GREENPEACE UK 1991

NUCLEAR FREE SEAS CAMPAIGN

Report on

THE PROBLEMS OF THE TRIDENT PROGRAMME

Report, together with relevant references and appendices

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GREENPEACE UK REPORT

The Nuclear Free Seas Campaign of Greenpeace UK has prepared the following Report:–

THE PROBLEMS OF THE TRIDENT PROGRAMME

PART I

INTRODUCTION

1. It has been the practice of the House of Commons Defence Committee to scrutinize the progress of the Trident Programme on an annual basis. This year Greenpeace has decided to make its own assessment of the Trident Programme. The following report is based upon a careful study of informed sources, including Defence Committee Reports and Proceedings.

2. One justification for the continuation of the Trident Programme has been that most of the money has been spent. This is not a sound basis on which to pursue policy, as the Ministry of Defence (MoD) have already conceded. Earlier this year, when explaining why two nuclear submarines were refitted almost to the point of completion and then scrapped (at a cost to the taxpayer of over £175 million), the MoD stated that, in the words of the Deputy Under Secretary of State (Policy), that the Ministry:

> "obey the old economist's maxim 'When it comes to taking a decision about what you will and will not do, you should let bygones be bygones' ... we obviously regret that we spent this money but it does not follow that, because we spent it, we should carry on regardless spending the future sums available to us."[1]

The justification for continuing with *Trident* because most of the money has been spent is also invalid because it refers only to the capital costs. In this report we have identified the true costs of *Trident*, which include some unattributed capital costs, running costs and post-lifetime costs. Scrapping the *Trident* programme now would save at least £10,676 million on the running costs and post-lifetime costs alone. That is £813 million more than the current estimate for the capital costs.[2] Up until the time when the PWR2 nuclear reactor cores are installed in the *Trident* submarines and become critical, cancellation would render each submarine, at worst, so much highly expensive scrap metal. Once the reactor cores become critical, the submarines will become a radioactive liability, and the environmental and fiscal costs of operating, maintaining, and ultimately disposing of them will have to be borne by this and future generations.[3]

3. The first Trident submarine, HMS VANGUARD, will not be launched from Vickers Shipbuilding and Engineering Ltd (VSEL) at Barrow-in-Furness until at least December this year. This report looks at the stages through which VANGUARD must pass before it will be ready for patrol. We conclude that, if HMS VANGUARD is to meet its in-service target date of December 1994, there will be little or no margin for error.

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[1] HC 69 of Session 1990-91, pxvii, paragraph 44.

[2] See Part II, Costs.

[3] The PWR2 reactor core has already been installed in HMS VANGUARD. However, until it reaches criticality, radioactive contamination of the submarine's systems will be minimal, meaning that decommissioning, storage and disposal costs would be less. In the *Polaris* programme, criticality of the reactor cores was not achieved until sea trials commenced ("Royal Navy Requirements and Achievements in Nuclear Training, Part 1", *Journal of Naval Science*, Vol.4, No.3, July 1978, p162).

4. Previous Defence Reports have consistently referred to the many difficulties and delays during the construction programme for Trident. Our report considers three major outstanding problems: the submarine's Tactical Weapon System; the explosives handling jetty at Coulport, and the A91 radioactive waste management facility at Aldermaston. The A91 problem could give rise to considerable delays in the operation of the A90 warhead production facility.

5. The target in-service date of HMS VANGUARD indicates how long the Government intends to keep the present Polaris submarines in operation. They have stated that it is their intention to keep the last Polaris boat in service until the third Trident submarine is ready for patrol, this could be as late as 1998. Two previous Greenpeace Reports have demonstrated major health and safety concerns about the ageing Polaris fleet, and have called for the immediate withdrawal of all Polaris submarines from service.[4]

6. Recently the world has seen the most significant changes in international relations for 45 years. Yet in the United Kingdom there is virtually no debate about why we are maintaining and building, at vast cost to the taxpayer and the environment, a nuclear weapons system born out of the Cold War and targeted on Moscow. Greenpeace calls for the immediate cancellation of the Trident Programme.

[4]Large & Associates, *Reactor System Defects in Royal Navy Nuclear Powered Submarines - Cause and Strategic Deployment Aspects*, Ref. No. LA RL1956-C, Greenpeace UK, London, 4 December 1990; Greenpeace UK, *Bring Polaris Home*, Greenpeace UK, London, May 1991.

PART II

COSTS

7. On 12 February 1991 the Secretary of State for Defence announced that his revised estimate for the cost of the Trident Programme was £9,863 million at 1990-91 prices [5], covering a period of expenditure from 1980 to 2000.

8. In the following section all costs have been converted to 1990-91 prices, unless specifically stated otherwise - that is, all costs are expressed at the same value as the current Ministry of Defence estimate.

9. There are a number of problems in identifying the true costs of the Trident Programme, because official estimates do not include certain expenditure, including:

(i) items which are excluded from the estimate but which are necessary for the Trident Programme to proceed;

(ii) the lifetime running costs of the Trident strategic nuclear force, along with the necessary infrastructure;

(iii) the post-lifetime costs of the Trident fleet itself, including the costs of submarine decommissioning and disposal.

Items excluded from the estimate

10. Some expenditure associated with the Trident Programme is excluded from official estimates because the work or facilities may be shared with other programmes (for example, the replacement programme for the ageing WE-177 nuclear free-fall and depth bombs, and facilities at Faslane which will be used by other submarines as well as Trident). In these cases the MoD either attributes none of the cost to the Trident Programme, or describes the work as "Trident-related", and attributes only part of the cost to Trident.

[5] House of Commons Deposited Paper 6739, 12 February 1991.

TABLE I

Trident Costs Not Included in Programme Estimates
(all at 1990/91 prices)

	£ million
Development of PWR2 nuclear propulsion plant (see Evidence, p1)	500
Aldermaston works (see Evidence, p1)	1,331
Faslane Works (see Evidence, p1)	350
Clyde Submarine Base externals, (roads & services) (see Evidence, p2)	2
Rosyth Work (see Evidence, p2)	326
VLF communications improvements (see Evidence, p2)	31
Total readily identifiable additional costs	2,540

Lifetime costs and post-lifetime costs

11. On the subject of the annual running cost of Trident, the Government have said:

> "It is too early to say with any precision what the likely running costs of the *Trident* force will be. They are not, however, expected to be significantly different from those of *Polaris*."[6]

The annual running cost of *Polaris*, including all support and ancillary services, has been given as "around £250m a year at 1984/85 prices".[7] This would give an annual running cost for the *Trident* force of £354 million a year at 1990/91 prices.

12. If each Trident submarine is in service for 7 years between refits[8], and each submarine is refitted three times, the life span will be approximately 30 years[9], leading to a figure for the lifetime running cost of Trident of £10,620 million.

[6]*Official Report*, 21 March 1990, col.638W.
[7]HC 479 of Session 1984-85, pxxi, paragraph 45.
[8]HC 479 of Session 1984-85, pxxiv, paragraph 57.
[9]If HMS VANGUARD is launched in 1992 (entering service in 1994), assuming 7 years between refit, each refit lasting 2 years, the submarine would come out of service in 2024, a service life of 30 years.

Decommissioning costs

13. The Royal Navy has little experience of decommissioning and disposing of nuclear-powered submarines. To date, only one submarine, HMS DREADNOUGHT, has been through the full decommissioning process. It is currently stored afloat at Rosyth, and no decision has been taken on a method of disposal or long-term storage. If the Trident submarine fleet were to follow the same procedures as DREADNOUGHT, it is likely that a long period of storage afloat would be envisaged.

14. The cost of decommissioning a nuclear-powered submarine, not including the cost of storage afloat, has been given as £10-12 million for each submarine, with further maintenance every 10 years at a cost of £2 million.[10] If a submarine is stored for, say, 30 years, the costs would be in excess of £14 million for each submarine. Costs for disposal or long-term storage cannot be calculated until the Government decides on which method to use.

TABLE II

Identifiable Lifetime and Post-Lifetime Costs for Trident

	£ million
Lifetime running costs	10,620
Decommissioning costs	56
Total	10,676

15. Therefore, to arrive at a more accurate figure for the overall cost of Trident, we must add the identifiable additional unattributed costs of £2,540 million (see Table I), and the identifiable lifetime running costs,and post-lifetime decommisioning costs of £10,676 million (see Table II), to the Secretary of State's 1991 estimate of £9,863 million. This would make the total cost of the Trident Programme £23,079 million.

Savings if SSBN 08 is not ordered

16. If the Government were to decide not to order the fourth Trident submarine, SSBN 08, the savings listed in Table III could be made. Savings from reductions in support services and infrastructure would be minimal, as these would have to be maintained for three Trident submarines as much as for four.

[10]HC 369 of Session 1990-91, "Declassified extracts from evidence previously submitted by the MoD", p64.

TABLE III

Potential Savings from Cancellation of SSBN 08

	£ million
Cancellation of SSBN 08	400-450[11]
Lifetime running costs of SSBN 08 (approx.)	846[12]
Savings on disposal costs	14
Total overall saving	1,260-1,310

Savings if the *Trident* Programme is cancelled

17. If the Trident Programme were cancelled tomorrow there would be substantial savings, over and above the savings on SSBN 08, in capital expenditure.[13] There would also be savings of at least £10,676 million in the running and decommissioning costs. This is £813 million more than the Government's current estimated capital expenditure on the Trident Programme.

18. We have shown that the "most of the money has already been spent" argument is untrue. We have also shown that overall savings of £1,260-1,310 million could be made by not ordering, the fourth Trident submarine SSBN 08, and savings of least £10,676 million by cancelling the entire Trident Programme. Our assessment of the potential savings is, if anything, conservative, due to lack of evidence for some costs.

[11]Verbal evidence given by MoD to House of Commons Defence Select Committee, 6 March 1991 (not published).
[12]The annual running cost of a *Polaris* submarine was given as £11.7 million at 1989-90 prices in *Official Report*, 21 March 1990, col.638W. To this must be added the cost of three refits at £156 million each, giving a total of £846 million.
[13]In 1990 the Defence Committee were informed that by the end of March 1992 £5256 million, in 1989-90 prices would have been spent. It would be extremely difficult to attempt to estimate savings in current capital expenditure at the present date. This is due to the many "break" (or penalty) clauses included in many of the contracts already placed for major items of *Trident*-attributed and *Trident*-related expenditure.

PART III

EVENTS IN THE UNITED STATES: MISSILES

19. A number of factors have led to safety concerns and delays in the Trident II (D5) missile development programme. A series of test failures involving the Trident II (D5) missile in 1989 have led to a redesign of the missile's first-stage motor[14], although there is some doubt whether this problem has yet been solved.[15] Severe criticisms of the safety of the US Trident II (D5) missile[16] have led the US Navy to consider changing the missile's propellant to a less volatile version.[17] Other studies are examining possible safety modifications to the United States' W-88 warhead for Trident II (D5).[18] Any design changes to the US missile system could result in a further delay in the UK missile procurement schedule, and increased unit costs.

[14]Evidence, p 3, paragraph 2-4.
[15]Evidence, p 3, paragraph 4.
[16]Evidence, p 4, paragraph 11.
[17]Evidence, p 4, paragraph 11.
[18]Evidence, p 4, paragraph 11.

PART IV

COMPOSITION OF THE PROGRAMME

SUBMARINES

20. Three Trident submarines, SSBN 05, HMS VANGUARD, SSBN 06, HMS VICTORIOUS and SSBN 07, HMS VIGILANT, are under construction at VSEL. No order has been placed for the fourth Trident submarine, SSBN 08, to date.

21. The projected launch date for VANGUARD is December 1991.[19] After launch, the submarine must undergo a sequence of contractor's sea trials lasting about 2 months, then a period at VSEL prior to commissioning. Following commissioning will come Royal Navy acceptance trials lasting a few weeks. After this, a long period of sea trials will take place, lasting up to 2 years, and including weapons work-up and missile test firings at Cape Canaveral in the United States. After loading its complement of Trident II (D5) missiles at King's Bay, Georgia, in the US, the submarine will arrive at Coulport for installation of the UK *Trident* W-88 warheads a few months before its first patrol.[20]

22. Although the precise in-service date for VANGUARD is classified, a number of sources have given an in-service date of 1994[21]. It is also known that the official MoD in-service date is December 1994. VANGUARD will only meet this target if the trials period between its launch and first patrol is exemplary (which would be rare in a first-of-class submarine), with no margin for error or delay. The evidence we have gathered in this report gives rise to doubts whether VANGUARD will be ready for its first patrol by December 1994.

[19]Evidence, p 6, paragraph table 3.1.
[20]Evidence, p 5, paragraph 6.
[21]Evidence, p 5, paragraph 5 and HC 374, Session 1988-1989 para 35 pxv-xvi.

TACTICAL WEAPON SYSTEM

23. The Tactical Weapon System (TWS) is essential to the operation of the Trident submarine. It consists of a computer system which processes all the information coming into the submarine from the Type 2054 sonar suite and other sensors. It also aids manoeuvring, and controls the torpedo systems. Without it, the submarine cannot navigate safely underwater or defend itself.[22]

24. In recent years the Defence Select Committee has criticized the MoD for being "less than frank" in describing problems and delays in the Type 2054 sonar suite development and production programme.[23] Sonar suite development was due to be completed in early 1987, but a number of factors led to a three-year delay, and an increase in the cost from £450 million (average 1986-87 prices) to about £728 million.[24] By 1989 the programme was a further 14 months behind schedule. The first harbour trial of the sonar suite with HMS VANGUARD was expected in August 1991.[25] In 1989 a number of problems were reported in the remainder of the TWS.[26] By 1990 it was revealed that these involved difficulties integrating the software and hardware in the subsystems which make up the TWS.[27] The 2054 sonar programme was said to be 2 years behind schedule:[28] The first harbour trial with VANGUARD is now not expected until some time in 1992.

25. Because it is essential to the submarine's operation, the TWS must be installed and functioning before any form of sea trials can commence. The MoD hope to resolve the software/hardware integration problems at their Shore Development Facility (SDF) before installation starts on VANGUARD.[29] Integration will only have been achieved using shore-based simulators, so extensive sea trials may be necessary to prove the TWS's performance in its working environment.[30] The TWS may not be ready on time, and further problems and delays may arise during VANGUARD's sea trials.

[22]Evidence, p 8, paragraph 2.
[23]Evidence, p 9, paragraph 7.
[24]Evidence, p 8, paragraph 5.
[25]Evidence, p 9, paragraph 10.
[26]Evidence, p 9, paragraph 11.
[27]Evidence, p 9, paragraph 12.
[28]Evidence, p 9, paragraph 12.
[29]Evidence, p 9, paragraph 8.
[30]Evidence, p 9, paragraph 8.

WORKS: CSB FASLANE AND RNAD COULPORT

26. The construction programme for Trident-related works at Faslane and Coulport has been plagued with cost overruns, problems and delays since construction started in 1985. Large quantities of asbestos had to be cleared at the Northern Development Area at Faslane, leading to a six-month delay and costs of some £20 million.[31] In 1987 the Property Services Agency (PSA) appointed Wimpey to coordinate the 110 or so separate projects in the construction programme at Faslane and Coulport.[32] In 1988 the cost of this programme was put at £657 million - a 116 per cent rise on the 1981 estimate.[33] In 1988 construction problems with the Faslane shiplift programme came to light[34], and by 1989 estimated costs for the construction had increased by £100 million.[35] By 1990 a number of projects, including the shiplift at Faslane and the explosives handling jetty at Coulport, were delayed, and the cost had risen by a further 9 per cent.[36] The shiplift project alone is now 2 years behind schedule, and £68 million over budget.[37] It is now apparent that the shiplift, which will be used to lift the Trident submarines out of the water, will not be ready for at least part, if not all, of VANGUARD's sea trials. Other arrangements have been made, but this will cause delays.[38] More seriously, in 1990 the safety standards of the shiplift were questioned by the Director General Submarines and the United Kingdom Atomic Energy Authority (UKAEA) Safety and Reliability Directorate.[39] These doubts have yet to be resolved by the MoD.

27. The explosives handling jetty is a floating, covered structure. Its main component is being built at Hunterston, Strathclyde. It will be used to house the Trident submarines while the UK's W-88 warheads are being mated to, or separated from, the missiles in the submarines' launch tubes. The most recent estimate is that it will not be completed until March 1994, 2 years behind schedule and £43 million over cost.[40] Further delays could arise from the most difficult and hazardous phase in the construction - floating the 200 metre-long jetty from Hunterston to Coulport and installing it - which has yet to be carried out.[41] Although it is conceivable that alternative arrangements could be made to load VANGUARD's first complement of warheads[42], the MoD consider that weather conditions and security dictate the use of the covered facility.[43] Further delays in this project could therefore jeopardize VANGUARD's first patrol and delay the in-service date.

28. In early 1991 Bovis were engaged by the MoD to carry out an external audit of the construction programme at Faslane and Coulport. The audit is understood to involve reviewing the progress of key projects, identifying future risks, and resources that will be required to complete the programme.[44] This may be simply a wise precaution. However, it could also signal that all is still not well with this massive civil engineering project. Neither the scope nor the results of the audit, which has just been completed, have been made public to date.

[31] Evidence, p11, paragraph 3.
[32] Evidence, p11, paragraph 4.
[33] Evidence, p11, paragraph 5.
[34] Evidence, p15-16, paragraph 16-22.
[35] Evidence, p11, paragraph 6.
[36] Evidence, p12, paragraph 7.
[37] Evidence, p13, paragraph table 5.2.
[38] Evidence, p 16, paragraph 22.
[39] Evidence, p 15, paragraph 21.
[40] Evidence, p 14, paragraph 12.
[41] Evidence, p 14, paragraph 12.
[42] Evidence, p 14, paragraph 10.
[43] Evidence, p 14, paragraph 10.
[44] Evidence, p 14, paragraph 9.

WARHEAD

29. Although originally scheduled to begin in 1986[45], the production of components for UK Trident W-88 warheads did not begin until early 1988.[46] Since then, severe staff shortages at both AWE Aldermaston and AWE Burghfield; an uncoordinated construction contracting policy[47], and many construction problems, have resulted in even more delays to the warhead programme. Presently, warhead production for HMS VANGUARD is taking place in the A45 plant at AWE Aldermaston, but this plant will not be able to supply warheads to the rest of the Trident submarines.[48] The new facility for warhead production, A90, is ready to come on-line, but cannot do so because of recent setbacks with A91, the radioactive waste management plant essential for production.[49]

30. In January 1988, fissile component production for W-88 warheads began in the A45 plant.[50] However, A45 is over 35 years old, and its limited capacity will not meet the increased production rate needed for the Trident warheads.[51] In 1988 the MoD assured the House of Commons that they would be able to meet the Trident Programme requirement, but this could only be guaranteed "provided the existing facilities did not break down".[52]

31. In 1978 the poor ventilation and inefficient, unsafe design of the present waste management facility, known as the "Industrial Chemical Group" (ICG), led to a recommendation that it be replaced.[53] When completed, A91, the new waste plant, will be the radioactive waste management facility for all buildings that work with radioactive materials within AWE Aldermaston.[54] However, setbacks in the construction of A91 bring into question when this facility will be operational. Recently, pipes within A91 designed to carry radioactive gases and liquids from the A90 warhead production facility were found to be corroded.[55] In addition, the stainless steel pipes in A91 are contaminated by bacteria.[56] Preliminary assessment of repair work put costs at "tens of millions" of pounds and predicted "considerable delay".[57]

32. The setbacks in the A91 waste management plant threaten the continued production of Trident warhead material. The A90 fissile production facility cannot be operated without the A91 plant,[58] since the ICG cannot cope with the amounts of waste that would be generated by A90's increased production.[59]

[45]Evidence, p17, paragraph 3.
[46]Evidence, p17, paragraph 3.
[47]Evidence, p17, paragraph 8&20,23.
[48]Evidence, p17, paragraph 5.
[49]Evidence, p22&PP23, paragraph 35-41.
[50]Evidence, p17, paragraph 4.
[51]Evidence, p17, paragraph 5.
[52]Evidence, p21, paragraph 24.
[53]Evidence, p22, paragraph 37.
[54]Evidence, p22, paragraph 35.
[55]Evidence, p22, paragraph 38.
[56]Evidence, p22, paragraph 39.
[57]Evidence, p23, paragraph 40.
[58]Evidence, p22, paragraph 35.
[59]Evidence, p22, paragraph 37.

33. Severe staff shortages at the warhead final assembly facilities at AWE Burghfield are adding to problems with the warhead production programme. Work started on the assembly of the first warheads at AWE Burghfield in 1989.[61] Shortages of assembly and support staff at Burghfield led to some rescheduling of the assembly programme, and transferral of some work to AWE Cardiff.[62] In 1989 the Director of the AWE admitted that even the modified schedule would be difficult to maintain if staff problems were not alleviated.[63] Despite Government review[64] and moves towards privatisation[65] these staff shortfalls have not been made up, and the prospect of the warhead programme meeting scheduled delivery dates is questionable.[66]

[61]Evidence, p17, paragraph 6.
[62]Evidence, p17, paragraph 7.
[63]Evidence, p17, paragraph 8.
[64]Evidence, p18, paragraph 14.
[65]Evidence, p18, paragraph 14.
[66]Evidence, p23, paragraph 41.

APPENDIX A

List of Relevant Parliamentary Documents

Fourth Report from the Defence Committee, *Strategic Nuclear Weapons Policy*, HC 36 of Session 1980-81.

First Report from the Defence Committee, *Statement on the Defence Estimates 1984*, HC 436 of Session 1983-84.

Sixth Report from the Defence Committee, *The Trident Programme*, HC 479 of Session 1984-85.

Second Report from the Defence Committee, *The Progress of the Trident Programme*, HC 422 of Session 1987-88.

Fifth Report from the Defence Committee, *The Progress of the Trident Programme*, HC 374 of Session 1988-89.

Ninth Report from the Defence Committee, *The Progress of the Trident Programme*, HC 237 of Session 1989-90.

Sixth Report from the Defence Committee, *Royal Navy Submarines*, HC 369 of Session 1990-91.

Nineteenth Report from the Committee of Public Accounts, *The United Kingdom Trident Programme*, HC 348 of Session 1983-84.

National Audit Office, Report by the Comptroller and Auditor General, *Ministry of Defence: Trident Project*, HC 287 of Session 1984-85.

National Audit Office, Report by the Comptroller and Auditor General, *Ministry of Defence and Property Services Agency: Control and Management of the Trident Programme*, HC 27 of Session 1987-88.

Thirty-first Report from the Committee of Public Accounts, *Naval Warships and Weapons Procurement*, HC 189 of Session 1987-88.

Forty-seventh Report from the Committee of Public Accounts, *Ministry of Defence: Major Defence Projects*, HC 371 of Session 1987-88.

HM Treasury, *Supply Estimates 1988-89, Class I Ministry of Defence*, HC 339-I, March 1988.

HM Treasury, *Supply Estimates 1989-90, Class I Ministry of Defence*, HC 231-I, March 1989.

HM Treasury, *Supply Estimates 1990-91, Class I Ministry of Defence*, HC 242-I, March 1990.

HM Treasury, *Supply Estimates 1991-92, Class I Ministry of Defence*, HC 236-I, March 1991.

Report of the Investigation into Radiological Health and Safety at the Ministry of Defence (Procurement Executive) Atomic Weapons Research Establishment, Aldermaston. Edward Pochin, Harwell, Oxfordshire, 30 October 1978.

APPENDIX B

List of Abbreviations and Terms

A45	The present nuclear warhead production facility at AWE Aldermaston.
A90	The new nuclear warhead production facility at AWE Aldermaston.
A91	The liquid waste treatment facility under construction at AWE Aldermaston.
AEA	Atomic Energy Authority
AWE	Atomic Weapons Establishment
AWE Aldermaston	The facility which designs, produces and maintains components for all United Kingdom nuclear warheads
AWE Burghfield	The final assembly facility for all United Kingdom nuclear warheads
AWE Cardiff	The facility which produces non-fissile components for all United Kingdom nuclear warheads
AWRE	Atomic Weapons Research Establishment (now AWE)
CERN	Controller R&D Establishments Research and Nuclear Programmes
CSSE	Chief of Strategic Systems Executive
CSB	Clyde Submarine Base, this term can be used to refer the Faslane submarine base alone, or Faslane together with the Royal Naval Armaments Depot Coulport
ELF	Extremely-Low Frequency; a radio transmission system for communicating with submarines.
Financial Year	Starts on April 5 and ends on April 4.
Fiscal Year	The US financial year which starts in October and ends in September.
gloveboxes	Sealed boxes in which radioactive materials are handled from outside by means of gloves attached to the walls of the box
HC	House of Commons Paper
HMS VULCAN	The shore-based facility near Dounreay, Scotland, where prototype nuclear reactors for use on submarines are tested
ICG	Industrial Chemical Group; part of which is the existing radioactive waste management facility at the Atomic Weapons Establishment Aldermaston
MoD	Ministry of Defence
NNC	National Nuclear Corporation; a private company which usually manages construction projects for the civil nuclear industry
Official Report	Hansard
PSA	Property Services Agency

PWR	Pressurised Water Reactor
PWR2	The new nuclear reactor which is being installed in the Trident submarines, and may be used in other submarines in future
RNAD	Royal Naval Armament Depot
SDF	Shore Development Facility; a test-bed for the Trident Tactical Weapon System at VSEL, Barrow.
SM607	Director General Submarines.
SMCS	Submarine Command System; a sub-system of the Tactical Weapon System
SSBN	A nuclear-powered submarine armed with ballistic nuclear missiles
Sunk Costs	Expenditure which has already occurred expressed at a current year price level
TWS	Tactical Weapon System; the system which will govern many of the essential functions of Trident submarines
UK	United Kingdom
UKAEA	United Kingdom Atomic Energy Authority now AEA
US	United States
VLF	Very Low Frequency; an existing radio transmission system for communicating with submarines
VSEL	Vickers Shipbuilding and Engineering Limited; builders of the United Kingdom Trident submarines, at Barrow-in-Furness
W-88	The United States' designation for a warhead design for the Trident II (D5) missile system; because the designation of the United Kingdom's version of the Trident warhead is classified, it is referred to as the "UK W-88" for convenience within this report.
WE-177	A variable-yield free-fall nuclear bomb, first introduced into service by the United Kingdom in 1966

LIST OF EVIDENCE

REPORTS INCLUDED IN THE EVIDENCE SECTION

EVIDENCE

1. COSTS: ITEMS EXCLUDED FROM THE ESTIMATE

PWR2

1. The development of PWR2, a new nuclear propulsion plant for the Royal Navy's submarines, was originally carried out to provide the propulsion unit for the follow-on to the TRAFALGAR Class, and only taken up for the Trident Programme when the Government announced the purchase of Trident in 1981.

2. Although the production cost of £86 million per Trident submarine(1) is included in the cost of the Trident Programme, none of the development costs of PWR2 are attributed to the cost of Trident, despite the current doubts over future orders for UK nuclear-powered submarines. The development costs of the PWR2 reactor are estimated to be at least £500 million,(2) although the exact figure is classified.

Aldermaston Capital Works

3. The costs of new work at Aldermaston, particularly the new production facilities, have not been wholly attributed to the Trident programme, yet in 1989 the MoD stated:

> "A major programme of capital works is currently taking place at AWE Aldermaston centred on the construction of a new facility for the processing of fissile material and manufacture of fissile components [the A90 building] with associated ancillary and support services. The purpose of these new facilities is to ensure a safe nuclear warhead production capability into the future, and to maintain the effectiveness of the UK deterrent ... The early stages of Trident production are taking place in AWE's existing facilities. These cannot however meet the total Trident requirement in the necessary timescale, and they are in any case nearing the end of their useful life."(3)

4. The capital works programme being undertaken at AWE Aldermaston is essential for continued production of nuclear warheads for the Trident programme. Yet less than 6 per cent of the cost of the capital works is attributed to Trident, and £1,331 million of the programme's costs are not included in the Trident estimate.(4) These figures do not account for any additional expenditure resulting from the problems found at Aldermaston since 1988. Also excluded are the costs of contractorisation of Aldermaston, which the Government believe necessary for the completion of the programme, as the MoD stated in July 1990:

> "Contractorisation will enable the more efficient utilisation of the considerable resources already allocated to the UK's nuclear warhead research, development and production capability, and ensure the successful completion of the later stages of the Trident warhead programme."(5)

Faslane and Coulport Works

5. At the Clyde Submarine Base (which comprises CSB Faslane and RNAD Coulport) some £350 million is described as "Trident-related expenditure", yet not included in the MoD estimate.(6)

Clyde Submarine Base Externals (roads and services etc.)

6. Some £2 million of Trident-related expenditure is not included in the MoD estimate.(7)

Rosyth Works

7. In order to refit the Trident submarines a major programme of works must be carried out at Rosyth to provide the necessary facilities. Some £326 million of this work is Trident-related, but not attributed to Trident in the MoD estimate.(8)

VLF Communications Improvements

8. The construction of an experimental Extremely Low Frequency (ELF) transmitter at Glen Garry in Scotland, which would allow communication with submarines submerged at great depth, was considered by the MoD but appears to have been abandoned. This gives increased importance to the programme of improvements to the Very Low Frequency, (VLF), shore-to-submarine communications system for Trident. These improvements are estimated to cost £31 million at 1990-91 prices, none of which has been attributed to the Trident Programme.(9)

References

1. HC 422 of Session 1987-88, p. xv, paragraph 32. The price of one PWR2 is given as £70 million at 1987-88 prices.
2. HC 369 of Session 1990-91, p. 56, A2. This estimate does not include the costs of running the prototype PWR2 reactor at HMS VULCAN after 15 May 1991.
3. *MoD Consultation Document on the Future Organisation of the Atomic Weapons Establishment*, House of Commons Deposited Paper 5452, 5 December 1989, p. 1, paragraph 6, and p. 2, paragraph 7.
4. HC 422 of Session 1987-88, p. xx, paragraph 62. Expenditure given as between £879 million and £1,133 million at 1987-88 prices, of which £52 million is attributed to Trident.
5. *MoD Consultative Document: Future of the Atomic Weapons Establishment - its workforce*, House of Commons Deposited Paper 6519, July 1990, pp. 11-12, paragraph 38.
6. HC 237 of Session 1989-90, p. 61, A20. Given as £473 million Trident-related expenditure at 1989-90 prices.
7. *ibid.* Given as £62 million Trident-related expenditure at 1989-90 prices.
8. *ibid.* Given as £390 million Trident-related expenditure and £87 million Trident-attributed expenditure.
9. HC 479 of Session 1984-85, p. vii, paragraph 9. Given as £22 million at 1984-85 prices.

2. EVENTS IN THE UNITED STATES: MISSILES

1. Information on the number of Trident II (D5) missiles being procured from the United States by the United Kingdom remains classified. The present estimate for UK expenditure on the missile programme is £1,034 million.(1) Safety concerns, spectacular test failures and budgetary problems have led to an increase in the cost of each missile.

Missile Test Firing Problems

2. On 21 March 1989, the world's most expensive "firework" was tested when a Trident II (D5) missile was launched for the first time from a submarine. The missile cartwheeled in the sky for 4 seconds before exploding.(2) The fault was believed to have been in the first-stage motor nozzle, which appeared to burn through. This component was reinforced in a redesign.(3)

3. On 2 August 1989, the second underwater test of a Trident II (D5) missile was carried out with a degree of success. After clearing the water, the missile went hard over, causing concern that there would be a repeat of the first test failure, but the missile corrected itself and headed downrange.(4)

4. On 15 August 1989, the third test missile exploded after launch. Again the problem was believed to be in the first-stage nozzle. After this second failure, the US Navy re-evaluated whether the initial fix to correct the problem had failed, and whether additional design changes were required.(5)

5. The first test failure put back the first US Navy operational date by 3 months, from December 1989 to March 1990. The second failure came 1 month before the Pentagon was to decide whether to move into full-scale production of the D5 missile.(6)

US Trident Procurement Budget Cut for Fiscal Year-90

6. Less than 4 weeks after this second test failure, as a result of Senators' anxiety about buying a weapon system before they knew it worked, the Senate Appropriations Defense Subcommittee cut the US Navy's entire procurement budget for the Trident II (D5) missile for Fiscal Year-90 (FY-90).(7)

7. The United Kingdom started a concerted lobbying effort on Capitol Hill in an attempt to get the US Congress to reinstate the Trident procurement budget. Letters were sent from the British Ambassador in Washington to the Senate Armed Services Committee and from the UK Secretary of State for Defence to his counterpart in the US. These were followed up by confidential meetings between Alan Clark, Minister of State for Defence Procurement and US Congressmen and the US Deputy Defense Secretary.(8) In the letter from the British Ambassador, it was warned that:

> "any withholding of production funding would have a knock-on effect ... and continue to impose time and cost penalties on the British Trident programme."(9)

8. When there is a disagreement between the US Senate and the House of Representatives, the two go into conference on the matter and a compromise is reached. The outcome of the conference on FY-90 Trident missile procurement was that $1.22 billion be awarded rather than the $1.598 billion asked for and that this money would only be provided if the US Navy successfully completed three consecutive firings of a Trident missile from a submarine.(10)

9. During this period of indecision on the part of the US, the UK spent $1 million on missile production to ensure "the continuation of the programme to meet UK requirements".(11)

The UK Cancels FY-91 Purchase of Missiles

10. In Fiscal Year-91, the US Navy was granted the $1435 million it asked for. However, the United Kingdom decided not to buy the 14 missiles it had planned to purchase that year. The reason given by the MoD was that some scope was identified for "rescheduling expenditures without prejudicing the programme's objectives". This decision is expected to add 9 per cent to the unit cost of each missile.(12) It is unknown how many missiles the UK will be purchasing from the US during Fiscal Year-92, if any.

Modifications Needed for Warhead Safety

11. As a result of a report by an eminent group of scientists on the safety of the United States nuclear weapons stockpile,(13) the United States are considering a number of options to make the Trident II (D5) weapons system safer. The US Navy are at present considering the possibility of changing the propellant in the Trident II (D5) to a safer, less volatile version.(14) Various studies are also underway to consider the possibility of carrying out safety modifications to the W-88 Trident warhead.(15) Any change in missile propellant or design modification to the US system, could present problems for the United Kingdom. For example, a change in missile propellant, would lead to the need for more missile tests,(16) thus increasing the unit cost and possibly leading to a delay in the UK receiving its missiles, as these are to be taken from a common US/UK pool.

References

1. HC 237 of Session 1989-90, p. xvi, paragraph 28.
2. "Navy Assesses Failure of First Trident 2 Underwater Launch", *Aviation Week and Space Technology*, 27 March 1989.
3. "US Navy Conducts Successful Underwater Launch of Lockheed Trident 2 Missile Off Florida Coast", *Aviation Week and Space Technology*, 7 August 1989.
4. *ibid.*
5. "Second Trident 2 Test Failure Points to Missile Design Flaw", *Aviation Week and Space Technology*, 21 August 1989.
6. *ibid.*
7. "Trident nuclear programme dealt blows by Senate cuts to budget", *The Times*, 13 September 1989.
8. "Britain steps up warnings on fund threat to Trident", *The Times*, 14 October 1989, p. 8, and HC 237 of Session 1989-90, p. 49, paragraph 10.
9. "Back-pedalling over Trident sparks US anger", *Sunday Independent*, 30 September 1990.
10. HC 237 of Session 1989-90, p. 49, paragraph 8.
11. HC 237 of Session 1989-90, Q381.
12. "United Kingdom pulls out of FY-91 buy of Trident missiles, may stub program", *Inside the Navy*, Vol. 3, No. 39, 1 October 1990.
13. Report of the Panel on Nuclear Weapons Safety of the Committee on Armed Services, House of Representatives, 101st Congress, 2nd Session, December 1990.
14. Smith, R J, "Navy Missile Handling Is Modified for Safety", *Washington Post*, 1 March 1991.
15. Claytor, R A, Assistant Secretary for Defense Programs, Department of Energy, in testimony on "Atomic Energy Defense Activities", Energy and Water Development Appropriations for 1992, Hearings before a Subcommittee of the Committee on Appropriations, House of Representatives, 102nd Congress, 1st Session, Subcommittee on Energy and Water Development, Part 6, p. 405.
16. Kidder, R E, "Assessment of the Safety of US Nuclear Weapons & Related Nuclear Test Requirements", Lawrence Livermore National Laboratory, 28 August 1990. Report reprinted in *Bulletin of the Atomic Scientists*, April 1991, pp. 32-34.

3. SUBMARINES

Summary

1. The building programme for the first Trident submarine, HMS VANGUARD is estimated to be about 4 months behind schedule. Even if problems and delays affecting a number of programmes essential to its operation are overcome on time and the trials period after launch proceeds smoothly, VANGUARD is only likely to meet its target in-service date of December 1994 if the trials period between its launch and first patrol is exemplary, with no margin for error or delay.

Progress

2. HMS VANGUARD was ordered on 30 April 1986, HMS VICTORIOUS on 6 October 1987, and HMS VIGILANT on 13 November 1990. The order for the fourth submarine, SSBN 08, as yet unnamed, has yet to be placed.

3. A prolonged strike at VSEL led to a four-month delay in the building programme for VANGUARD and a three-month delay for VICTORIOUS.(1) In 1990 there were also reports that there were technical difficulties with the main machinery plant while it was under test ashore.(2) Problems with the Trident Tactical Weapons System are dealt with in Evidence, Part 4. In addition, the Faslane shiplift is unlikely to be ready to assist in any repairs which might be necessary during VANGUARD's trials period, and there are doubts whether the explosives handling jetty at Coulport will be ready in time to allow the loading of the warheads for VANGUARD's first patrol (see Evidence, Part 5).

4. The delay in ordering the third Trident submarine, VIGILANT is expected to set back its in-service date by about 6 months, and any such delay in ordering SSBN 08 will similarly affect its in-service date.(3)

5. The in-service date for HMS VANGUARD is classified. The Ministry of Defence have only ever given "the mid-1990s"(4) as a date. However, it is also known that the target date is December 1994.

The Trials Period

6. The sequence of trials which HMS VANGUARD will have to undergo has been described to the Defence Select Committee:

> "Upon completion, HMS VANGUARD will first undergo contractor's sea trials lasting some two months, and will then return for a period before commissioning. Thereafter the submarine will go under Royal Navy control for acceptance trials of a few weeks, followed by Contract Acceptance by the Royal Navy. After this there is a long period of trials, principally associated with the tactical weapons system and other tests, including the work-up of the weapons and the test firings at Cape Canaveral. Because HMS VANGUARD will have to carry out first-of-class trials, this period of trials will be somewhat longer - eighteen months to two years - for her than for subsequent submarines of her class. After the submarine has picked up its missiles it will arrive at Coulport to install the re-entry bodies [warheads] a small number of months prior to initial deployment."(5)

7. Even though the MoD remain confident that HMS VANGUARD will be ready in time to meet the in-service date, the likely timescale shown in Table 3.1 indicates HMS VANGUARD could only start its first patrol in December 1994 if the outstanding problems with a large number of the Trident Programme's projects are overcome on time, no further problems develop, and the sea trials period is kept to an absolute minimum.

TABLE 3.1

HMS VANGUARD - Outline of Significant Dates Between Launch and First Patrol

Launch[i]	December 1991
Contractor's sea trials[ii]	February 1992
Period at shipbuilders before commissioning[iii]	February 1993
Acceptance trials followed by Contract Acceptance by Royal Navy[iv]	March 1993
Trials period - ending[v]	September 1994-March 1995
Faslane/Coulport to load warheads[vi]	December 1994-June 1995.

Notes:

i. Jane's Fighting Ships 1991-92, Jane's Publishing Company, 1991.

ii. See HC 374 of Session 1988-89, p. xv, paragraph 34, and Q238.

iii. The length of the period VANGUARD is to spend at VSEL prior to commissioning has never been specified. We have assumed 12 months as this is the only timescale that would allow an in-service date of December 1994 to be met.

iv. See HC 374 of Session 1988-89, p.xv, paragraph 34; and Q238. The period is given as "a few weeks". We have rounded this up to 1 month.

v. See HC 374 of Session 1988-89, p. xv, paragraph 34; and Q238.

vi. See HC 374 of Session 1988-89, p. xv, paragraph 34; and Q238. The period is given as "a small number of months", so we have assumed a period of 3 months.

Problems and Delays During Sea Trials

8. Sea trials are designed to show up problems, so it is not surprising that evidence from previous submarine programmes indicates that a problem-free trial period would be rare, especially for a first-of-class submarine.

9. The trials problems that can beset a first-of-class submarine are well-illustrated by the progress of HMS UPHOLDER, the first of a new class of UK diesel-electric submarines. Like HMS VANGUARD, HMS UPHOLDER incorporates the most up-to-date submarine technology.

10. In July 1989, HMS UPHOLDER suffered a total power failure while on trials off Campbeltown, Scotland. It was forced to surface hurriedly. After surfacing, a temporary power

source was rigged up which enabled the submarine to get to Campbeltown, where the fault was rectified. Tests were conducted while it was berthed in Loch Goil, and it was expected to resume sea trials within 7-10 days. A spokesman for Vickers was quoted as saying:

> "She's very much a prototype and while you hope that everything goes alright on trials it does not surprise you when every now and again some snag arises. It is the sort of thing that trials are designed to show up."(6)

The following month it was found that HMS UPHOLDER was unable to fire its torpedoes because of a design fault. The problem was discovered during harbour trials when the inner set of hydraulic interlocking doors opened, allowing water to pour in. The torpedo tubes had to be bolted shut.(7) The submarine is still unable to fire its torpedoes except in extreme emergency.(8)

11. Table 3.2 lists the documented incidents and accidents that have happened to UK Polaris submarines during sea trials.

TABLE 3.2

Documented Incidents/Accidents Involving UK Polaris Submarines During Sea Trials

5 November 1967	HMS REPULSE (S23) ran aground in Walney Channel, Barrow-in-Furness, 30 minutes after being launched at VSEL. Seven tugs were required to pull it free.
9 January 1968	*The Times* reported that HMS RESOLUTION (S22) developed a defect in its electric generator while on its final trials in the Atlantic before test missile firings at Cape Canaveral, Florida. On 8 January 1968 the submarine was towed back to Faslane for repairs. UK officials said the repairs would not delay RESOLUTION's arrival at Cape Canaveral.
10 June 1985	HMS RESOLUTION (S22) collided with the US yacht *Proud Mary* off Cape Canaveral, Florida. The submarine suffered minor damage.

Source: Arkin, W and Handler, J, *Neptune Papers No. 3: Naval Accidents 1945-1988*, Greenpeace, June 1989.

12. The number of problems and delays which have beset the Trident programme to date make the MoD's insistence that the in-service date of December 1994 can still be achieved seem highly optimistic.

References

1. HC 237 of Session 1989-90, p. xiv, paragraph 22.
2. *ibid.*
3. HC 237 of Session 1989-90, p. xv, paragraph 24.
4. HC 374 of Session 1988-89, p. xvi paragraph 35.
5. HC 374 of Session 1988-89, p. xv; and p. 24, Q238.
6. "Solution to submarine failure at hand, says Vickers", *The Scotsman*, 10 July 1989.
7. "Navy denies submarine snags probe", *Financial Times*, 31 August 1989.
8. "Sub that cost £40m too much can't fire", *The Scotsman*, 16 May 1991.

4. TACTICAL WEAPON SYSTEM

Summary

1. The Tactical Weapon System (TWS) is an essential part of the Trident submarine, consisting of a computer system which processes all the information provided by the Type 2054 sonar suite and other sensors, and governs other vital functions. This part of the Trident programme has been a saga of problems, delays and cost overruns. Even at this late stage in the programme there are still problems. These must be corrected before HMS VANGUARD can complete sea trials.

Components of the TWS

2. The Tactical Weapon System comprises the Submarine Command System (SMCS), which aids manoeuvring and weapons deployment; the 2054 sonar suite; Electronic Counter-Measures; the torpedo handling and discharge systems, and optical systems in the periscopes. Once submerged, a submarine is almost entirely dependent upon its sensors, the most important being the sonar. Hydrophones, which detect underwater noises, are also carried, usually with arrays near the bow, amidships and near the stern to give all-round coverage. The vast amount of data provided by the sensors must be managed by the computer system, whose functioning depends on problem-free software.

The Sonar Suite

3. The sonar suite functions as the eyes and ears of the submarine:

> "A very large bow array and the towed array are the primary sensors which in normal operation listen and detect passively, generating an enormous volume of data which is then processed to determine the presence of a threat by analysing that data. Further, the submarines can determine the range, course and speed of any other vessel and, most importantly, identify it. The intercept arrays are intended principally to detect active transmissions such as other submarines and torpedoes. The data from those arrays is processed separately, since it alone requires a large amount of computing power with sophisticated software. The substantial number of processing and computing equipments ... together with the operator consoles, are, of course, housed within the submarine, so that is referred to as inboard equipment."(1)

4. In January 1987, in their annual report on Trident, the MoD reported that:

> "The tactical weapon system is meeting its required programme ... The development and production of the sonar suite for HMS VANGUARD is progressing satisfactorily."(2)

5. However, by July 1987, with the release of a National Audit Office report all was obviously not "progressing satisfactorily". The original cost estimate of £450 million (average 1986-87 prices) for the Tactical Weapon System increased by 62 per cent in real terms to £728 million, mainly due to additional requirements (26 per cent), under-estimation of development and production costs (20 per cent) and transfers from the submarine budget (7 per cent). These increases occurred in the early years of the project.(3)

6. In addition, the original development programme for the sonar system was due to be completed by early 1987, with contracts for the production of sonar sets for the third and fourth Trident submarines being placed competitively. However, there were numerous delays, which led to a three-year delay in the programme overall:

(a) the development phase was delayed by an estimated 12-18 months during the period 1980-83 by several factors, including uncertainties over the suitability of the planned specification,

and changes in the items to be covered by it;
(b) further delays arose when the prime contractor (Plessey) fell behind by 9 months in the Project Definition and Demonstrator stages;
(c) internal reviews, investigations and reorganisation contributed to a delay of 5 months;
(d) there was a four-month delay while the relative merits of fixed price and incentive contracts for full development and supply of prototype and pre-production models were considered and appraised;
(e) in addition, Ministerial approval was withheld during this period while MoD tried to persuade the prime contractor to either reduce the proposed fixed price or accept a maximum price for an incentive contract.(4)

7. In the annual report for 1988, the House of Commons Defence Committee stated that it was less than pleased with past statements that had been made on the Tactical Weapon System and in particular the sonar suite:

"We consider that the Ministry of Defence has been less than frank with us over problems experienced with the sonar suite ... Such demonstrable lack of frankness in respect of one element of the programme will inevitably tend to cast doubt on other elements which are accurately reported and where there is no cause for concern."(5)

The Shore Development Facility

8. The Shore Development Facility (SDF) at VSEL plays a crucial role in guaranteeing the correct functioning of the Tactical Weapon System. The outboard equipment – the sensors requiring hull-mounting, or provision for it - must be ready for the shipbuilder at an earlier stage of the construction programme than the inboard equipment – the processing and control systems. In an effort to overcome any integration problems, the SDF was built to house all the major elements of the Tactical Weapon System. Where the sonar system is concerned, the SDF houses only the inboard equipment. The signal inputs that would arrive from the outboard array when the submarine was at sea thus have to be provided by simulators and "stimulators".(6) Although MoD aims to achieve system integration in the shore facility before work starts on the submarine, a considerable number of sea trials will be necessary to prove the sonar's performance in its working environment.

9. In 1988 the main problems encountered related to the supply of equipment for the SDF, which was showing some signs of slippage. It was reported that this was not affecting the submarine construction programme.(7)

10. By 1989 prototype production units of the whole sonar suite, with software, had been installed in the SDF, and full acceptance of the facility was expected to be completed by October 1989. The first harbour trials for the complete sonar system on board HMS VANGUARD were expected to take place in August 1991. These are unlikely to occur as scheduled, because HMS VANGUARD is not expected to be launched until December 1991 at the earliest. It was estimated in 1989 that the completion of development of some aspects of the Type 2054 sonar suite was "up to 14 months behind schedule".(8)

11. As for the remainder of the Tactical Weapon System components, there were about a dozen problems of some significance at the beginning of 1989, but the MoD were confident that these would be resolved by July 1989. They went on to say that "there are lots of other very minor, trivial problems",(9) but these were not specified.

12. By 1990 the development contract for the Type 2054 sonar suite had slipped another 10 months, and it was now assessed to be 2 years behind schedule. Trials involving HMS VANGUARD had now receded to some time in 1992. Problems previously regarded as minor

persisted. Although the applications software was reported to be progressing well, it was noted that difficulties remained with the infrastructure software. The major difficulty apparently lies in integrating the myriad pieces of equipment, and "ensuring that they speak satisfactorily each bit to each other bit".(10) The failure to integrate the software for the Tactical Weapon System "is a potential cause for concern".(11)

13. By 1991 a number of software development problems remained unsolved, but it appears that satisfactory progress had been made in dealing with the outstanding issues with the sonar suite. However, another sub-system of the TWS, the Submarine Command System, continued to present problems. This sub-system comprises a new, advanced computerized command system to aid manoeuvring and weapons deployment in the submarine.(12)

> "The Tactical Weapon System continues to progress satisfactorily. Although it has taken longer than expected, significant progress has been made towards resolving outstanding development issues with the Sonar Suite, although a number remain with the Submarine Command System software. The outstanding development issues are not impeding the submarine construction programme, and the TWS production programme remains on schedule."(13)

14. It cannot be overemphasized that all of the difficulties contractors are experiencing with the TWS and its various components must be overcome before HMS VANGUARD can complete its first sea trials.

References

1. HC 237 of Session 1989-90, p. xviii, paragraph 47.
2. HC 422 of Session 1987-88, p. xvi, paragraph 40, and p. xvii, paragraph 42.
3. HC 27 of Session 1987-88, 1 July 1987, p. 8, paragraph 3.13.
4. *ibid.*, p. 9, paragraph 3.185. HC 422 of Session 1987-88, p. xvii, paragraph 46.
6. HC 374 of Session 1988-89, p.xviii, paragraph 48.
7. *ibid.*, p. xvi, paragraph 41.
8. HC 374 of Session 1988-89, p. xix, paragraph 52.
9. HC 374, Q225.
10. HC 237 of Session 1989-90, p. xvi, paragraph 33.
11. *ibid.*, p. xvii, paragraph 33.
12. HC 27, 1 July 1987, p. 8. paragraph 3.15.
13`. House of Commons Deposited Paper 6739, 12 February 1991.

5. WORKS

Summary

1. The works programme at Faslane and Coulport is one of the largest civil engineering projects in the United Kingdom. Given its scale and complexity it is no surprise that many key projects that need to be ready before HMS VANGUARD is introduced into service, such as the Trident shiplift at Faslane and the explosives handling jetty at Coulport, have experienced serious problems, delays and cost overruns. It is a greater cause for concern that fears have been expressed about the safety of some of these projects. The fact that the MoD engaged Bovis to carry out an external audit of the programme may be a further indication that all is not well with the works programme.

Progress

2. The Clyde Submarine Base at Faslane and the Royal Naval Armaments Depot at Coulport are undergoing dramatic changes in preparation for their role in supporting the new Trident submarines. The massive construction programme, involving approximately 110 separate projects, is one of the largest civil engineering programmes ever undertaken in the United Kingdom.

3. Difficulties started with the initial construction phase in 1985, when works at Faslane were delayed for some 6 months by the need to clear large quantities of asbestos waste from the Northern Development Area,(1) where the large majority of construction work was due to take place. In the end the waste had to be buried on site, and the total cost of the operation was some £20 million.(2)

4. In 1987 the Property Services Agency (PSA) appointed Wimpey as the construction programme coordinator for Faslane and Coulport, at a cost of £13 million. The PSA had been considering appointing a coordinator since 1985, and contractors had been pressing them for an early decision on how the numerous projects would be managed because an increasing number of contracts were being let.(3) By December 1987 some 40 per cent of the contracts by value had been let, with another 25 per cent out to tender.(4)

5. In 1988 the cost of shore construction at Faslane and Coulport was put at £1 billion, of which £657 million was attributable to Trident. This was made up of £410 million on specific projects, £150 million for contingencies, PSA resource costs of £94 million, and price variations on sunk costs of £3 million. This represented a 116 per cent rise in estimated costs in real terms compared with the provisional 1981 estimate, consisting of:

(a) a £159 million increase in individual works projects;
(b) a £51 million increase in PSA resource costs;
(c) the addition of a £202 million contingency fund to cover uncertainties in the programme.(5)

6. MoD witnesses to the Defence Select Committee in 1988 acknowledged that:

"... this is a very large project, a huge project. It still has a long way to go and it has a very tight timescale. It is also complex in technical terms and in management terms and it would be surprising if we had no difficulties at all with the completion of the programme."(6)

However, by 1989 the only admitted difficulties in this construction programme were connected with the Faslane shiplift, and an increase in estimated costs of some £100 million for the works as a whole.(7)

7. By 1990 the true extent of problems at Coulport and Faslane was emerging. The cost of the programme had risen significantly, some 9 per cent in real terms. This was apparently due to increases in pay and prices (£159 million), the imposition of VAT (£33 million), and additions to the programme (£7 million).(8) (See Table 5.1 for the yearly cost estimates.)

TABLE 5.1

Price Variation on Yearly Estimates to 1990

	Construction programmes	Attributable to Trident	Contingency	PSA resource cost	Sunk costs
	(£ million)	*(£ million)*	*(£ million)*	*(£ million)*	*(£ million)*
1988	753	410	150	94	3
1989	883	491	101	104	12
1990	1,259	629	59	118	61

Source: HC 374 of Session 1988-89, p. xx, Table XI; and HC 237 of Session 1989-90, p. xvii, Table XVII.

8. In 1990 the shiplift was still causing problems. In addition, the Coulport explosives handling jetty had been delayed, and its timetable now allowed little room for manoeuvre. Other projects were also delayed and over cost (see Table 5.2).

TABLE 5.2

Delays Involving Projects at Faslane and Coulport to Date

		Delay	Rise in estimated cost *(£ million)*
a) Faslane: shiplift and 12 berth(i)			
Year of start	1987-88		
Estimated year of completion	1990-91		
Current estimate	1992-93	2 years	68
b) Faslane: Northern Utilities Building			
Year of start	1987-88		
Estimated year of completion	1989-90		
Current estimate	1991-92	2 years	74
c) Faslane: finger jetty(ii)			
Year of start	1987-88		
Estimated year of completion	1990-91		
Current estimate	1991-92	1 year	15
d) Faslane: Strategic Weapons Support System			
Year of start	1988-89		
Estimated year of completion	1990-91		
Current estimate	1991-92	1 year	2
e) Faslane: infill behind 2 to 6 berths and tunnel			
Year of start	1986-87		
Estimated year of completion	1988-89		
Current estimate	1990-91	2 years	10
f) Faslane: modernization of 6 berth			
Year of start	1986-87		
Estimated year of completion	1988-89		
Current estimate	1990-91	2 years	14
g) Coulport: explosives handling jetty(iii)			
Year of start	1988-89		
Estimated year of completion	1991-92		
Current estimate	1993-94	2 years	43

Notes: Explanation for major cost overruns
i. Revised estimate reflecting increased safety requirement
ii. Revised estimate reflecting increased safety requirement
iii. Revised estimates for Closed Circuit Television, accommodation and reinforcement. Additional requirements for mooring, access doors and security requirements.

Sources:
HM Treasury, Supply Estimates 1990-91, Class I Ministry of Defence, 20 March 1990, HC 242-I.
HM Treasury, Supply Estimates 1991-92, Class I Ministry of Defence, 12 March 1991, HC 236-I.

9. Early in 1991 Bovis were called in by the Ministry of Defence to carry out an external audit of the construction programme at Faslane and Coulport. The extent of this audit is unknown. The MoD's only comment on the matter was that it was prudent to ensure that the proper management structures and resources were being employed, and particularly so at a time when the project was about to move on to "key mechanical and electrical installation work". However, it is understood that Bovis were appointed to review the state of key projects and to identify progress and future risks and resources that would be required as the project continued.(9) This audit seems very similar to the one carried out by John Brown Engineering in 1987 for the Capital Works project at Aldermaston, (see p21, paragraph 26).

Explosives Handling Jetty

10. The Coulport explosives handling jetty is vital to the Trident programme. In 1985 Rear Admiral Groves told the Defence Select Committee:

"A major component at Coulport will be the facility that we will require to mate the UK warheads with our missiles ... For that purpose we are using a floating covered jetty because this is a very important part of our process and we need to carry it out under the most benign conditions. Many of you probably know that in that part of the world for something like 187 days of the year it is either raining or blowing a force seven. Therefore, we are building a covered facility for that. That also has advantages from the security point of view ..."(10)

If installation of UK warheads is to be carried out during the winter months, it is unlikely that this process can be conducted safely and successfully without the use of this facility. Any further delay in this project will undoubtedly delay the first patrol by HMS VANGUARD.

11. The main structure for the explosives handling jetty is being built in a drydock at Hunterston, Strathclyde. The jetty consists of a floating structure made up of twin 200-metre long concrete pontoons, each 25 metres wide and 12 metres deep, linked at one end by a short third side. The Trident vessels will moor inside this extended 'U' shape in an internal 160-metre by 30-metre dock, enclosed by concrete on three sides and sealed by a floating steel caisson at the entrance.

12. The contingency period allowed for construction of the jetty is almost exhausted. At present it is estimated that it will not be completed until the end of March 1994 at the latest, 2 years behind schedule and £43.208 million over cost. In addition, perhaps the most difficult phase of this construction has yet to be carried out. Once it is floated from Hunterston to Coulport, the jetty must then be connected into the mooring booms. Divers and heavy lifting gear will be needed to position the 6,000-tonne underwater bracing,(11) so further delays may yet occur.

Magnetic Treatment Facility

13. The MoD have defined the need for a new magnetic treatment facility at Faslane:

"All steel vessels do acquire a magnetic signature during build. That magnetic signature can be reduced by deperming magnetic treatment and at the moment the facilities that we have at Faslane for treating the existing Polaris submarines are not suitable, not big enough for treating the Vanguard class [Trident submarines], so that is why we need to have this particular facility."(12)

14. The contract for this facility was let in April 1989. It was originally planned as a floating facility, jutting out into the Gareloch behind the Faslane shiplift. This proposal is now being reassessed, and the plan now is to attach the facility alongside the sea wall at the Northern

Development Area at Faslane. *Jane's DefenceWeekly* have reported that, as part of this plan, the steel supports for the sea wall will be removed.(13) This operation could disturb the asbestos waste buried behind these steel supports: some 90,000 cubic metres of contaminated material. The magnetic treatment facility was originally scheduled for completion by 1993. It is unknown what delays, if any, will be incurred as a result of this rethink. Without it the Trident submarines could be relatively easy to detect because of their intense magnetic signature.

Faslane Shiplift

15. In July 1987 Cementation were awarded the contract to build a shiplift at Faslane at an estimated cost of £128.927 million. At present it is 2 years behind schedule and £68 million over budget.

16. Problems were encountered some 6 months after piledriving began. Work was slowed down because the vertical tubular steel piles were drifting out of tolerance during the driving process. In addition, the hammers used to drive the piles keep breaking down, and one underreaming drill used to form the pile sockets has been lost, while another took 3 days to recover.(14)

17. Later in 1988 it was reported that a total of 103 tubular steel piles had drifted out of tolerance, and that the cost of the project had risen to £175 million; 73 of these piles have had to be redriven. At this point the project was still expected to be completed in Autumn 1990.(15)

18. In mid-1989 71 out of 188 underreamed raking piles had to be rejected. This resulted in a six-month delay to the project.(16) These piles are vital to the shiplift's overall safety as they have to accommodate all the shiplift's considerable uplift forces while a submarine is being lifted out of the water.(17)

19. Poor compaction and segregation of concrete have been blamed for the failure, and the piles are being redrilled or cut off at the seabed and replaced.(18) However, a number of raker piles were not replaced because they were at the landward end, and work had already started to lay the concrete deck on top of them.(19)

20. Later in 1989 corrosion was reported to have affected as many as 800 of the piles, and they may all require costly remedial treatment. The PSA said that surveys indicate up to 75 per cent of the piles may be affected to some degree, with up to 10 pits per pile. The maximum depth of pit has been 4mm, but on average only 1mm to 1.5mm. The PSA says that loss in sectional area from corrosion has been 0.5 per cent, which "does not prejudice the design".(20)

Safety Fears

21. In 1990 an internal row about the safety of the Faslane shiplift emerged. In a memo dated 27 March 1990, R E Crawford, Commander Royal Navy, Director General Submarines wrote:

> "... construction is proceeding at risk without an approved safety justification. At this stage, based on the evidence presented to date, SM607 [Director General Submarines] has little confidence that an acceptable safety case will be presented within the programme timescales available."(21)

The memo refers to a failure to resolve fundamental questions raised at two meetings, in September and December 1989. The United Kingdom Atomic Energy Authority Safety and Reliability Directorate expressed concern at the ability of the project to meet the necessary nuclear safety standards. Despite holding evidence of numerous serious accidents involving shiplift hoists around the world, the MoD still decided to go ahead with the project:

"The MoD remains satisfied that the shiplift is the most efficient and economic docking

option for submarines at Faslane and that it will adequately meet the stringent nuclear safety standards laid down by the MoD safety authorities and comparable with those in the civil nuclear energy industry. The MoD is confident that the complete safety case will be established by independent assessment in time for the facility to meet the requirements of Trident and other submarine programmes. There has never been any question of the Shiplift Programme proceeding at risk in the sense of not meeting the required nuclear safety standards which give rise to a degree of uncertainty – or "risk" – insofar as programme timescales are concerned."(22)

22. In 1989 the MoD acknowledged that any further delay to the shiplift would mean that it would not be available for HMS VANGUARD's sea trials.(23) At the time, the shiplift was 12 months over schedule.(24) It is now 24 months over schedule.(25) They further admitted that, if it were necessary to lift the submarine out of the water during the trials period to deal with problems or carry out repairs, the unavailability of the Faslane shiplift would cause delays in the trials. A dock at Rosyth is being refurbished to act as an alternative until the shiplift is ready,(26) at a cost of just over £8 million.(27)

23. Despite all these considerations, the MoD has remained sanguine about the situation:

"The programme for the construction of the Shiplift facility, which will be used to lift submarines out of the water for maintenance, was revised during 1990, and satisfactory progress is being made against this revised programme."(28)

24. As with other parts of the Trident Programme, the suspicion is that when delays reach a certain level, schedules are "revised" (meaning target dates are postponed), so the MoD can say that "satisfactory progress" is being made.

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6. WARHEAD

Summary

1. Despite the rescheduling of warhead assembly work at AWE Burghfield, it was noted in 1989 that unless staff shortages are resolved it would prove difficult to maintain even a modified assembly schedule for the UK Trident W-88 warhead production. Similarly, in 1990 a warning was given that remedial measures to improve staffing levels at AWE Aldermaston were a matter of some urgency if the longer-term warhead production programme was not to be placed in jeopardy. A year later, and with no significant improvement in staffing levels at Aldermaston and Burghfield, it was warned that the shortages were now so acute, they were threatening the warhead production schedule. To compound the problems for the warhead production programme, the capital works programme at Aldermaston is in tatters. Fissile component production at the plant is at present and seemingly for the near future reliant on antiquated facilities over 35 years old and well below the capacity required to produce the requisite number of warheads for all four Trident submarines in the timescale envisioned.

2. A shadow of doubt must now be cast over whether the Atomic Weapons Establishments can produce the warheads needed for the second, third and fourth Trident submarines. Further, there must be doubts whether the assembly programme at Burghfield can be sustained at a level high enough to ensure there are enough warheads for HMS VANGUARD.

Progress Towards Production

3. In 1980, Mr Fielding, the Director of Aldermaston at the time, envisaged that production of components for Trident warheads would have started by 1986.(1) In 1987, the Trident design programme was "frozen" and declared completed, after a "complex but highly successful development programme".(2)

4. In January 1988, fissile component production for Trident warheads began in the existing A45 plant. Work was also begun at AWE Cardiff on non-fissile components, with only minor problems at the outset.

5. However, A45's capacity is far below that needed for full-scale production of Trident warheads:

> "if the requirement for the three other [Trident] SSBNs ... [is] to be met, then warhead production rates must be substantially increased."(3)

6. With the completion of the first plutonium pits and highly enriched uranium components at Aldermaston, work started on the assembly of the first "re-entry vehicles" (warheads) at AWE Burghfield in 1989.(4)

7. Shortages of assembly and support staff at Burghfield led to some rescheduling of the assembly programme and the transferral of some work to AWE Cardiff.(5)

8. In 1989, the Director of AWE told the House of Commons Defence Select Committee there was a risk that, if the manpower problems at Burghfield were not resolved, it would prove difficult to maintain even the modified schedule.(6) As can be seen from the section entitled "Staff Shortages" below, these problems have not been resolved. By 1990 staff shortages at Aldermaston and Burghfield were so acute that they were threatening the production schedule of warheads.(7)

Staff Shortages

9. In 1990 the Defence Select Committee concluded that:

> "recruitment at Aldermaston of staff with the necessary skills is not yet satisfactory and that unless there is an improvement in the next two years this could have an impact on the programme."(8)

10. When the 1988 figures for shortfalls in staff at AWE Aldermaston are compared with those for 1990 (see Table 6.1), the only area that has shown a marked improvement has been in Supervisory, Administrative, Executive and Clerical Grades, where there has been a 68 per cent reduction in staff shortfall.(9)

11. For "Specialists" there has been a 132 per cent increase in shortfall. For "Industrials - Craft" there has been a 335 per cent increase in shortfall. For "Industrials - Non-Craft" there has been a 1,260 per cent increase in shortfall.(10) In January 1989, 83 per cent of AWE vacancies related directly to the Trident Programme.(11)

12. In 1990 the Defence Select Committee noted that:

> "there is now a significant risk that some elements of the warhead programme may fail to meet their scheduled delivery dates,"(12)

and that:

> "remedial measures are a matter of some urgency if the longer-term warhead production programme is not to be placed in jeopardy."(13)

13. Between 150 and 200 staff are required during the period when A90 moves into production, in addition, 700 to 800 staff are needed annually to replace those leaving or retiring.(14)

14. In mid-1989 the Government ordered a review of how Britain's nuclear weapons factories were managed and operated. The review was carried out by Sir Francis Tombs, Chairman of Rolls-Royce. The "Tombs Report" remains secret. Shortly after its completion, in December 1989, Tom King, the Secretary of State for Defence, announced in the House of Commons that the Atomic Weapons Establishments were to be "privatised". The management of those factories was to be handed over to a private contractor:

> "the need for increased production from 1992 for later Trident deliveries, against the background of the keen demand for skilled labour in the Thames Valley area, poses an increasing challenge, and one for which a greater production management capability is required.
>
> The Government consider that the best way to address these problems is by full contractorisation, with the land, facilities, and other assets remaining in the Government's ownership."(15)

TABLE 6.1

Staff Shortages at AWE Aldermaston and AWE Burghfield

a) AWE Aldermaston (approx. 5,500 staff - actual number classified)

	01/03/88	01/03/89	01/03/90
Supervisory, Administrative, Executive and Clerical Grades	111	89	36
Specialists	65	147	151
Industrials - Craft	40	52	174
Industrials - Non-craft	+10	71	136
Total	226	359	497

b) AWE Burghfield (approx. 600 staff - actual number classified)

	01/03/88	01/03/89	01/03/90
Supervisory, Administrative, Executive and Clerical Grades	13	12	13
Specialists	3	8	1
Industrials - Craft	24	34	29
Industrials - Non-Craft	22	15	12
Total	62	69	55

Source: HC 237 of Session 1989-90, p. xxiii, Table VIII.

The Capital Works Programme at Aldermaston

15. In 1978, after an extensive inquiry into the safety of continuing to operate various buildings and plant at AWE Aldermaston, the "Pochin Report" criticized the continued use of inefficient and unsafe facilities.(16) As a result, the MoD embarked upon a major refurbishment of certain facilities at the base.

16. In 1980 the then Secretary of State approved the construction of nine major new and improved facilities at an estimated cost of £134 million.

17. By 1982, and with the decision to purchase the Trident II (D5) weapons system, there was a need for a greater production capacity than originally planned, and a need to produce the warheads 2 years earlier than originally planned.

18. The cost of the original nine projects rose to £370 million by September 1985, and programme slippage was forecast.(17)

19. The MoD and the Property Services Agency (PSA) carried out a review of 32 capital and works projects, which was completed in May 1986. The review confirmed that there were difficulties, and disclosed that the 32 projects could cost as much as £1,060 million. Projects critical to Trident would cost, as a best case, £657 million.(18)

20. In 1982 Ministers were warned in writing of the danger of proceeding with the capital works programme at AWE without a clear idea of what they were supposed to be building and what was to go into those buildings. This resulted in the PSA following a policy of sequential contracting, whereby structures were designed and built without a full appreciation of the equipment they would house. Ministers apparently considered that the urgency of ensuring that AWE met the needs of the Trident Programme was far more important than following normal building procedures.(19)

21. In January 1986, MoD reported to the Defence Committee that:

> "Both the development of the nuclear warhead and the construction of the new facilities at Aldermaston and Burghfield to support the programme continue to make satisfactory progress."(20)

However, at the time, the Controller R&D Establishments Research and Nuclear Programmes (CERN) was in the middle of a major review because of concerns over problems at Aldermaston.(21)

22. In 1987, when asked if the production of warheads for Trident was on schedule, MoD replied:

> "The preparatory stages for warhead production are proceeding satisfactorily. There have been delays with some of the new production facilities at AWRE but the Ministry of Defence expects that planned weapon-in-service date to be achieved."(22)

23. However, the Comptroller and Auditor General had this to say about the AWE capital works programme:

> "(a) A review in 1985-86 by MoD in conjunction with PSA, following evidence of significant cost escalation and delay, identified deficiencies in overall planning and control of the programme and a need for improvements in the co-ordination of individual projects and in liaison between CERN and CSSE ...
> (b) To meet the Trident timetable, there have been departures from normal procedures for control of capital works projects: in particular sequential contracting, involving the letting of contracts for buildings before the plant to be housed was designed; the letting of contracts before completion of designs; and a reduction in the number of discrete planning stages.
> (c) The risks associated with accelerating the start of the capital works have been reflected in uncertain estimates of cost and completion.
> (d) The nuclear works programme, although not formally part of the Trident Programme, remains an additional source of risk financially."(23)

24. Warhead production was in an uncertain predicament:

"We are dismayed and concerned at the lack of control of the size and cost of this programme and the inadequate co-ordination with the main Trident programme ..."(24)

"... They told us that provided the existing facilities did not break down, their use decreased the risk to the programme in comparison with not having them available. We note MoD's assurances that they expect to meet the programme. However there is clearly some risk of breakdown and we are concerned at the extent of reliance on the use of ageing facilities which need to be replaced."(25)

25. The Defence Committee was critical of MoD progress reports in the light of the Comptroller and Auditor General's report:

"The MoD's statement in January 1986 did not relate to 'the programme overall'. The part that related to the development programme was accurate. The part which related specifically to the construction of the new facilities at Aldermaston and Burghfield was demonstrably inaccurate.

We consider that MoD can have little cause for complaint if future assurances are not taken at face value."(26)

26. In 1987 John Brown Engineering was given a six-month contract by the MoD to carry out a special audit into what was going wrong with the construction programme at AWE. In order to assist AWE with the coordination and integration of key projects in the construction programme, John Brown was asked to prepare a detailed inventory of the project and a forward project plan, to provide an estimate of time and cost, and to comment on forward management plans.(27) At the time of the audit,

"Many multi-million pound contracts which should have started over a year ago have still to get underway. Others are overbudget."(28)

27. The John Brown audit found that construction costs at AWE were likely to triple from an initial estimate of £321 million to over £1 billion. As a result of the audit the MoD decided to appoint a management contractor to oversee construction.

28. The National Nuclear Corporation (NNC) was contracted to provide an integrated project management service in June 1988:

"It had been anticipated that the A-90 production complex would be handed over to the establishment in 1986, but this expectation changed to 1988 after the Government opted for the D-5 version of Trident ... The new facilities are planned to come into production in early 1992, and will then take over from production in existing facilities. Deliveries of finished components will begin before the end of 1992."(29)

Problems With the A90 Production Complex

29. In May 1990 it was reported that ducting used to carry inert gases to and from "gloveboxes" was found to be in a dangerous condition. The ducting in A90 had to be ripped out and replaced at a cost of £5 million.(30)

30. It was also discovered that the ducting was being supported by struts which were below the required standard. Instead of using 2.5mm steel U-channels, 1.5mm U-channels were used. These are normally used for light-duty jobs, such as carrying suspended ceilings. Apparently, in

some areas these struts were beginning to buckle under the weight. Witnesses inside A90 reported that, in December 1989, these substandard struts were still in place, 12 months after work to replace the defective ductwork had begun.(31)

31. Pressure-sensing equipment that detects changes in air pressure inside air ducts was found to be unsatisfactory. A similar model is being considered as a substitute.(32)

32. In the trade magazine *Building*, it was claimed that "a considerable amount of work" was carried out in February 1989 to replace under-powered fans in the air conditioning system. Testing of the system, which was due to be complete by September 1988, showed higher than expected levels of resistance to airflow. The upgrading of fans has forced the introduction of higher capacity electrical cabling.(33)

33. The material movement control system in the A90 building incurred a large number of software errors.(34)

34. The replacement of A90 Zone 1 ductwork and its supports by a pipework system was completed in April 1990, and full leak testing of the replacement pipework had been carried out successfully, 5 months later than planned.(35)

Problems With the A91 Radioactive Waste Management Plant

35. Aside from the delays there have been in A90, another building, A91, which is crucial to the safe operation of not only A90 but of all buildings within the Aldermaston complex that work with radioactive materials, is having severe problems. Any delay in A91 will have a knock-on effect to the safe operation of A90.

36. Liquid wastes will be fed into this building via gantry pipelines from all the main radioactive buildings. Here they will be held in totally enclosed vessels and treated to remove radioactive contaminants on a flocculent precipitate of ferric hydroxide. The clear liquid after filtration will be held for analysis to confirm its quality and purity before release. The contaminants will be retained in sludges, which are to be mixed with cement in steel drums, sealed and sent for disposal.(36)

37. The existing waste management facilities have been in operation for over 35 years, but their age, along with the increasing workload from current and future facilities, dictates the need for a new plant.(37) The existing facilities are unlikely to be able to cope with the increased output of waste from all the radioactive areas of the plant. The "Pochin Report" stated:

> "In the longer term the relocation of these processes [handling liquid and solid waste] as a whole is likely to be required as soon as practicable."(38)

38. Stainless steel pipes within A91, the liquid waste treatment plant, designed to carry away radioactive gases from A90 were found to be corroded. The corrosion occurred when a chloride solution was flushed through the pipes to test for leaks. One worker was quoted as saying that the joints in pipes were so weak it was possible "to push a pencil through them".(39)

39. The same stainless steel piping within A91 is contaminated with a microbiological problem: bacteria commonly found in the environment are thought to be eroding these pipes. Brian Richards, the Director of AWE, when interviewed about this problem, said:

> "Stainless steel is assumed to be stainless and totally resistant to corrosion. It is not true. It is simply more resistant than ordinary steel but not infinitely resistant to all kinds of attack. And

we have discovered the processes and the materials in there have produced not the extremely low level of almost non-corrosion we had expected but a slightly higher level. There is no hazard whatsoever as a result of that corrosion. The reason that you do commissioning is to ensure 'bugs', excuse the pun are ironed out."(40)

He further said that a repair programme was being set up, but stressed it would not delay the Trident Programme.

40. The Atomic Energy Authority at Harwell want an internal inspection of every inch of pipeline to be carried out with miniature cameras, in order to discover the full extent of the damage. In contrast with Mr Richards' reassuring comments, it was reported in Construction Weekly:

"The two [corrosion and bacteria] have damaged the system so badly that the site has been at a standstill for weeks while AWE considers a course of remedial action ... The cost of remedial work is certain to run into tens of millions of pounds ... the delay involved will also be considerable.

A delay of at least a year would seem to be inevitable, with an equally inevitable knock-on effect on Trident warhead production ... The A91 commissioning errors must add to the already ballooning budget for the Aldermaston construction programme."(41)

41. Without the A91 waste management facility in working order, it appears that the entire fissile material production capability of Aldermaston has ground to a halt.

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