; and UK Nuclear Operations and Targeting Centre in support of North Atlantic Treaty Organisation (NATO) operations. Chairman of the Joint Chiefs of Staff Instruction, CJCSI 3231.04E, 12 August 2008.

[9] Security classification policy for Multiple Independently Targetable Reentry Vehicles and Maneuverable Reentry Vehicles. Chairman of the Joint Chiefs of Staff Instruction, CJCSI 5220.01A, 1 July 2004.

[10] ibid

Other critical vulnerabilities to US cyber attack in the UK Trident system

Nuclear Warhead Arming, Fuzing and Firing System

The Arming, Fuzing and Firing System (AF&F) in the UK Trident warhead is manufactured in the US. It is a slight variant of the AF&F deployed on the US W76 warhead. The hardware and software in the AF&F are produced in the US. UK Trident warheads are currently being upgraded from Mk4 to Mk4A. The modification programme includes replacing the AF&F with a new US-supplied Mk4A AF&F. The new AF&F has substantially more computer power. It can carry out more sophisticated targeting, andmonitor the status of the warhead.

Nuclear Warhead Intent Word

The new Mk4A AF&F requires a unique authorisation code (Intent Word) before the warhead can detonate. The hardware and software for the UK Intent Word system is produced in the US. The US Navy issued contracts for the development of UK Intent Word and the displays for UK Intent Word as part of contracts for the Trident Fire Control System. [11]

D5 Missile Flight Electronics and Guidance Systems

The flight of UK Trident missiles is controlled by the Flight Electronic System and the Guidance System. These are replaceable components on the missile. The hardware and software in both systems is produced in the US.

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[11] FBM Fire Control Mod 4/5 software, contract N00030 04 G 0046NJ16, 20 December 2004. FY05 Mod 5 UK Intent Word Displays, contract N00030 02 G 0054NJ52, 17 March 2004. US/UK software, fleet documentation and UK Intent Word, contract N0030 04 G 0046NJ41, 20 July 2005.