Changing the Atomic Weapons Establishment - John Ainslie

The Atomic Weapons Establishment (AWE) is currently embarked on an expensive programme of expansion. This paper raises a range of alternative futures for AWE and considers the potential for diversification.

Criteria that determine the capabilities of AWE

The current and proposed facilities reflect notions of what capabilities Britain requires. These should be questioned.

Number, yield and reliability of nuclear warheads

A critical factor underlying the range and scale of facilities at AWE is the Government's estimate of the size and type of the stockpile. The basis on which the current level of 160 100-kiloton warheads has been determined as the minimum is not known.

Some of the criteria used to determine the scale of the nuclear arsenal in 1978-80 can be gleaned from the archives. Foreign Secretary David Owen proposed that 1 million deaths in the Soviet Union would be sufficient.[1] This was rejected by the Defence Policy Staff. The main criterion for an attack on urban targets was that Britain would require sufficient warheads to cause irreparable damage to 40% of the buildings in Moscow, Leningrad and two other cities.[2] More warheads were needed for the alternative option of destroying National Leadership bunkers.[3] Far fewer warheads would have been required if targets protected by the Moscow ABM system were excluded.

The issue is not just how many nuclear warheads are in the arsenal. A reduction in the required yield would have dramatic effect on AWE. If Britain were to abandon thermonuclear weapons and retain only their fission component then the research and production facilities for the fusion element would no longer be required.

Reducing the reliability criteria would also have an impact. A major ~~justification for~~ current research ~~is the requirement~~ to maintain high confidence that the nuclear warhead would detonate. If the reliability standard was lowered then both research and production facilities could be reduced.

Surety

The RRW design would have introduced Insensitive High Explosive and new Use Control features into a US Trident warhead. These enhanced-surety features would reduce the effect of an accident and make unauthorised use of the warhead more difficult. However this was not the real driver behind the programme. Since RRW was abandoned it has been argued, in the US, that new surety features may only be needed on air-delivered weapons and not on Trident.

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[1] Letter from David Owen to Jim Callaghan, 11 December 1978. Nuclear Papers, David Owen, Liverpool University Press, 2009, page 150.

[2] Factors relating to the future consideration of the future of the United Kingdom nuclear deterrent, December 1978 (Duff-Mason Report) Part 2 Annex Unacceptable Damage; Cabinets and the Bomb, Peter Hennesey, page 324.

[3] The Future of the UK Nuclear Deterrent – A Commentary, 1979, DEFE-25-335-e97(i)

If both probability and consequence are considered, the greatest risk is not from an accident or a terrorist incident but from the deliberate use of nuclear weapons.[4] Building new warheads undermines disarmament efforts, encourages proliferation, and so makes the use of a nuclear weapon more likely. Making new high-surety weapons increases the greatest risk, of nuclear use by a state, in order to reduce the lesser risks, of accidents and terrorism. Measures such as de-mating and dismantling warheads offer alternative ways to minimise these dangers.

The special relationship

Research work at AWE has been heavily slanted by the desire to retain the special relationship with the US nuclear weapons laboratories. This is also true of production technologies. The UK Trident warhead contains at least three components procured from America – the Neutron Generator, Gas Transfer System and Arming Fusing and Firing System. AWE retains the expertise to develop each of these components although they are not manufactured in Britain.

The UK could adopt lower criteria for the yield, surety and reliability of its nuclear weapons than those used by the US. There could be significant reductions in workload and capabilities at AWE if the attempt to keep in step with the American laboratories were abandoned.

Expertise

In the US, the desire to retain and recruit key staff was a primary motive behind the Reliable Replacement Warhead (RRW) programme.[5] Similar arguments are made in Britain - that new programmes are needed to attract and retain staff. But the emphasis should not be on creating projects to keep a very large number of personnel busy, but rather on minimising the workload.

Nuclear Warhead Capability Sustainment Programme

The Nuclear Warhead Capability Sustainment Programme (NWCSP) is a multi-billion pound project of redevelopment at AWE. In July 2005 it was announced that £1 billion would be spent over the coming three years on new facilities and additional staff.[6] In September 2009 a written statement was released saying that the programme had been extended until March 2013 and that expenditure "is valued at an average of around £1 billion per annum".[7] The project is due to continue until around 2020.

NWCSP does more than retain the facilities of AWE at a 2005 level. Many of new facilities are intended to be much more capable than those they would replace.[8] At a minimum the NWCSP

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[4] The probability an accidental nuclear yield of 2kg TNT equivalent in the British nuclear weapons' programme should be greater than 1 in 100,000,000 per year (JPS 538 Regulation of the Nuclear Weapon Programme). The probability of nuclear war from a Cuban Missile Crisis type event has been estimated at between 1 in 5,000 and 1 in 20,000 per year and the overall probability of nuclear war at around 1 in 100 per year (Risk Analysis of Nuclear Deterrence, Martin Hellman, www.nuclearrisk.org).

[5] Interviews with Stan Orman, ex-AWE, and Pete Nanos, Dept of Defence. Project on Nuclear Issues (PONI) http://csis.org/program/us-uk-nuclear-cooperation-after-50-years (audio files no longer online)

[6] Hansard, Commons, Written Answer 19 July 2005, Col 59WS.

[7] Hansard, Commons, 9 September 2009, Col 136WS, Written statement by Quentin Davies.

[8] For example the new Hydrus facility will be far more powerful than the current Moguls hydrodynamic facilities. Project Hydrus and Pulsed Power at AWE. http://tridentreplacement.net/node/1240

programme should be drastically curtailed. There is scope for making substantial savings over the next few years and over the decade as many of the major contracts have not yet been placed.

The purpose of NWCSP is "both to ensure we can maintain our existing nuclear warhead for as long as necessary and to enable development of a replacement warhead should that be necessary".[9] The programme could be reduced if the objective was limited to maintaining the current warhead.

NWCSP was started when it was assumed that the Bush administration would produce the RRW. Statements from US experts show that Britain was expected to develop an equivalent new warhead.[10] This would have led to an unprecedented level of Anglo-American collaboration.[11] In 2004 the Mutual Defence Agreement was amended to facilitate this exchange.[12] However President Obama has abandoned the plans for RRW. It is unlikely that AWE will go it alone and develop a new warhead.[13] One outcome of the US presidential election is that the main pillar supporting NWCSP, the plan for a new warhead, has been removed.

Construction of a new Enriched Uranium Facility (EUF) is scheduled to start in 2011. The main function of this building would be to build the fusion component, the secondary, of nuclear warheads.[14] The case for building EUF would be far weaker if it is acknowledged that there is no plan for a new warhead.

The options study for EUF looked at the possibility of using existing facilities at AWE rather than constructing a new building.[15] Some tasks could be carried out by alternating between work on plutonium and uranium in an existing bay in the A90 facility. Another option was to utilise a laboratory inside Bay 3 of A90 for uranium work.

A new Hydrodynamic research facility, Hydrus, is due to be in service by 2015.[16] Hydrus would use advanced X-ray machines to view dummy nuclear weapons as they implode. The effectiveness and cost of these machines, which are at the forefront of technology, is uncertain.[17] The initial case for Hydrus may have been based on the requirement to model the primary of a future nuclear warhead. Most pits in US nuclear warheads have a potential life of over 100 years.[18] Assuming the current

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[9] Hansard, Commons, Written Answer 1 June 2009, quoting the 2007 pre Budget report, Cm 7227

[10] "They are working on the same kind of thing for their W76 variant" Interview with Franklin Miller, Former Special Assistant to the President for Defence Policy and Arms Control. PONI. "They are involved in our studies examining the Reliable Replacement Warhead approach" Interview with John Harvey, Policy Director, NNSA. PONI

[11] "If the US embarks on an aggressive transformation of the stockpile to smaller, safer, more reliable then that [US-US collaboration] will increase and accelerate". Interview with Glen Mara, LLNL. PONI

[12] The MDA was amended to give the UK access, for the first time, to Use Control information. Use Control was an essential feature of RRW. The amendment was a prerequisite for liaison with the UK over RRW. Interview with John Harvey, Policy Director, NNSA. PONI

[13] "it is much more difficult for the UK to .. go it alone". Interview with Glen Mara, LLNL. PONI

[14] The mission of EUF is similar to the proposed UEF at Y12 in the US and there has been Anglo-American liaison over the two projects. The primary purpose of UEF is the production of the secondaries and radiation cases of warheads.

[15] Enriched Uranium Project, Summary of Findings of Studies Supporting Best Practicable Environmental Option Selection, AWE, September 2006

[16] Hansard Commons 7 January 2008 Col 29W & 30W Written answer by Des Browne.

[17] The 2nd axis for the DARHT facility at Los Alamos, with a similar function to Hydrus, was late and over budget.

[18] Pit Lifetime, JASON study, 11 January 2007, http://www.fas.org/irp/agency/dod/jason/pit.pdf

warhead is retained, it is unlikely that the pit will be modified. So the justification for the expensive new Hydrus facility is weak.

If AWE were to develop a new warhead it could not be tested in an underground explosion without breaching the Comprehensive Test Ban Treaty. The design could only be certified by using complex computer models and related experimental data. AWE have acquired super-computers and intend to build more, as part of NWCSP. The IT capabilities needed to develop a new warhead are far greater than would be required to keep the current warhead in service. There is scope for curtailing the expansion of IT facilities at AWE. Savings can be made by delaying contracts, as the price of super-computers declines over time.

Construction of a new warhead assembly/disassembly plant at Burghfield is scheduled to start early in 2010. The planned throughput of this facility should be curtailed and the number of assembly bays and cells reduced.

Other elements of the NWCSP plan are a new Systems Engineering building and new Materials research facilities. The case for both should be reviewed.

Also hidden within the NWCSP heading is expenditure on the Mk4A upgrade of the current Trident warhead.[19] Sandia National Laboratory have developed a new fuzing system which will make the Mk4A version of the warhead more effective than the original Mk4. In 2007 Des Browne admitted that the new Mk4A Arming, Fuzing and Firing system would be incorporated into the UK warhead. The Mk4A upgrade/refurbishment is probably the main warhead programme currently underway at AWE.

Potential steps for AWE

<u>Step 1 Submarines armed but not on continuous patrol</u>

If continuous patrols were ended the proportion of warheads stored on shore rather than on submarines could be increased, bringing some of the benefits of a de-mated system to part of the arsenal.

<u>Step 2 De-mated Trident system</u>

If all of the warheads were removed from submarines and stored in Coulport there would be safety and security benefits. The danger from loading/unloading missiles at the EHJ would be reduced. All the warheads would be stored in one facility, simplifying security requirements.

There might be less concern about warhead reliability in a de-mated system. It would be easier to carry out non-intrusive surveillance of all the warheads. Detailed surveillance and replacement of Limited Life Components, which are outside the Nuclear Explosives Package, could be carried out on the entire arsenal. The warheads would be stored in an environment which was more benign than a missile tube. Tritium reservoirs could be rotated on a shorter cycle than at present. Replacing tritium is a simple way to improve warhead reliability.

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[19] Expenditure on the Mk4A is included in the AWE costs in the 2006 White Paper on the Future of the UK Deterrent, Hansard Commons 8 December 2009 Col 214W Written Answer by Quentin Davies.

The safety and security hazards associated with transporting weapons by road would be reduced if the warheads were all stored at AWE rather than Coulport. Storing a large number of warheads at AWE would only be possible if a new store was build. In this scenario the day to day security requirements for Coulport could be reduced.

Step 3 Dismantled nuclear arsenal

Dismantling all nuclear weapons and retaining the components at AWE would achieve the benefits of returning complete weapons to AWE. In addition it would reduce the risks associated with refurbishing or replacing warheads. There would be no ongoing risk of an accidental or unauthorised detonation of a nuclear weapon. The high explosive and plutonium pit would be stored separately. There are probably adequate facilities for both at AWE. The secondaries could be stored as complete units or dismantled and their various exotic parts stored separately. There may be a need for improved storage facilities for some warhead components.

Each component could be stored in an optimum environment. This would minimise the risk that they would degrade. Separating the parts would remove the risk of chemicals moving from one component to another, which is currently a major concern. Surveillance of all the individual parts could be carried out as required. It would be easier to carry out surveillance and to identify problems from aging. As a result the reliability of the arsenal might be greater than at present.

Assembling a warhead at Burghfield takes around 3 months.[20] The current assembly facility and its proposed replacement can probably assemble 30-50 warheads per year.[21]

Step 4 Virtual nuclear arsenal retaining AWE

If the components of the current warhead were not retained, AWE could still be kept going to retain the potential to produce warheads. A possible scenario would be to retain the ability to produce, with US assistance, a small number of fission weapons, based on the UK Trident primary, which could be delivered by aircraft. For this a number of key production facilities would need to be retained along with the associated expertise. A new Arming and Fusing System would be required. Production of plutonium pits takes around 9 months.[22]

Step 5 Virtual nuclear arsenal without AWE

Even if the AWE site was decommissioned Britain could still retain a virtual nuclear capability. Japan is considered to be a virtual nuclear power because it has large stocks of plutonium and facilities to enrich uranium. It has a high level of expertise in nuclear power. These materials and skills could potentially be used to produce nuclear weapons. Britain has a large bank of knowledge of how to build a range of nuclear weapons, including data from nuclear tests. Even if AWE were closed down it would be easier for Britain to produce nuclear weapons than it is for Japan today.

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[20] Reply by Dr Tom McLean, AWE, The Progress of the Trident Programme, House of Commons Defence Committee 5th report 1988/89, HC 374, 21 June 1989, page 5.

[21] The new Project Mensa facility at Burghfield is designed to have a similar capability to the old assembly facility. The maximum assembly rate for Trident warheads was probably between 30 and 50 per year at a time when the facility was also refurbishing WE 177 and Chevaline warheads.

[22] Reply by Dr Tom McLean, AWE, The Progress of the Trident Programme, House of Commons Defence Committee 5th report 1988/89, HC 374, 21 June 1989, page 5.

Step 6 Active elimination of expertise and material

A final step would be to go beyond the retention of a virtual nuclear capability and to actively destroy the records of how to build nuclear weapons. Nuclear materials could also be transformed so they could not easily be used for weapons.

While the reduced-readiness options above would all involve programmes to capture and retain knowledge, this approach would involve the opposite. An example was South Africa's destruction of not only its nuclear weapons facilities but also its nuclear records at the close of the apartheid era.

Timescale to restore capability

The following is a rough guide to how long it might take to redeploy nuclear weapons:

	12 warheads	**48 warheads**
a. Complete warheads stored at Coulport	1 week	2 weeks
b. Complete warheads stored at AWE	3 weeks	6 weeks
c. Dismantled warheads stored at AWE	5 months	15 months
d. Virtual arsenal, retaining AWE	2 years	2 ½ years
e. Virtual arsenal, AWE decommissioned	10 years	11 years

In the case of options a, b, and c, this shows the time to arm one submarine. Option a assumes that a submarine is in Coulport ready to be loaded. Option b assumes that a nuclear convoy is available at short notice. The timings would be longer if this logistical support was at a lower state of readiness. In the case of a options d and e the length of time to restore a capability would depend on the sophistication of the type of warhead which was to be produced. The degree of restrictions imposed on Health and Safety grounds would also be a factor.

It is not correct to say that if Britain gave up its nuclear capability then the country could never again be a nuclear weapons' state. The question would be one of affordability. Restoring a lost or reduced capability would require a significant political and financial commitment. The degree of effort put in would affect how quickly nuclear weapons could be deployed.

Transferable skills and diversification

In 2004 the Armed Forces Minister Adam Ingram explained that AWE maintain a dialogue with industry and academia in order to achieve their nuclear weapons' mission and that some of their research could have wider application. He added - "Beyond this, it is not AWE plc's function within its contract with the MOD to diversify out of the core business it is required to undertake." [23]

In June 2008 Ploughshares Innovations, an offshoot of the Defence Science and Technology Laboratory, were asked to develop technology transfer at AWE. Their first task is to raise awareness within AWE of Intellectual Property issues and the potential for wider application of their research. A press release issued at the start of this project showed that AWE has had little experience of

[23] Written Answer by Adam Ingram, Hansard 18 March 2004; This approach is confirmed in Technical Outreach at AWE, September 2008 http://www.awe.co.uk/Contents/Publication/69facf0AWE%20Technical%20Outreach.pdf

transferring their technologies to the outside world.[24] There is a lot of potential for diversification at AWE. Although little has been done at home, the UK has assisted projects to find alternative work for scientists and technicians in the closed nuclear cities in Russia.[25]

In the United States there has been growing interest in changing the focus of Los Alamos, Lawrence Livermore and Sandia Laboratories. The suggestion is that they could function, as their titles suggest, as National Laboratories with a wide security remit rather than just nuclear weapon facilities.[26] Currently the proportion of their budgets dedicated to nuclear weapons' work ranges from 43% at Sandia to 60% at Lawrence Livermore.[27] Most of the additional work is on non-nuclear defence projects. One problem, which could also apply to AWE, is that it has been estimated that research work at the National Laboratories costs an average of two or three times more than private industry.[28]

There is currently a Work For Others (WFO) programme at the US laboratories. This gives government agencies and other organisations access to the facilities and expertise of the laboratories. WFO is also intended to encourage technology transfer from the laboratories to industry. A key motive behind WFO is that this additional work will help the laboratories to retain key skills within their workforce.

A report on technology transfer at Los Alamos Laboratory shows the potential for researchers at the laboratories to support projects other than the production of nuclear weapons.[29] Examples include: nanotechnology with potential applications in solar energy and energy storage; climate modeling of the oceans and sea ice; developing alternatives to oil-based materials; research into AIDS; and satellite imagery analysis following natural disasters.

Areas where the skills required at AWE merge with those required in the wider economy include science, engineering and Information Technology. There are particular overlaps with the civil nuclear industry and with conventional military research and production.

Some of the skills required to produce a fusing system for nuclear weapon are similar to those employed in the development of fuses for conventional weapons. Much of the explosives and explosives-safety expertise in the nuclear weapons programme is applicable to the conventional military sector. It should be possible for AWE to take on more conventional military work or, if AWE were closed, for some key skills to be retained in the conventional defence sector.

Nuclear safety and monitoring skills used in nuclear weapons' production are similar to those in the civil nuclear sector. AWE are currently working on their own decommissioning programme and the skills and technologies involved have potential applications in the wider nuclear industry.

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[24] http://www.ploughshareinnovations.com/news/documents/PSREFundPressRelease.pdf
[25] United Kingdom-Russia Closed Nuclear Cities Partnership, http://www.cncp.ru/eng/eng.shtml
[26] Leveraging Science for Security: A strategy for the Nuclear Weapons Laboratories in the 21st Century, Frances Fragos Townsend, Lt Gen Donald Kerrick, Henry L Stimson Center, March 2009. http://www.stimson.org/cnp/pdf/Leveraging_Science_for_Security_FINAL.pdf
[27] Townsend & Kerrick, page 14
[28] Townsend & Kerrick, page37
[29] Technology Transfer Report 2007/08 LANL; http://www.lanl.gov/partnerships/

A current area of expansion at AWE is Information Technology. Some of these are skills in scientific and engineering modelling, others are in IT itself. In both cases there are substantial overlaps with the requirements from the wider economy. For example the visualisation capabilities, with large screens showing details from complex computer simulations, can be used in the health sector and many areas of industry. The super-computers at AWE and the personnel who programme them could be used for climate modelling.

Current material science work looks at ageing problems with existing materials and the properties of potential replacement materials. There is significant potential to use the same capabilities to develop new materials for the wider industrial world.

Verification and Non-Proliferation

Research related to verification and non-proliferation could be expanded. The UK has already been involved in developing methods and procedures for verifying nuclear disarmament.[30] One focus has been on how to verify nuclear disarmament without compromising security considerations.[31] Radiation monitoring techniques have been developed to detect the presence of nuclear weapons. The UK and Norway conducted a series of joint exercises between 2008 and 2009 to develop ways of verifying nuclear disarmament, with the UK inspecting a mock nuclear weapon facility in Norway.[32] There has been some similar research conducted by the US Laboratories.[33]

AWE has developed capabilities to detect nuclear tests including radionuclide detection stations on four British dependent territories around the world and a seismology team at Blacknest. This work supports the implementation of the Comprehensive Test Ban Treaty.[34]

There is scope for the UK's work on verification and non-proliferation initiatives to be increased. The US Department of Energy budget request for Non-Proliferation work in FY 2010 was $2.1 billion.[35] There is also scope for greater US-UK collaboration in this area. There should be enhanced collaboration into verification and non-proliferation rather than into how to design new warheads.

Summary

The current and planned capabilities at AWE are based on assumptions of the number, yield and reliability of warheads required, along with a desire to increase surety and to sustain the special

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[30] Verifying Nuclear Disarmament: A Role for AWE Aldermaston, T Milne and H Wilson, British Pugwash Group 1999; Road to 2010: Addressing the nuclear question in the twenty first century, Cabinet Office, July 2009, Cm 7675, page 40

[31] A summary report by the Ministry of Defence on the study conducted by the Atomic Weapons Establishment Aldermaston into the United Kingdom;s capabilities to verify the reduction and elimination of nuclear weapons. http://www.mod.uk/NR/rdonlyres/3B3D7417-EAE1-487F-A0BB-891E841FA973/0/nuclearweaponsverification.pdf

[32] Presentation on the UK-Norway Initiative on Nuclear Warhead Dismantlement Verification to the NPT PrepCom May 2009. http://www.vertic.org/assets/Events/090509%20UK-Norway%20Initiative%20Presentation.pdf

[33] Technical Approaches and Information Security, AD Dougan, Lawrence Livermore National Laboratory. http://www.carnegieendowment.org/static/npp/pdf/20090409-dougan.pdf

[34] CTBT radionuclide verification and the British laboratory, C Comley and O Price, Verification Yearbook 2003 http://www.vertic.org/assets/YB03/VY03_Comley.pdf

[35] FY2010 Congressional Budget Request National Nuclear Security Administration, Department of Energy. http://www.cfo.doe.gov/budget/10budget/Content/Volumes/Volume1.pdf

relationship with the US. All of these can be questioned. There is scope for cutting back the multi-billion NWCSP redevelopment plan, particularly if there will be no new warhead. Steps that could be taken to radically alter AWE include de-alerting, de-mating, dismantling nuclear weapons, a virtual nuclear, and finally the active elimination of nuclear expertise. The skills used at AWE are not unique and could be used to benefit other projects. A reduction in AWE's design and production work could be offset by expanding the verification and non-proliferation programme.