# MUST LIFE EXTENSION COMPROMISE RESPONSIVENESS?

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In the 1998 Strategic Defence Review, the UK government made some sweeping choices that shaped the UK's current nuclear policies. It reaffirmed Britain's commitment to maintaining the role of its minimum nuclear deterrent for national security so long as it is needed. It did so while also stating its policy of pursuing the ultimate goal of global multilateral nuclear disarmament and reaffirmed the importance to UK national security of arms control treaties and their effective verification. . This statement of policy was demonstrated by some concrete actions undertaken by the Government: the UK's signature and ratification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) and the retirement of the Chevaline and WE177 warheads[1].

All these activities were made possible by technological advancements made under the science-based stockpile stewardship program or "CTBT Methodology" (O'Nions *et al.*, 2002). While this program has undoubtedly increased the UK's understanding of its nuclear warheads, many have questioned whether the adopted strategy was ultimately degrading the ability of the infrastructure to react to strategic developments, which might be expressed as future government requirements. Several factors prompted these concerns: sustaining the UK infrastructure's human capital and resource constraints. For example, in the late 1990's, because there was only one nuclear weapon system in service, there were significant reductions in the AWE budget and the workforce, to a level of about 50% of the levels of the early 1980s. Were the resources devoted to stockpile stewardship eating away at ability of the broader capability to restructure? Parallels are seen in the United States.

Without reference to such questions, in 2005 the British Government announced significant investment in the Atomic Weapons Establishment. This did not represent any change of policy with regards to the British nuclear deterrent or the role of AWE – maintenance of the Trident Warhead in service and a capability[2] to field a successor warhead if tasked to do so. This paper explores this latest development and whether it can address the previously expressed concerns.

### *The UK's Nuclear Infrastructure*

The UK Atomic Weapons Establishment (AWE) is the national nuclear warhead design and manufacturing complex. Employing some 3600 staff in 2003, it comprises two main sites: Aldermaston[3] and Burghfield, which house the engineering, R&D and fissile component manufacture, and the assembly/ disassembly functions respectively. Uniquely among the nuclear powers, AWE covers the whole life cycle of nuclear warheads, in a single organization. This includes initial concept and design, through component manufacture and assembly, to in-service support and, finally, decommissioning and disposal. The establishment is operated as a Government Owned Contractor Operated (GOCO) enterprise, by AWE Management Limited[4] (AWEML), as a management and operating contractor.

Working under a single output-based contract, AWE's missions are to support the in-service UK Trident warhead; maintain the capability to design, deploy and support a successor warhead if tasked to do so; support the UK government's threat reduction activities[5]; and manage the associated infrastructure, including the legacy facilities through to decommissioning and the stewardship of military fissile material outside of Safeguards.

### *Recent History*

The preeminent task of underwriting the safety and performance of Trident prompted a robust science-based approach of physics methodologies (often referred to as science-based stockpile stewardship or the CTBT methodology) that encompasses a predictive modeling capability underwritten by previous underground nuclear test (UGT) data and above ground science experiments (AGEX), and this naturally extends to the capability to design and underwrite a successor warhead if needed. Although this and other programs maintain certain aspects of the engineering and, to a much lesser extent, integration capabilities, they naturally provide less stretch to the engineering community[6], which faces much the same challenge: to migrate to a model-based (or perhaps biased) predictive enterprise in the absence of a successor warhead project.

### *Issues*

The result of all this is an annually reducing workforce of physics designers and warhead engineers with UGT experience of Chevaline, Trident, and even the extinct Future Theatre Nuclear weapon (FTNW) projects, together with a lack of inspirational focus (that a successor project would bring). Some potential successor capabilities have been intentionally "gapped" – a process of reducing the immediate AWE capacity (e.g. to "Intelligent Customer" status – see below). Through this process, some capability may have been inadvertently lost, having not been tested well for a decade, and modern standards (e.g. safety and security) and political context (e.g. the combination of the need to tackle perceptions of self-deterrence and limit any collateral damage of any proportional sub-strategic use) of any successor system create a new set of design constraints and challenges that would be faced.

Fortunately there has been a wide consensus within the British nuclear policy and technical community on the subject of gapping, that key capabilities should not be totally gapped, but there does remain a question mark over certain areas where knowledge management and reduced program activities began to supplant stretching and testing project work.

### *Objectives and Measures*

The objectives set for engineering capability areas, such as the nuclear physics package and non-nuclear components are set using a simple framework at AWE:

- Supplier Authority
- Expert Customer
- Intelligent Customer
- Procurement Agent

For *Supplier Authority* status AWE would be able to specify, design, manufacture and support in service a component or sub-system; for *Expert Customer* status AWE would be able to specify and design items for manufacture by others; as an *Intelligent Customer* AWE would be able to specify requirements and understand the design issues and processes; and as a *Procurement Agent* AWE would rely heavily on a supplier.

Although it is inappropriate to go into details in this paper, to illustrate the point, it can be seen that as the Trident delivery system and non-nuclear components were procured under the Polaris Sales Agreement (as modified for Trident) from the US6, the AWE organizational competency levels required to procure for any successor system could be very different.

*Strategies*

The challenge falls first to the UK Ministry of Defence (MoD): to be able to specify and manage user requirements and maintain AWE capability for the current and future security environments. The strategy of turning the management of AWE over to a managing and operating contractor in 1993, which began its second cycle in 2000, created an innovative environment, which has helped put Trident into service and maintain successor capability against a backdrop of declining annual budgets. The contract let in 2000, an evolution of the concept, was structured to protect science programs and was extended from ten to twenty-five years, bringing the possibility of the use of private finance to accelerate capital infrastructure improvement programs.

However, it is a real challenge to set objective tests against the objectives' framework set out in the contract and its annual output specifications. Recent approaches, related to systems engineering and integration, have been limited by resource and policy constraints, but include foundation technology maturation and periodic integration of sub-systems as 'technology vehicles' (TVs) and much less frequently into 'system technology vehicles' (STVs). The latter is focused on exercising engineering processes rather than developing technology. To an extent such activities can be evaluated through internal peer review and through the UK-US 1958 Mutual Defence Agreement by the US National Laboratories. This has been augmented by the creation of unclassified test assemblies that contain many of the engineering features that would be found in warhead assemblies. One such item 'MACE', a modal test assembly, has been used to exchange data and analysis between AWE and both US National Laboratories and universities.

AWE engineers and scientists are encouraged to become involved in the development of modern standards (e.g. nuclear safety and security requirements) that would affect any future warhead design activity. Paper impact studies are conducted from time to time. Conceptual design exercises and technology and systems technology vehicle design exercises would take these into account.

As the true ability of the capability of AWE to field a successor system would not be fully tested until called upon, perhaps under demanding time constraints, other strategic interventions have been added to the program. These include the Aldermaston Discretionary Research Fund (ADRF) and the AWE Outreach Program. The ADRF gives researchers and technologists the freedom to explore their own ideas (off the program axis), so that challenging tasks related to the Trident or any successor project can be staffed by problem solvers in the right general fields. The Outreach Programme is a multidimensional strategy that provides additional depth of expertise, improved access to new recruits, breath of opportunity for AWE staff, peer review and support for academic and professional development.

Prior to 2005 the program containing the above approaches were described by some as a graceful exit strategy. On the other hand the program encompassed some world-class elements that kept AWE as an intellectual peer with the United States in key areas and preformed the mission of underwriting Trident in service. Thus, the strategy could be viewed as a success. But at what cost or risk? Indefinite progression along 1993-2005 strategic trajectory would eventually challenge the viability of the British warhead complex.

***The 2005 Statement and what it meant***

In July 2005, the British Government announced a three-year, circa £1b ($1.75b) investment program in AWE infrastructure (*Hansard*, 2005a and 2005d). This announcement was the result of studies, reviews and negotiations that had begun sometime after AWE Management Ltd. (AWEML) was awarded the managing and operating contract for AWE in April 2000 (*Ibid.*). The associated MoD press statement (reproduced as Annex A) states "The package will enable AWE to take forward a program of work aimed at sustaining key skills in the AWE workforce and modernizing some of its core research and manufacturing facilities, including the provision of some extra supporting infrastructure." It also disassociates the funding from any decision on the future of Trident –"this is required irrespective of decisions on a successor warhead." However, in the absence of this funding, it might be reasonable to assume that intellectual and infrastructure capabilities future options would have been more limited or less credible. In October 2005 John Reid, the Secretary of State for Defence put the investment figure at nearer £2b (McSmith, 2005) over the next three years, more than trebling the AWE budget by the end of the third year. The November 29, 2005 ministerial statement broke down the budget as follows, "around 45 per cent. is capital costs, principally on new facilities including the new Orion laser, and around 55 per cent. is operating costs". The 2005-6 UK defence budget is £30.8b ($53.5b)[8].

No details of the funding breakdown were given at the time, but various statements made in Parliament (*Hansard*, 2005c and 2005d), by MoD and by AWE, together with press comments provide some further information: In its *Site Development Strategy 2005*[9] AWE set out plans for modernization projects in four areas of research: laser physics, hydrodynamics, materials science and high performance computing. The use of these technologies in the post-underground test (UGT) era is comprehensively discussed by O'Nions *et al* (2002). A Select Committee on Defence (2005) report provides some additional commentary on the rationale for the investment and additional contents of the program.

*Orion Laser*

First publicly mooted in AWE's 2002 annual report[10], AWE described its new laser project (Project Orion) in *Discovery* (2005)[11]. It will be of a revolutionary "short pulse long pulse" design – a very efficient way of getting the temperatures and energy densities of interest. The media price the project at £100m ($175m). The British Government stated, "[its] primary role will be to enable the safety and reliability of the Trident stockpile to be underwritten through the remainder of its service life" (*Hansard*, 2006). The facility is seen as a key gravity point to attract scientists to AWE in addition to its intrinsic ability to recreate the plasma temperatures and densities that occur during the detonation of nuclear warheads

(Sample 2006a). Orion will replace AWE's HELEN laser, which has been operating for 25 years.

*Hydrodynamics Research Facility*

Hydrodynamics facilities and their associated pulse-power flash x-ray machines are needed, as described in the following terms in the obituary of Charlie Martin CBE, one of the great pioneers of pulse power, "Nuclear weapon designers need pulsed power to provide the energy for flash radiography, whereby they can photograph inside a warhead and verify the way its 2,000 parts have been assembled. It has also been needed increasingly to verify the integrity of the nuclear stockpile since atomic testing was abandoned." (Fishlock, 1999). AWE proposals for a new hydrodynamics research facility[12] are set out on the AWE web site. These include multi-axis flash x-ray machines and a containment facility. The web site also describes the three key hydrodynamic activities used to underwrite warheads: tamper movement trials, core punches and shock studies. The author found no public evidence of progress on implementation of this proposed project beyond the select committee memorandum (*Op. Cit.* 2005), which said that concept and feasibility studies are to be taken forward on facilities for hydrodynamic experiments.

In addition to the hydrodynamics facilities at AWE, which are capable of firing contained subcritical experiments on fissile materials (O'Nions *et al.*, 2002), AWE conducts similar tests at the U1a facility in cooperation with the US National laboratories at the Nevada test site (Nevada Site News Office, 2006 and Sample, 2006b). Owing to the time it takes to plan and prepare from such work, it is unlikely that the increased funding could have prompted this work.

*Supercomputer*

On 8 February 2006 AWE announced the order of Europe's biggest supercomputer[13], costing approximately £20m ($29.25m). Such AWE computer facilities are used for predictive science-based modeling of, for example aging effects and accident conditions for warheads. The above ground experiments (AGEX) in the areas of hydrodynamics and laser physics and archived underground test data are key to validating these supercomputer codes.

*Materials Science*

The AWE sites development plan[14] lists the following material types as warhead materials: metals, inorganic salts, rubbers, foams, adhesives, high explosives and radioactive materials. The plan goes on to say that AWE will be consolidating materials facilities in a few state of the art facilities. Again there has been no further public statement on this topic.

*Manufacturing, Assembly and Disassembly Facilities and Other Facilities*

The Select Committee Memo (*Op. Cit*.,2005) testifies that 80% of AWE's infrastructure was built before 1960 and is increasingly expensive and inefficient to operate. Much of this includes basic infrastructure including heating and electrical systems and office accommodation. The memo states that a great deal of the additional investment will focus in this area. In addition, it highlights the need to replace, refurbish or modernize some of the basic assembly / disassembly and manufacturing facilities at Aldermaston and Burghfield, including those that handle high explosives, highly enriched uranium and warhead non-nuclear components.

**Table 1 AWE Notices of Proposed Development**

| Date Reviewed | Application No. | Facility | Notes |
|---|---|---|---|
| 17 December 2003 | 03/02313/OUT & 04/00945/OUT | Proposed New Laser Facility (Outline) | No objections raised |
| | | | |
| 23 February 2005 | 04/02977/FUL | Temporary Module Buildings | No objection raised |
| 23 February 2005 | 04/02978/FUL | IT Service Stations | No objection raised. Letter sent to the secretary of state urging that an environmental impact assessment be undertaken for the whole AWE site development plan |
| 21 September 2005 | 05/01646/OUT | 4 Temporary Module Buildings (office accommodation - Site C) | Approval of exterior design and materials - no objections raised |
| 23 November 2003 referred to 25 January 2006 | 05/02003/RESM-AJ | Proposed New Laser Facility (Orion) | Resubmission, treated as a new submission including an environmental impact statement |

*Progress with AWE Infrastructure Development*

Until recently, as AWE is on Crown land, in lieu of local planning review, AWE deposited Notices of Proposed Development with local authorities – West Berkshire Council in the case of Aldermaston. If there is significant local opposition or specific concern about a particular development, such applications could have been referred to the Deputy Prime Minister (the responsible Secretary of State for planning review), who could initiate a public enquiry. These notices provided further detail of capital infrastructure development projects at AWE. Such notices were discussed with the local community during AWE Local Liaison Committee Meetings. Table 1 shows the notices relating to Aldermaston reviewed to 30 March 2006. From 1 April legislation removed Crown Immunity from such development projects, which now are required to undergo planning review, like any other proposed development.

*Operational Programs*

There is no public information about the use to which the increased operational funds will be put beyond, "…aimed a retaining key skills…". It would be reasonable to expect that they will be applied across the board – stockpile management and surveillance, stockpile stewardship, facilities maintenance, decommissioning, threat reduction and successor capability maintenance. The emphasis being the bolstering of the Trident mission with the last reinforcing the suite of activities that should allow AWE to design and put into service a future warhead if tasked to do so.

*Intellectual Investment*

Addressing a key concern, the additional investment in the development of the human capital is central and complementary to the facilities' modernisation. Indeed, Sample (2006a) observes that modern facilities play an important role in attracting and retaining young scientists.

In the absence of a new design and procurement project the effects of increases in the workforce are best measured through simple metrics such as headcount, demographics (age and years' experience in the business), turnover trends and publication rates combined with scientific peer review from academia, industry and the US National Laboratories. It has been clear from the press (including job advertisements from AWE) that AWE is taking on many new technical and scientific recruits. The Select Committee Memo. (*Op. Cit.*, 2005) puts the increase at a rate of some 350 per year until 2007/8, which would represent an additional 20 per cent of the workforce. The memo goes on to say that these will be split roughly 70 per cent. "nonindustrial" (i.e. scientists, professional engineers and administrative support staff) and 30 per cent. "industrial" (technician, skilled and semi-skilled craftsmen, process workers and unskilled employees). Competency matrices, where skills are scored according to knowledge and experience, are used to set targets for the intellectual capability requirements and to record progress against the targets.

In addition to these new employees AWE is reportedly taking on a large number of contractors. Key strategic relationships have been agreed with Jacobs Engineering, which has been contracted to be the managing agent for the infrastructure investment program at AWE under a three-year contract[15], and WS Atkins and Mott McDonald, both engineering consultants. Akins will take a "Design House" role with the recently awarded contract, which is expected to bring their resident workforce up to 450 engineers[16].

***Discussion***

The recently announced investments will surely put the British capability to maintain and underwrite Trident into the future and to field a successor warhead if required on a much firmer footing than before. However, current policy and practical constraints on AWE are likely to mean that successor capability programs will not be exposed to genuine systems issues that are likely to be more demanding, this does not mean that AWE's responsiveness is currently eclipsed by the Trident mission. Even with additional funding, there is a limit to how far successor capability programs can go. Current policy aside, the challenges of providing a more realistic environment for warhead concept and design studies could be prohibitively costly for a capability program. Realistic system studies such as the U.S. Reliable Replacement Warhead (RRW) – taken to a level of maturity that could proceed to development and deployment – in a U.K. context would require support from industry in areas where there are presently no working relationships.

Finally, the wisdom of any such further investment, even if affordable, could be challenged. Observers of the British nuclear complex and associated British policy will continue to ask questions: How realistic is a future British nuclear weapon system procurement project that departs from the "Trident procurement model"? How definitive was the decision in 1980 (made after the costly Chevaline upgrade to Polaris) for Britain never to go it alone again? Is there a case for U.K. involvement in the RRW design competition? And if the U.K. were to seek involvement would the U.S. be receptive to the idea?

***Conclusions***

In answer to the title question, it can be concluded that the *balanced* additional funding for investment in human capital and modern facilities will go a long way to improving the responsiveness of AWE, while bolstering the ability to maintain and underwrite Trident in service. But in the absence of a procurement project for a new weapon system and warhead, the artificialities of certain aspects of the AWE capability (particularly systems engineering and warhead integration) are likely to leave some capabilities relatively untested. This is likely to increase the technical risk and hence the development time and cost of any future British deterrent.

However, in an era that requires policy makers to better balance and manage risk, these decisions may be entirely appropriate. Some have observed that the most credible options for any future warhead for any future British deterrent system are refurbishment or remanufacture of the UK Trident warhead or development of a British design compatible with the US Trident missile and related technologies. Therefore a future project perhaps would not rely too heavily of these skills if the 'Trident procurement model' were extended beyond the current weapon system configuration. There are many questions left to be explored.

## *References and Bibliography*

*Discovery*, 2005. 'Project Orion – unique new laser facility for AWE', *Discovery*. Issue 7, p.2-3.

Fishlock, D., 1999. Obituary: Charlie Martin, *The Independent*, April 8 1999.

*Hansard*, 2005a. 3 Mar 2005: Column 1343W

*Hansard*, 2005b. 19 Jul 2005: Column WS71

*Hansard*, 2005c. 28 Nov 2005: Column 123W

*Hansard*, 2005d. 29 Nov 2005 : Column 334W

*Hansard*, 2006. 6 Feb 2006: Column 825W

McSmith, A., 2005 'Revealed: Blair's Nuclear Bombshell', *The Guardian,* October 17, 2005

Nevada Site News Office, 2006. 'Krakatau Subcritical Experiment Conducted', *Nevada Site Office News*, 23 September 2006.

O'Nions, K., Pitman, R. and Marsh, M.C., 2002. 'Science of nuclear warheads', *Nature*, 415, 853-857, 21 February.

Sample, I., 2006a. '£100m laser project will mimic nuclear explosion', *The Guardian.* 20 January 2006

Sample, I., 2006b. 'Is Britain conducting nuclear tests?', *The Guardian.* 25 February 2006

Select Committee on Defence, 2005. 'Investment at the Atomic weapons Establishment', *Select Committee on Defence Memorandum*, November 2005.

West Berkshire Council, 2003. *Circular 18/84 Notice of Proposed Development for proposed laser research facility (outline).* http://www.westberks.gov.uk/

West Berkshire Council, 2005. *Eastern Area Planning Committee Minutes of the meeting held o 23 February 2005, at The Cornwell Centre, Tilehurst.* http://www.westberks.gov.uk

West Berkshire Council, 2006. Eastern Area Planning Committee Minutes of the *Meeting held on 25 January 2006 at the Calcot Centre, Calcot.* http://www.westberks.gov.uk

Youngs, T. and Taylor, C., 2005. *Trident and the Future of the British Nuclear Deterrent,* House of Commons Standard Note SN/IA/3706

[i] Decisions on any replacement for Trident are likely to be needed during this Parliament, but have not yet been taken. Until then, the MoD will continue to take appropriate steps to ensure that the range of options for maintaining a nuclear deterrent is kept open.

[II] Today's announcement of planned investment is required to sustain the existing warhead stockpile in-service and this is required irrespective of decisions on a successor warhead.

[III] The Defence White Paper 'Delivering Security in a Changing World: Future Capabilities' made clear last July the Government's commitment to maintaining the effectiveness of the nuclear deterrent, including making the necessary investment in facilities at AWE.

[IV] The package will enable AWE to take forward a programme of work aimed at sustaining key skills in the AWE workforce and modernising some of its core research and manufacturing facilities, including the provision of some extra supporting infrastructure. Local Planning Authorities will be consulted on this work in the normal way.

[V] For further information, call Miguel Head in the Defence Press Office on 020 7218 7931.

[1] Chevaline was the UK upgrade for the Polaris submarine launched ballistic missile system; it entered into service in 1979. WE177 was a Royal Air Force and Royal Navy free fall bomb.

[2] Successor *capability* is here defined as the people, facilities and data necessary to design , underwrite and deploy a successor warhead if tasked to do so.

[3] During World War II an airfield was built on the Aldermaston site, which was used by the United States Army Air Force for glider operations on D-day.

[4] AWE plc is its wholly owned employment company. Trading as AWE, it is owned by three equal equity partners: British Nuclear Fuels Ltd., Lockheed Martin UK Ltd. and Serco Defence Ltd.

[5] The AWE Threat Reduction Programme provides technical advice to the defence intelligence community, treaty verification support, advice and research and an organization crisis and consequence management response capability.

[6] Physics methodologies favor "near neighbour" designs, i.e. close to designs previously underwritten through UGT experiments – this constrains the design space and hence the engineering freedom.

[7] Often called "the Trident procurement model".

[8] Defence News, 'Interview: Lord Drayson' 13 March 2006

[9] http://www.awe.co.uk/Images/New%20Site%20dev%20plan%2002b_tcm6-4092.pdf

[10] http://www.awe.co.uk/Images/annual_report_2002_tcm6-1762.pdf

[11] http://www.awe.co.uk/Images/Iss7.orion_tcm6-2519.pdf

[12] http://www.awe.co.uk/main_site/scientific_and_technical/featured_areas/hydrodynamics_contents/hrf/index.html

[13] http://www.awe.co.uk/main_site/news/articles/NI_2006_036.html

[14] http://www.awe.co.uk/Images/New%20Site%20dev%20plan%2002b_tcm6-4092.pdf

[15] Press release, 'Jacobs receives contract from AWE'. http://www.jacobsbabtie.com/company/1-2-2_newsstory.aspx?id=165&s=204&sm=0&c=1&d=1550

[16] Press release, 'AWE awards major Design House contract to Atkins'. http://www.atkinsglobal.com/news/25360/5801899_Internet