Aldermaston
- preparing for the next generation of nuclear weapons

The Comprehensive Test Ban Treaty dictates the way that nuclear designers at Aldermaston go about their work. Testing a warhead by blowing it up is no longer an option. Instead substantial scientific resources are dedicated to trying to understand exactly how a nuclear warhead works. This approach is called Science Based Stockpile Stewardship.

Supercomputers

At the centre of the design effort is the production of computer models. These simulate how a nuclear warhead functions. In 2002 Aldermaston installed the Blue Oak computer, with a power of just under 3 Teraflops. In 2006 an order was placed for a new computer with a maximum power of 40 Teraflops. If this machine were in service today it would be the most powerful computer in Europe. And this is only a stepping-stone. Aldermaston plans to have a 100 Teraflop computer by 2010. The US example suggests that they won't to stop there. Thoroughly assessing the reliability of a complete nuclear warhead would require a 350 Teraflop computer.[1]

The Aldermaston computing project is running 4 or 5 years behind its American equivalent. For most of the last decade the biggest computers in the world have been those in the US nuclear-weapon laboratories. The one exception has been the Japanese Earth model, which for a few years was at the top of the supercomputer league. The Japanese Earth model simulates tsunamis and the effects of climate change. The same money, technology and human ingenuity can be used either to prevent disaster or to cause it. It can be applied to understand climate change, or to construct Weapons of Mass Destruction.

Experimental facilities

The computer models are verified by comparing the results of the simulations with experimental data. Laser, hydrodynamic and subcritical tests provide much of this data.

Lasers

Aldermaston are preparing to build a powerful new laser called Orion in a large building within the site. British scientists currently have access to two lasers in the US – the National Ignition Facility (NIF) and the Omega laser facility. The US laboratories primarily use NIF and Omega to understand the secondary (fusion) element of nuclear weapons, although they can support other work. It is likely that the focus of work at Orion will be similar. Its construction is a sign that scientists at Aldermaston envisage that they will continue to support and design high-yield thermonuclear weapons in the future.

Orion will take 5 years to build and commission (2005 site plan)

Hydrodynamic facilities

New hydrodynamic testing facilities are planned as part of the redevelopment of Aldermaston. Hydrodynamic tests analyse how metal responds when explosives detonate next to it. The tests use steel in place of plutonium. The resulting data is illustrates how the primary (fission) part of a nuclear weapon works. The design of any new or modified primary will rely heavily on these tests.

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[1] The basis of the US approach to warhead certification is Qualified Margins and Uncertainties (QMU). The US warhead development plan is to achieve QMU for the W76-1 warhead in 2009. By this time they plan to have a 350 Teraflop computer in service.

Plan to construct a new Core Punch Facility (2005 site development plan)

Subcritical tests

Subcritical tests are similar to hydrodynamic tests, but use plutonium. High explosive is place next to a small quantity of plutonium, which is not enough for a nuclear yield. This device is then detonated in an underground chamber. This provides further information on the primary (fission) part of the warhead.

There have been two British subcritical tests – Etna in February 2002 and Krakatau in February 2006. Both took place at the Nevada nuclear test site in the US and both used devices manufactured at Aldermaston.

Material science

Plan construction of new facilities at Aldermaston and possibly Burghfield (2005 plan)

A45 and Uranium component manufacture

A45 produces the secondary part of the warhead, using Highly Enriched Uranium. First operational in 1957. The area of A45 is shown in the 2005 site development plan as an area where there will be major refurbishment. In addition plans are being drawn up for a replacement uranium component manufacture facility close to the centre of the site (2005 plan)

A90

A90 is a copy of a building in Los Alamos and produces plutonium pits for new warheads. The area of A90 is shown in the 2005 site development plan as an area where there will be major refurbishment. Should have been operational in 1986. Started production in 1997 (Hansard March 1997)

Explosive Handling Facility

A new facility in Aldermaston is planned. This will replace a number of buildings in Aldermaston and Burghfield.

Warhead Assembly and Disassembly Facility

The complex of facilities within the secure area at Burghfield will be replaced with a single new facility. Plans will emerge during 2006. The map indicate that the new facility will be built to the West of the current complex. (2005 plan) This is likely to be an expensive development (original site development plan)

Is Aldermaston designing a new nuclear bomb ?

In response to a question in Parliament, John Reid said that Britain is not designing a new nuclear weapon. However the MoD also say that Aldermaston maintains the capability to design a new warhead, should one be required. When Aldermaston changed hands in 2000 the new owners were asked to come up with a plan of how they would achieve this goal of a new-design capability.

US Developments

The nuclear warheads currently deployed on British submarines are Anglicised copies of the American W76-0 design. Today in the US there are two programmes to substantially modify the W76.

W76-1

The first W76-1 warhead is due to be completed in 2007. This will re-use the nuclear material at the heart of a dismantled W76 warhead, but many crucial components will be replaced with new designs. It will have a new Arming, Fuzing and Firing system, a new Gas Transfer System and a modified high explosive package.

Reliable Replacement Warhead (W76-2)

This is a programme to design a new weapon for the US arsenal. The study is initially focusing on a new plutonium pit for the primary of the W76 warhead. The likely designation of this warhead is W76-2. The new primary could also be used in other warheads.

The new US pit design is expected to avoid using Beryllium, which is a toxic component of the existing W76 warhead and its British counterpart. Beryllium for Trident warheads was originally fabricated at the Atomic Weapons Establishment in Cardiff. When this factory closed, vital equipment was transferred to Aldermaston. Machining Beryllium is a problematic issue for Aldermaston.

The head of Los Alamos nuclear Laboratory has said that data from the British Krakatau subcritical test would be used for the Reliable Replacement Warhead project. He also said he would be surprised if the British were not watching this programme pretty closely.

<u>British plans</u>

When asked about British collaboration with the American W76-1, W76-2 and Reliable Replacement Warhead projects Defence Ministers have refused to confirm or deny their involvement, saying only that they discuss a range of issues with their American counterparts.

In 2000 a British contribution to a US scientific report said that the main objective of the British nuclear weapon's programme was to ensure that the Trident warhead could remain in service for significantly longer than its original planned life.

This emphasis on planning beyond the original lifespan (2025) is revealed in other statements. When quizzed about the Krakatau subcritical test the MoD said their interest was in understanding the effects of ageing on the warhead. Their concern is not just about how the warhead will perform during its planned life, but whether they can continue to use the nuclear components at the heart of each warhead for many years after 2025.

It is unlikely that Aldermaston are seriously considering continuing with the current design as it is. A number of critical components are procured off-the-shelf from the US. These include the Arming, Fuzing and Firing System, the Gas Transfer System and the Neutron Generator. In 2002 a new American model of Neutron Generator began to be installed on British warheads. It is likely that Aldermaston plans to replace several components when new ones become available from the US.

The US Laboratories currently plan to convert only a limited proportion of their Trident warheads to W76-1. They have not yet decided whether to roll out this programme further, or to replace it with the W76-2. The MoD have probably not yet chosen whether they will adopt the W76-1, W76-2 or an alternative. However it is likely that Aldermaston are carrying out initial work on a range of possibilities to keep their options open.

While the emphasis will be on Trident, their work will extend beyond this. One possible option would be to resurrect the warhead design developed for the Tactical Air to Surface Missile (TASM) in the 1980s. This design was tested in the 1980s but never built. One problem is that the US equivalent was also never manufactured.

Production and refurbishment

The original batch of Trident warheads was assembled at Burghfield between 1992 and 1998. However production did not stop then. Aldermaston has manufactured new warheads every year since and plans to continue to do so for many years.

Each year several Trident warheads are returned from Scotland to Burghfield where they are dismantled. Some of the warheads are then rebuild with several components, such as the high explosive, replaced. But other warheads are decommissioned. Their nuclear components are taken apart and analysed. New warheads, assembled from scratch, replace those that have been decommissioned. It is not clear what proportion of returned warheads are replaced rather than refurbished.

The Strategic Defence Review and Parliamentary answers in 1998 showed that at the time there were between 180 and 200 Trident warheads in the stockpile. The total has probably been sustained around the same level since then.

The two main production facilities in Aldermaston are A90 and A45.

New weapons for new roles

The US laboratories are being asked to design weapons that can be used in new scenarios, as well as in an all-out attack on Russia. The new emphasis is on increased accuracy and lower-yield. This is seen as making nuclear weapons more "useable".

There is no clear indication that a lower-yield or variable-yield warhead for Trident is being developed in by the US Laboratories or Aldermaston. However both are probably interested in going down this road. The variable-yield option is more likely as it would enable a smaller stockpile of weapons to be used for a variety of roles.

Lockheed Martin have designed an "Accuracy Adjunct" for the Trident warhead. This was flight tested in 2002 and 2005. It substantially increases the accuracy of Trident by adding flaps to the Reentry Vehicle so it can be manoeuvred. The Accuracy Adjunct was designed for nuclear Trident. Current proposals to arm some US Trident missiles with conventional warheads are based on the same technology. The Accuracy Adjunct would provide the increased accuracy which a lower yield warhead would require. So it is likely that Britain is interested in this.

Expenditure

In 2000 the new operators were issued a contract worth £ to operate Aldermaston over a 25 year period. In 2005 the government announced that an additional £1 billion would be spent on building new facilities over a three year period. If Aldermaston continues to design and produce nuclear warheads then this is likely to involve substantial additional expenditure over many years.

Cost of earlier new facilities £1.2 billion(25 March 2006 Hansard)

The AWE report for 2003 says that cost will affect future developments: "Progress on this plan will depend on affordability, but our determination to see it through is absolute."

An alternative use for Aldermaston

Today a small part of the work of Aldermaston is monitoring observance of the Comprehensive Test Ban Treaty. A report by Pugwash has explained how the resources of the Atomic Weapons Establishment could be diverted away from building nuclear weapons towards verifying nuclear disarmament.[2]

In what scenarios are the new facilities needed

Dismantling Trident tomorrow

If the objectives of Aldermaston and Burghfield became immediate disarmament then there would be no need to proceed with most of the planned developments. While it would be safer to disassemble warheads in a new facility at Burghfield, much of the current stockpile would have been be taken apart in the exising facility before the new one was built. There would be no need for the Orion Laser or Core Punch Facility. If A90 was totally dedicated to dismantlement then it could dismantle both the HEU secondaries and the plutonium pits. This would remove the need for new HEU facilities. Improved facilities would be required for handling nuclear waste. AWE would place its emphasis on developing the skills required for nuclear decommissioning.

Trident remains in service for its original planned life

Trident warheads would all be withdrawn from service between 2020 and 2025. If a new facility was built at Burghfield it would be available to disassemble the warheads. This would take around 5 years after which the facility would be decommissioned.

Both Britain and the US have extensive experience of keeping warheads in the stockpile up to an age of 25 years. If the stockpile were to be retired at this age then the warhead surveillance programme could be substantially reduced. It would be difficult to justify expenditure on Orion and the Core Punch Facility. These would only be in service for around 10 years supporting a warhead with a limited life. If the surveillance programme were reduced then space would be freed up at A90. This would remove the need to construct new HEU facilities.

The life of Trident is extended

The new facilities could be used to substantially extend the life of Trident. The economic viability of this expenditure is greater if the intention is to extend the warhead life by decades rather than by a few years.

New warhead designed and produced

Most of the nuclear tests carried out by the United States were done to develop new weapons. A few warheads were removed from the stockpile and detonated to prove that they work, but this only accounts for a small proportion of all tests.

The Comprehensive Test Ban Treaty has a greater effect on the ability to design new weapons than on the ability to sustain an arsenal and guard against the effects of ageing.

The 2003 AWE annual report says that Aldermaston must "maintain a capability to provide warheads for a successor system should Her Majesty's Government ever require one." The requirement is probably not just to have the capability to design a replacement warhead but also to produce and assemble it.

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[2] Verifying Nuclear Disarmament: A Role for AWE Aldermaston, Tom Milne & Henrietta Wilson, British Pugwash Group, 1999.

The past record of Aldermaston projects

A91

Radioactive Liquid Effluent Treatment Plan. Need identified in 1978. Completed in late 1980s, declared unfit for purpose in 2000. Written off in November 2005 at cost of £147 million. Existing A12N plant continues to be used to process radioactive wastes.

Decommissioning: A37 & A50 currently being decommissioned. A1.1 and parts of A45 being prepared for decommissioning (1998)

Trident warheads can "be maintained in service at least into the 2020s, with some relatively minor upgrading and refurbishment during the first half of the next decade2 – with confidence from new facilities at AWE.

£350 m a year over 3 years - 2005

"it would be premature to abandon a minimum capability to design and produce a successor to Trident should this prove necessary" (MoD memorandum to Def Cmte 19 Jan 06)
"we must also retain a capability to produce a successor weapon if the Government requires this in the future2" (AWE 2004/05 annual report)

Q what is design life of Trident nuclear warhead – A – SDR we needed to ensure we could sustain Trident in-service for up to 30 years. (1994-2224)

Trident warhead expected total lifetime of around 30 years. (2003 & 2005 site development plan). Trident weapon "is likely to remain in service for perhaps up to 30 years" (original site development plan)