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NATIONAL AUDIT OFFICE

Report by the  
Comptroller and  
Auditor General

FOR CONSULTATION ONLY

# Ministry of Defence and Property Services Agency: Control and Management of the Trident Programme

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# **Ministry of Defence and Property Services Agency: Control and Management of the Trident Programme**

## **Summary and conclusions**

1. In July 1980 the Government announced its decision to purchase the United States (US) Trident I (C4) strategic weapon system to replace the Polaris force from the 1990s. Following the US decision to replace the Trident I (C4) by the Trident II (D5) system the Government in March 1982 announced its revised choice of the Trident II (D5) system at an estimated cost of some £7,500 million (at September 1981 prices and exchange rates). Defence Open Government Documents 80/23 and 82/1 explained the background to, and various factors involved in, the decision to purchase Trident and 87/1 (published in January 1987) discussed "Trident and the alternatives".

2. My first report on the Trident programme in February 1984 (HC 287) and the Public Accounts Committee (PAC)'s subsequent 19th Report of 1983 - 84 (HC 348) both concluded that the Ministry of Defence (MOD) had established a satisfactory framework for control of the project but that this had not been fully tested in practice. This report summarises the results of an examination by the National Audit Office (NAO) in 1986 of the control and management by MOD and the Property Services Agency (PSA) of the major elements of the programme to see how the arrangements were operating in practice, taking into account the conclusions reached by PAC in their 1983 - 84 Report. I intend to provide PAC with further details to supplement this Report, on a confidential basis.

## **Main findings and conclusions**

3. The results of this further review of the developing Trident programme indicate that the framework of financial control and project management described in my earlier Report is generally operating effectively. However delays and cost increases have occurred in the Trident works programme and in the programme for new facilities at the Atomic Weapons Research Establishment (AWRE) which is not formally part of the Trident programme. The need for improvements in the arrangements for both of these programmes and in the co-ordination of the AWRE and Trident programmes has been recognised and new measures have been introduced by MOD and PSA.

4. MOD expect the weapon system in-service dates to be achieved at a reduced estimated cost in real terms — at 1986 - 87 prices, £9,265 million compared with the November 1981 estimate, after adjustment for inflation and exchange rate variations, of £10,769 million. However, the bulk of the expenditure still has to be incurred, and the sterling cost of the US part of the programme is vulnerable to any future unfavourable movement in exchange rates. The US missile development programme is significantly more

advanced than the United Kingdom (UK) Trident programme and there is no indication of any US problems which would jeopardise the UK programme. However some sources of risk to the UK programme remain, particularly in the building works and AWRE capital programmes and also as a result of shortages of specialist staff in MOD for weapon system software development and at AWRE.

5. Annual expenditure on the Trident programme will increase substantially over the next few years and I propose to keep it under review and report as necessary. In the meantime NAO's examination has suggested that the following points, all of which MOD or PSA have in mind, are important to continued effective management and control of the programme:

- (a) the introduction of a top level critical path network to monitor the programme as a whole (paragraph 2.4);
- (b) the size and use of the large central contingency, which should be kept under close review during the later stages of the programme (paragraph 2.9(a));
- (c) the negotiation of a fair price for the further submarine orders, taking account of improvements in productivity arising from the Submarine Facilities Project (paragraph 3.6);
- (d) the adequacy of scientific staff resources for proving the effectiveness of the Strategic Weapon System (paragraph 3.11);
- (e) the need to ensure that the contractual responsibilities and liabilities of the various parties involved in the Trident works programme are clearly defined and that the working of the arrangements involving the Construction Programme Co-ordinator and other special measures introduced to improve control of the programme are closely monitored by the appropriate MOD/PSA Headquarters Committees (paragraph 3.24(d) and (e));
- (f) restriction to a minimum of departures from normal procedures for works projects (paragraphs 3.24(f) and 3.28(b));
- (g) the need to ensure the effectiveness of the improvements in the management of the AWRE capital programme and its co-ordination with the main Trident programme (paragraphs 2.3 and 3.28(a)).

# Ministry of Defence and Property Services Agency: Control and Management of the Trident Programme

## Report

### Part 1: Programme Costs

1.1 The Trident acquisition programme comprises the construction of four nuclear-powered ballistic missile submarines; the provision of missiles and nuclear warheads, and associated building works and research and development programmes; and the supply of necessary training, support and refitting facilities. The US will supply the missiles and associated strategic weapon systems equipment, certain warhead-related components and services, and missile preparation and refurbishment services; the remainder of the programme will be carried out by the UK.

1.2 In its Sixth Report of 1984-85 in July 1985 (HC 479), the Select Committee on Defence concluded that on the information available at the time there was no reason to doubt the cost estimates for Trident. Nevertheless the Committee expressed concern regarding the possible effects of Trident cost increases on the rest of the Defence Programme and emphasised the need for the Government to keep Parliament fully informed on all aspects of Trident progress. In response MOD have submitted progress reports to the Defence Committee and to PAC (on 11 March 1986 and 27 January 1987) which confirmed that the programme was on schedule, gave details of progress on the major elements of the programme and showed the changes between the current and previous cost estimates. MOD intend to issue similar progress reports annually in future.

1.3 The decision to acquire Trident II (D5) in March 1982 was made on the basis of a November 1981 estimate of total project cost of £7,520 million at the September 1981 price level and exchange rate (£1 = \$1.78). This figure was subsequently reduced as a result of the decision later in 1982 to prepare and refurbish the UK missiles in the US at Kings Bay, Georgia. At average 1986-87 prices and an exchange rate of £1:\$1.50 the current estimate is £9,265 million. The changes are shown in the following table.

1.4 The programme consists of a number of separate major projects. NAO examined the arrangements for control of the overall programme and the main projects. As shown in the table, substantial real cost savings have occurred on the US elements of the programme. In the UK elements some estimates have increased substantially, partly offset by substantial savings on submarines. The increase in the UK element for item (e)

	Estimated cost £m	Expenditure in US £m	UK £m
November 1981			
Estimate (Sept 1981 prices, \$1.78)	7,520	3,313 (44%)	4,207 (56%)
Inflation	2,444	1,001	1,443
Exchange rate variations	805	805	—
Kings Bay changes	(767)	(317)	(450)
Other real cost changes:			
(a) Submarines (less weapon systems equipment)	(803)	(98)	(705)
(b) Missiles	(635)	(619)	(16)
(c) Weapon system equipment (including tactical systems)	(15)	(337)	322
(d) Shore construction	360	—	360
(e) Warhead, miscellaneous and unallocated contingency etc	356	(269)	625
Current estimate (1986-87 prices, \$1.50)	9,265	3,479 (38%)	5,786 (62%)

mainly reflects a decision to procure certain materials in the UK rather than the US. The increases on items (c) and (d) occurred early in the programme and no substantial cost increases have been reported since 1984.

1.5 The table at Appendix 1 reconciles the estimate figures at the three stages referred to in paragraph 1.3 above and the effect of changes in the dollar/sterling exchange rate is shown at Appendix 2. Taken together these illustrate how, if the pound strengthens against the dollar, the difference in real terms between the earlier and current estimates, like the proportion of US costs, progressively decreases. Total expenditure on the Trident programme to 31 March 1987 was some £1,000 million, with a further £2,000 million committed.

Further substantial commitments will be entered into in 1987, in particular the planned placing of the second submarine contract. Annual expenditure will peak in the late 1980s/early 1990s at some £950 million, tapering thereafter to less than £100 million (exclusive of central contingency) in 1999 – 2000.

1.6 The Trident costing is more comprehensive than those for MOD's conventional projects. It includes the cost of the weapon platform and armaments and associated training, support and refitting facilities, MOD's estimated additional resource costs and an element for those of the PSA. It does not include the cost

of MOD's existing staff resources, or running costs after entry into service, and there are some areas of expenditure associated with the Trident system, as indicated in my earlier Report (HC 287, paragraph 8), which are not reflected in the programme estimates. MOD informed NAO that where Trident needed to share the use of new or already existing facilities, or of development or production programmes, any additional costs incurred were attributed to Trident. NAO examined the arrangements for providing some facilities not charged to the programme, but vital to its success, in the light of evidence of significant cost increases (paragraph 3.28 and Appendix 4).

## Part 2: Programme Management and Financial Control

### Overall control structure

2.1 My earlier Report (HC 287 paragraphs 13-16) described the arrangements for overall programme management. The main features, which still apply, are

- (a) general oversight by a top-level Trident Group;
- (b) regular reviews of progress by the Trident Watch Committee (TWC) at senior level;
- (c) overall management by the Chief Strategic Systems Executive (CSSE), who has total technical and financial accountability for the nuclear powered submarines and the Strategic Weapon System (SWS): he is responsible for liaison with the US on SWS development and procurement and for co-ordinating the work of other MOD directorates, and through them the staff of the PSA, on support and building works: he also co-ordinates work on warhead development and production;
- (d) procurement of the UK warhead, including development and production, is the responsibility of Controller R&D Establishments, Research and Nuclear Programmes (CERN).

In July 1986 the Chairman of the Trident Group, the chief of Naval Staff, was appointed to take overall charge of the Trident programme including the warhead procurement. The problems which led to this change are described in paragraphs 2.3, 3.28 and Appendix 4.

### Monitoring and management of progress and performance

2.2 NAO found that Trident's progress was monitored by a hierarchy of committees. The Trident Group directs CSSE, oversees the planning, progress and costs of the Programme on the basis of reports from the TWC, and monitors technical and financial exchanges with the US authorities. The TWC reviews all aspects of the programme at four monthly intervals on the basis of progress reports from CSSE and CERN. Representatives from all areas of the programme report monthly to CSSE on the current status of projects across the whole field of Strategic Systems work. In February 1986 CSSE introduced a Trident Project Review to provide him with the opportunity to review all aspects of the project prior to his report to the TWC.

2.3 The overall programme management structure and procedures are designed to ensure that problems arising in any part of the programme are quickly brought to the attention of senior management so that any detrimental effects on other parts of the programme can be assessed and remedial action taken where necessary. However, while in general the procedures appeared to operate satisfactorily, difficulties and delay in the associated capital works programme at the Atomic Weapons Research Establishment (AWRE) (paragraph 3.28), which is managed separately from the Trident building works programme (paragraphs 3.22-3.24), pointed to some lack

of co-ordination with the main Trident programme. The TWC was notified of the problem and its possible consequences in May 1986 and as a result steps were taken to improve future co-ordination and reporting. Apart from the widening of control by the Chief of Naval Staff noted above, Trident-associated capital work at AWRE has been placed under a single programme director. CERN now holds regular briefing and progress meetings with CSSE, who is also a member of CERN's Nuclear Facilities Management Board which was formed at the beginning of 1987. These changes are designed to ensure that any future problems will be brought to notice quickly.

2.4 MOD have also recognised the scope for improvement in CSSE's procedures for co-ordinating and monitoring all the various Trident projects to achieve the objectives set out in the overall programme. At present CSSE monitors progress on individual projects against some 800 programme objectives (or "milestones") selected from a hierarchy of some 3,000 inter-related Directorate milestones. However as a result of manpower shortages it has not yet been possible to introduce a network for the programme as a whole, to assist the analysis of the critical path and the monitoring of areas of concern. The lack of such a network would increasingly reduce the effectiveness of the management information system. To improve programme monitoring and to enable interdependencies to be more readily appreciated, MOD have commissioned a firm of consultants to formulate a top level monitoring network. Work commenced in April 1986 and MOD expected the new monitoring system to be operational by mid-1987.

### Cost control

2.5 Financial management and control of the Trident programme are exercised on CSSE's behalf by the Director of Resources and Programmes (Strategic Systems) (DRP(SS)), who is also responsible for financial oversight of the Polaris and Chevaline programmes. Records of Trident financial estimates and expenditure are maintained under DRP(SS) by the Trident Finance Officer (TFO).

2.6 Eighty-three per cent of the Trident programme expenditure, including that for non-CSSE areas, is identified by specific Sub Items on Defence Votes. The remaining expenditure is generally within areas where Trident costs are an integral part of a wider programme and where the budget holders are responsible for identifying and reporting Trident costs to the TFO. The TFO operates a computerised project management system which produces cost and programme information for the Trident Cost Plan.

2.7 The future spread of the Trident estimate is reviewed each year as part of MOD's Long Term Costing (LTC) exercise designed to match resources with commitments during the following ten years. Reductions of £28 million were identified as part of the LTC 86 savings exercise. Ministerial and Treasury approval is sought to



enter into any additional financial commitments necessary to maintain the Trident programme during the financial year. In the main this is sought by the TFO through the Trident Annual Funding Submission, although because Works and Special Nuclear Materials Costs are part of wider programmes, approvals for these are sought separately. Major items such as submarine orders are also submitted separately.

2.8 NAO noted that the main UK contracts covering submarines, weapons and building works awarded by the end of 1986 were valued at approximately £2,100 million. Of that sum contracts totalling £240 million were let as a result of competition, whilst £650 million relating to the contract for the construction of the first submarine and completion of First of Class work was let in a competitive environment (see paragraph 3.4).

2.9 NAO concluded that financial control was sound and operated effectively, subject to the following comments:

(a) The total programme estimate includes contingencies of £1,530 million or just over 22 per cent of remaining expenditure. These fall into two categories: those for component projects, controlled by the project managers; and a central contingency, controlled by CSSE with the advice of DRP(SS). CSSE is responsible for ensuring that the project contingencies are reasonable and for determining the size of the central contingency. Following the Trident Group's examination of the updated estimates in February 1986, the balance between project and central contingencies was re-examined on the basis that the retention of substantial project contingencies might weaken the incentive of Project Managers to keep costs to a minimum. A total of £188 million falling outside the LTC period was returned from two projects to the central contingency but in the works, support and nuclear projects, existing contingency provisions were considered to be justified. NAO concluded that it was prudent to retain a large central contingency at

this stage but that its size and its use would need to be kept under close review during the later stages of the programme.

(b) Estimates of UK expenditure are prepared in accordance with normal MOD procedures. The US provides by 1 April of each year detailed estimates of the cost and incidence of expenditure on US supplies and services for the UK. This information is incorporated into the LTC exercise which spans the following year. MOD have encountered two problems in using these US estimates.

(i) MOD, initially assuming that US estimates were on a constant price basis and comparable with their own, revalued them each year using US inflation indices; in 1984 however MOD learned that the US estimates included estimated inflation over the life of the contract and thus their own estimates were overstated by 5 per cent. US estimates are now provided without an inflation element.

(ii) MOD questioned the realism of US estimates after noting that prior to 1985 cash payments actually made to the US were considerably lower than expected commitments; MOD made their own adjustments for provision in the LTC and subsequently US estimates were reduced. As the Trident programme becomes an increasingly large proportion of the Defence budget, inaccurate expenditure forecasts could have a detrimental effect on other MOD programmes. Following discussion at the September 1985 meeting of the US/UK Finance Working Group the US reported improvements to their forecasting procedures to provide more realistic figures in future. The Trident Budget Estimates submitted by the US in May 1986 included a "realism adjustment" reducing the estimated UK liability during the period of acquisition by some \$420 million (10 per cent).

## Part 3: Control and Management of Individual Projects

3.1 NAO examined the management and financial control of five of the major projects which form a part of the Trident programme: the submarine itself, the strategic and the tactical weapon systems, the supporting building works, and the nuclear programme. In conjunction with the last item, NAO examined the arrangements for provision of the associated facilities, ie the AWRE capital works, which are not charged to the Trident programme.

### Submarines

3.2 In their 35th Report of 1984-85, PAC were concerned at the general low level of productivity in the warship yards and that MOD had allowed Vickers Shipbuilding and Engineering Ltd (VSEL) to exploit their monopoly position in nuclear submarine procurement. They trusted that measures to improve management and productivity of VSEL would continue but were convinced there were substantial savings to be made in the proposed £2 billion programme for nuclear submarines and intended to keep progress under review.

3.3 They also expressed concern over problems in the co-ordination of ships and weapons development which had resulted in delay in bringing a number of First of Class ships to full operational effectiveness. MOD at that stage were addressing this problem by considering ships and weapons as a package from the start. Within the Trident programme, which involves the construction in the UK of four nuclear powered ballistic missile submarines, this responsibility rests with the Director Trident Submarines (DTR). He is required to manage the overall design and procurement of the submarines, within the approved programme budget and specifications, on a whole ship and weapon basis. Among his major tasks is that of co-ordinating the preparation of the overall project budget, including those equipments being procured or specified by the Deputy Controller Warship Equipments. He is also responsible for identifying the responsibilities of other authorities in relation to the project, defining and agreeing their tasks and the related interfaces, and monitoring their progress; and for arranging the placing of contracts for and managing the procurement, construction, testing and trials of the submarine, including its tactical weapon system, and, in conjunction with Director General Strategic Weapons Systems (DGSWS), its strategic weapon system. The submarine and these weapon systems are however the subject of separate contracts.

3.4 The current estimate for submarines, excluding weapons, of £2,849 million represents a real cost saving of £803 million (22 per cent) on the 1981 estimate, due mainly to re-assessment of build costs (13 per cent) and the contingency allowance (5 per cent). A target price contract for the construction of SSBN 05, the first Trident submarine, and completion of First of Class work was let to VSEL in April 1986 at an estimated cost of £650 million. The target price was some £45 million below VSEL's initial tender. The favourable price was due partly to the unique situation provided by the competition between VSEL and Trafalgar House to purchase

the VSEL Yard at Barrow on privatisation; and partly to the improved productivity resulting from the modernised yard facilities, the Submarine Facilities Project.

3.5 The contract price includes the cost of the submarine's nuclear propulsion system, the PWR 2, which VSEL will purchase from Rolls Royce and Associates Ltd. The Trident programme does not include development of the PWR 2, which is a general MOD development project, but it will bear the costs of modifying PWR 2 for Trident submarines and of nuclear cores purchased by MOD from Rolls Royce and Associates Ltd for installation by VSEL.

3.6 In their 40th Report of 1985-86, on the procurement of warships, PAC noted that the savings on the first Trident submarine order were achieved as a result of competition between potential purchasers of VSEL but emphasised that it was important that the improved productivity resulting from the Submarine Facilities Project, which was funded mainly from Public Dividend Capital, should also be reflected in the prices for later submarines which would not be subject to competition. In their 43rd Report of 1985-86, on assistance to British Shipbuilders, PAC said that they were surprised to learn from the Department of Trade and Industry that when negotiating the sale of VSEL they had not sought to impose any conditions to ensure that benefits arising from the Submarine Facilities Project would accrue to MOD. Had this been done it would undoubtedly have strengthened MOD's hand in future negotiations. MOD hope for more economic prices for future submarines as the full potential of the facilities is realised but it is clear that they will have to negotiate very hard in the absence of competition.

3.7 The standard MOD Contract Break Clause gives the Ministry the power to determine the contract at any time, subject to payment of the contractor's fair and reasonable costs within the limit of the price that would have been payable had the contract been completed. Because of the importance of the SSBN 05 contract to the future of VSEL and the severe damage they would suffer if it was cancelled, the company sought to remove entirely the limit of liability provision. In the event, after hard and protracted negotiations, VSEL accepted an upper limitation of 125 per cent of the contract price, to be reduced to the standard 100 per cent when the order for SSBN 06 was placed (planned for the summer of 1987), from which point both contracts would be subject to the standard Break Clause terms. MOD told NAO that no other Trident contracts provided for termination payments in excess of the standard 100 per cent; NAO's examination confirmed this for the major contracts.

### Strategic Weapon System

3.8 The Trident Strategic Weapon System (SWS), a ballistic missile system, is being developed and produced in the US. The Director, US Strategic Systems Program Office will design and produce the necessary subsystems and components of the SWS, except for the



warhead, which is being developed in the UK. Control of the US elements of the programme is described in paragraphs 4.1 to 4.10. In the UK, DGSWS is directly responsible to CSSE for the procurement of the SWS, including the determination of specifications and the assessment of system performance and effectiveness.

3.9 In 1982 the Government decided that UK Trident missiles should be processed in US facilities at Kings Bay, Georgia. This reduced the estimated cost of the SWS from £3,556 million to £3,171 million (1986-87 prices and £1:\$1.50). Since 1982 the estimate has been reduced by a further £928 million to £2,243 million. Most of this reduction has been due to better estimating, re-allocation of some of the work to the support area and reduced contingencies as confidence in estimates has increased; 95 per cent of this sum will be spent in the US.

3.10 In 1984 MOD told PAC that the supply by the US of the SWS and missiles did not create any problems since the US were very much further forward in their design work; and that while substantial areas of the programme were dependent on the US, there were frequent and close contacts between the UK and US to liaise on all aspects of the joint programme. This remains the position and the information provided by the US enables MOD to monitor progress effectively by monthly reviews of technical progress and programme milestones. Although the Strategic Systems Program Office are reporting cost and timescale over-runs on some areas of the total weapon system, they remain confident of finding solutions and overall progress is good. In May 1986 the Procurement Executive told MOD's Equipment Policy Committee during its review of the UK Trident project that there was little doubt that the US would produce the Trident SWS to time and cost by means of their well tried and proven procurement methods. And MOD derive additional comfort from the knowledge that the US programme of test firings commenced on time with the pad launch of the first Trident II on 15 January 1987; and also that the system is due to be operational in the US in late 1989, some five years earlier than in the UK.

3.11 The performance and capability of the SWS will be proven by the US during development and production. However, proving the effectiveness of the system for UK purposes is dependent on the production in the UK of software for targeting, modelling and effectiveness assessment. DGSWS currently has a continuing shortage of scientific staff to carry out these tasks and has had difficulty in recruiting such specialists since 1982. The position is not yet critical, but could become so, with a potential risk to assurance of the effectiveness of the UK system. Software work is being contracted-out to complete essential tasks.

### **Tactical Weapon System**

3.12 Development and production of the equipments which comprise the Tactical Weapon System (TWS) in the UK is managed by the Deputy Controller, Warship Equipment, while it is DTR's responsibility to bring these together to function as a system and to integrate them into the submarine (paragraph 3.3). Management effort is co-ordinated by a TWS Steering Committee

established to consider both programme and financial aspects and chaired by DTR. Below this level the Chairman of the TWS Management Team, who reports to DTR, is responsible for overall co-ordination of the TWS while the Finance Co-ordinating Officer provides a financial management and secretariat service for the TWS and co-ordinates inputs to higher Trident management and the TWS Steering Committee and Management Team. The Finance Co-ordinating Group monitors TWS development and production costs and is one of several working groups reporting to the TWS Management Team.

3.13 The original cost estimate of £450 million (average 1986-87 prices) has 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). The increases occurred in the early years of the project. Late in 1985 MOD undertook a cost revalidation exercise to consolidate the effects of management changes, better definition of the TWS requirement and the advancement of the programme by two years since the endorsement of the Trident staff requirement. NAO concluded that the system of control based on continuous monitoring and periodic review appeared to be keeping costs within a ceiling figure set in 1984, and that in general the management and financial control of TWS was now operating satisfactorily. In this connection NAO noted that some changes aimed at strengthening control in the TWS area had been introduced and these took account of recommendations made in a review by MOD's Internal Audit during Autumn 1985.

3.14 At project level financial advice and assistance to project managers is provided by project finance staff. Their responsibilities cover oversight of the propriety and regularity of all project expenditure, including the exercise of delegated financial powers. They are also responsible for ensuring that adequate provision is made in LTCs and Estimates; establishing and monitoring project financial plans; monitoring performance against budgets, estimates and LTC provisions; maintaining financial records; and co-ordinating and editing submissions to the Equipment Policy Committee with regard to accounting requirements. NAO examined two of the major component projects within the TWS.

#### *(i) Submarine Command System (SMCS)*

3.15 The SMCS sub-system comprises a new advanced computerised command system to aid manoeuvring and weapons deployment in the submarine and was the subject of a competitive feasibility study between two companies. To meet the Trident timescale the competitive Project Definition phase which followed, based on a Cardinal Points Specification, was compressed to six months. The resultant bids for full development and production, received in June 1985, were too expensive and MOD considered the solutions unsuitable for the Trident timescale. Both companies were asked to re-submit compliant bids to meet the full Staff Requirement, together with a reduced cost option in line with the LTC provision. MOD were seriously concerned at this situation: the only alternative equipment was not up to the task and the Trident programme timescale would have meant a

very tight programme for the development of a new, large software project. Problems occurring in the management of similar software projects had given rise to the review by MOD's Chief Scientific Adviser referred to in my Report on the Development of Major Equipments (HC 568). This identified the difficulty in such cases of defining the requirement and the acceptance criteria sufficiently to support competitive fixed price procurement. For the SMCS the tight timescale increased this risk. In these circumstances the Defence Staff agreed that the contract should permit a phased delivery of software, to meet the minimum essential requirement initially, provided that the system had the potential to accommodate additional requirements.

3.16 Following evaluation of revised tenders received in December 1985, MOD accepted a firm price bid by Gresham CAP Ltd of £123 million for the reduced cost option. This offered acceptable performance specifications and acceptance criteria which MOD considered reduced the risk to acceptable levels and met the minimum essential requirement agreed by the Defence Staff.

3.17 The contract covers the development, production and upkeep of the first batch of equipments, with the right to take up the offers for batches 2 and 3 when appropriate or to put those batches to further competition. The firm price arrangement involves less detailed MOD monitoring than for a cost reimbursement contract. The stage payment scheme allows retention of at least 10 per cent of incurred expenditure (up to 30 per cent in the early stages) and requires the contractor to absorb the financing cost of about £3 million. These arrangements provide the valuable feature of risk sharing in a software based project involving substantial development. The timetable remains very tight; however MOD are confident that the contractor has good incentives to perform well and deliver to time.

#### (ii) *Sonar 2054*

3.18 The original development programme for this 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. The development phase was however delayed by an estimated year to 18 months during the period 1980-1983 by several factors, including uncertainties over the suitability of the planned specification and changes in the items to be covered by it. Further delays arose when the Prime Contractor (Plessey) fell behind by nine months in the Project Definition and Demonstrator stages; internal reviews, investigations and re-organisation contributed to a delay of five months; and finally there was four month's delay while the relative merits of fixed price and incentive contracts for full development and the supply of prototype and pre-production models were considered and appraised. In addition Ministerial approval was withheld during this period while MOD attempted to persuade the Prime Contractor to either reduce his proposed fixed price or accept a maximum price for an incentive contract.

3.19 All these delays increased the pressure on the overall Trident timescale and weakened MOD's negotiating power against the Prime Contractor's monopoly

position. MOD's negotiations with the contractor were unsuccessful. The matter was referred to the Secretary of State for Defence who concluded that the cost gap between the fixed price and target cost incentive contracts (some £23 million) was too wide to justify agreeing the fixed price. MOD therefore accepted the incentive contract but the Secretary of State asked for monthly progress reports and decided that dual sourcing, including European sources, should be considered for future sonar equipment.

3.20 In total these matters have contributed to a three year development/production overlap which may rule out competition for production of Sonar 2054 before the last submarine, other than at the second tier sub-contract level. This case illustrates MOD's recently tougher approach to contract negotiations but also the effect on the project of action by agencies outside the direct control of the Project Manager.

3.21 Apart from the problems referred to above, progress on the TWS appeared to NAO to be satisfactory.

#### **The Trident building works programme**

3.22 A substantial building programme is required in support of the Trident project since existing Polaris facilities will largely be inadequate or unavailable to Trident while Polaris and Trident are both in service. The programme comprises some 110 major works projects, mostly at Faslane and Coulport on the Clyde, but also at Rosyth and locations in the south of England; MOD are considering other projects for inclusion. The programme contains projects required both wholly and partly in support of Trident. The total estimated cost of the Trident-related programme (excluding PSA's resource costs) is £945 million (September 1986 prices). Of this, £595 million (63 per cent) is currently attributed to the Trident budget, in accordance with the criteria in paragraph 1.6 above.

3.23 The works programme is vital to the successful deployment of the submarines. It is the largest and most complex works programme ever undertaken by MOD and PSA and has encountered considerable environmental, technological and political difficulties. In 1984 MOD told PAC that while the Trident programme as a whole was on target, the main area of uncertainty was the construction programme for shore facilities and infrastructure; in 1985 the Select Committee on Defence noted that the works programme was an area where cost estimates were still extremely uncertain.

3.24 The arrangements for management and financial control of the works programme and the results of NAO's examination are described at Appendix 3. The main points are:

- (a) by 1984 the estimated cost of the programme had increased in real terms by more than 100 per cent compared with the original provisional estimate in November 1981, on the basis of which approval had been given; a review in 1984, at which stage the detail of the facilities to be provided was becoming clear, resulted in changes in the management arrangements and the establishment of a revised baseline cost which has not subsequently been revised in real terms.



(b) the programme cost estimate of £671 million (1986-87 prices), including PSA resource costs, currently contains a contingency provision of some £200 million but MOD and PSA consider that it is necessary to cover many further uncertainties; many of the projects are at a very early stage and contracts have been let for only about 20 per cent by value of the programme.

(c) MOD and PSA have established a strong committee and reporting structure and arrangements to co-ordinate the various elements of the programme to ensure completion to time and cost.

(d) MOD and PSA have also introduced improvements in works control procedures specifically for the Trident Programme, in particular the appointment of a Trident Works Project Manager in MOD; a MOD/PSA Statement of Understanding on construction matters; direct reporting by PSA to MOD during the course of individual contracts; and joint MOD/PSA cost and requirements audits during the design phase. The effectiveness of these arrangements appeared to NAO to be crucial to the successful completion of the works programme, and therefore to require close monitoring by the appropriate Headquarters committee.

(e) as a result of problems arising and a shortage of the necessary specialist staff, PSA in February 1987 appointed a Construction Programme Co-ordinator to manage the construction sites at Faslane and Coulport; it is important that the contractual responsibilities and liabilities of the various parties in such a complex programme are clearly defined and the arrangements closely monitored.

(f) cost control currently was generally satisfactory, although there had been some modifications to normal financial control procedures for works projects.

(g) some of the time budgets had already been eroded but MOD and PSA expect that the bulk of the programme will be completed on time and are making contingency plans to meet requirements should key facilities not be available.

(h) the Works Programme nevertheless remains a high risk area for the Trident Programme.

### **The Nuclear programme**

3.25 CERN is responsible for procurement of the UK warhead, including development, production, testing and special materials, and certain surface support equipment. In my earlier Report (HC 287 paragraph 8) I referred to the new production and research facilities being constructed at AWRE as being an area of expenditure associated with the project but not charged to the programme. NAO examined the arrangements for management and control of both the nuclear element of the programme and the associated capital works, and also the action being taken to overcome staff shortages at AWRE, including the associated factory at Burghfield, which represented a risk to the programme.

3.26 The results of NAO's examination are described at Appendix 4. The main features are summarised in the following paragraphs.

#### **(i) Warhead procurement**

3.27 The current estimate for this item shows a real cost reduction of about 16 per cent on the 1981 estimate. The main expenditure areas are development, production and special materials. Most of the expenditure on development and production is incurred in the US under the arrangement described in paragraphs 4.1 to 4.10. The arrangements for purchasing special materials, the main item of UK expenditure, are satisfactory.

#### **(ii) AWRE capital works**

3.28 To meet the requirements of Trident, existing proposals to refurbish the AWRE and meet new safety requirements were enhanced and the timetable advanced. At the time of my earlier Report (HC 287 paragraph 8) the estimated cost of nine facilities was £250-300 million. The latest cost for a wider programme of 32 projects is between £836 million (including £657 million for projects critical to Trident) and £1,069 million (at Autumn 1985 prices). The main features of this increase are as follows:

(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; steps have been taken to introduce improvements and a Facilities Integration Contractor has been appointed, but not all the measures adopted to control the Trident works programme (Appendix 3) have been introduced.

(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.

#### **(iii) AWRE staffing**

3.29 Early in 1985 MOD considered the problem of obtaining the additional staff required at AWRE to man the new production facilities on which the Trident programme depended. Since then special measures, including financial inducements, have been introduced. The risk to the Trident programme now appears to have been reduced but MOD are monitoring the position closely. There may have been some detrimental effect in other parts of MOD through transfers of staff to AWRE.

## Part 4: US Arrangements and UK Employment

### UK expenditure on US contracts

4.1 Most of the costs to be incurred in the US come under the provisions of the Polaris Sales Agreement which has been extended to cover the sale of Trident II (D5). This provides, broadly, for the UK to purchase missiles and equipment on the same terms as they are acquired by the US Government — a significant advantage to the UK. The remaining US costs either fall under the 1958 US/UK Defence Agreement covering the uses of atomic energy for mutual defence purposes, or are incurred under a direct contract between MOD and the Electric Boat Division of the General Dynamics Corporation.

4.2 Increases in the November 1981 estimate of US expenditure of £3,313 million, arising from inflation and the fall in the value of the pound against the dollar, have been substantially offset by savings in the estimated costs of some individual projects and the production of some materials in the UK rather than the US. The January 1987 estimate of £3,479 million accounts for 38 per cent of the total UK programme but less than 10 per cent of the US programme.

4.3 Under the Polaris Sales Agreement each country is entitled to establish liaison representatives in the project office of the other. The UK has about 30 staff in the US under the control of the Strategic Systems Executive Representative, Washington (short title: SPRN), who is resident in the offices of the US Navy Strategic Systems Program Office which manages the US programme. SPRN is responsible for the co-ordination of all aspects of the UK activities in the US in implementing the Polaris Sales Agreement; he has close liaison with the US authorities, including the right of direct access to the Director, Strategic Systems Program Office, on matters involving the UK's interest. The US Government places contracts with manufacturers on the UK's behalf and UK requirements are incorporated in, or placed on the same terms as, US Government requirements.

4.4 UK rights of access to US records of expenditure are restricted, and MOD's normal policy for overseas purchases is to rely upon the supplying Government's own internal control and audit systems. Most expenditure incurred by the Polaris Sales Agreement passes through the Polaris Trust Fund from which the US draws funds to pay bills incurred on the UK's behalf. Representatives of the British Government are entitled to audit US records of expenditure from the Trust Fund. In view of the substantial sums involved in the Trident purchase, MOD's Internal Audit exercised this right in 1984 but concluded that the limited examination of vouchers provided by the Agreement did not significantly add to financial control or provide significant additional assurance.

In their 19th Report of 1983-84 on the Trident programme, PAC urged MOD to pursue changes in the fund-

ing arrangements for expenditure in the USA under the Polaris Trust Fund. They considered that cash balances held by the US authorities on the UK's behalf should be kept at the lowest possible level; NAO's examination confirmed that MOD had taken appropriate action and reduced the size of the cash balances. PAC also recommended that MOD should seek the payment of interest on any unused balances. NAO have reviewed the progress made by MOD in this matter and I intend to report to PAC separately on this.

4.6 The US Trident programme, like other US Government programmes, is subject to audit by the US General Accounting Office (GAO) which reports directly to Congress. GAO have assured me that their test audit of US Department of Defense expenditures would cover UK components of Defense Department procurements and give them proportional attention and coverage. In planning their programmes of work GAO have regard to the main issues affecting the achievement of value for money but they also respond to requests from members of Congress for investigations of matters of public concern. The GAO's most recent study of the Trident II System in 1984 raised no significant issues affecting UK interests.

4.7 The US Trident programme or components of it are also subject to audit by other professional audit organisations within the Department of Defense, i.e. the Defense Contracts Audit Agency (DCAA), the Office of the Inspector General, and the Navy Audit Agency.

4.8 DCAA perform contract audits and provide accounting and financial advice on contracts to Defense Department procurement staff. DCAA's audit services are used in negotiating contract prices that are based on cost, both incurred and estimated, or on cost analysis, and in the administration and settlement of contract payments. The UK does not have the right of access to DCAA reports on US-placed Trident contracts. However, the UK has placed one direct contract with the Electric Boat Division of the General Dynamics Corporation. In this case DCAA report annually to SPRN on the outcome of their investigations, and these reports are used in pricing work under the contract.

4.9 The Navy Audit Agency examine the operation of the Trust Fund each year and report to MOD whether expenditure has been reasonably and properly incurred. Their latest report was issued in February 1986 and covered transactions in the period 1 October 1983 to 30 September 1984.

4.10 NAO discussed with GAO the audit of the US Trident programme and the available evidence on the results of examinations carried out by the other audit agencies referred to. There was no evidence of any significant audit criticisms affecting UK expenditure on Trident in the US.

### **Contracts awarded to UK companies**

In their 19th Report of 1983-84 PAC emphasised with UK Trident expenditure in the US then expected to amount to nearly £4,000 million, and with offset provisions for US purchases of UK equipment, it is important that UK firms should obtain as much of the work as possible. Under the arrangements agreed with the US, UK manufacturers are able to bid for Trident component work on the same terms as US manufacturers, and the Defence Export Services Organisation made special arrangements to assist potential bidders. By 31 December 1986, 461 companies had contacted US sub-system contractors; 357 companies had been approved or were under review as bidders into the programme; and 236 contracts with a total value of £100 million had been awarded. This seems a disappointing result given the size of the programme but MOD told PAC that these were initial awards and the potential for follow-on orders was much greater.

### **Employment resulting from Trident**

4.12 In October 1980 the Ministry informed the Select Committee on Defence that on a broad statistical basis they considered that, in its peak years in the second half of the 1980s, the Trident programme might provide employment for up to 25,000 people annually in the construction, shipbuilding and engineering industries, and perhaps another 20,000 indirectly elsewhere. Subsequent estimates have followed a downward trend; in July 1986 MOD estimated that in the peak years of 1989-91 the number of jobs would be 15,000 direct and 12,000 indirect and that throughout the procurement period the average would be 8,000 direct and 7,000 indirect. In January 1987 MOD informed PAC that the estimated average numbers were now 7,500 direct and 6,000 indirect. Further jobs would be generated in industry by the contracts won by UK firms from the US Trident programme, although these could not be quantified.



**Appendix 1**  
**Breakdown of costs**

	Nov 1981 Estimate 9/81 prices, \$1.78			1981 Estimate less Kings Bay Ave. 86/7 prices, \$1.50			Current Estimate Ave. 86/7 prices, \$1.50		
	US £m	UK £m	Total £m	US £m	UK £m	Total £m	US £m	UK £m	Total £m
Submarines	267	2,333	2,600	412	3,241	3,653	313	2,536	2,849
SWS Equipment	918	74	992	1,369	97	1,466	1,029	144	1,173
SWS Missiles	1,275	44	1,319	1,675	31	1,705	1,056	14	1,070
Tactical Weapon System	—	326	326	—	450	450	2	726	728
Shore Construction	—	579	579	—	311	311	—	671	671
Warhead, miscellaneous and unallocated contingency, etc	853	851	1,704	1,348	1,071	2,419	1,078	1,696	2,774
	3,313 44%	4,207 56%	7,520	4,803 48%	5,200 52%	10,003	3,479 38%	5,786 62%	9,265

**Note:** Figures rounded to nearest million, hence any apparent imbalances.

**Explanation of changes (Totals)**

	US £m	UK £m	Total £m
November 1981 Estimate (9/81 prices, \$1.78)	3,313	4,207	7,520
Inflation	1,001	1,443	2,444
Exchange rate variations	805	—	805
Kings Bay changes	(317)	(450)	(767)
Other real cost changes	(1,324)	586	(738)
Current Estimate (ave. 86/7 prices, \$1.50)	3,479	5,786	9,265

## Appendix 2

Effect of exchange rate variations (non-hybrid estimates)  
Average 1986 - 87 prices

	I 1981 estimate less Kings Bay (dollar content \$7,205)			II Current estimate (dollar content \$5,219)		
	US £m	UK £m	Total £m	US £m	UK £m	Total £m
• \$1/£1	7,205 (58%)	5,200 (42%)	12,405	5,219 (47%)	5,786 (53%)	11,005
• \$1.25/£1	5,764 (53%)	5,200 (47%)	10,964	4,175 (42%)	5,786 (58%)	9,961
• \$1.50/£1	4,803 (48%)	5,200 (52%)	10,003	3,479 (38%)	5,786 (62%)	9,265
• \$1.75/£1	4,117 (44%)	5,200 (56%)	9,317	2,982 (34%)	5,786 (66%)	8,768
• \$2/£1	3,602 (41%)	5,200 (59%)	8,802	2,609 (31%)	5,786 (69%)	8,395

## Appendix 3

### The Trident building works programme: Management and financial control (paragraphs 3.22 to 3.24 refer)

1. The Trident works programme comprises some 110 major works projects. NAO examined the arrangements for management and financial control of the programme and the individual works projects but did not carry out any detailed examination of the latter. NAO noted that following a review of the Trident works programme in 1984, a baseline budget was prepared and this showed a substantial increase in the cost of the works programme compared with the original November 1981 estimate. The baseline budget included a sizeable allowance for contingency to reflect the complexity and uncertainty of the required works projects, and new arrangements were introduced for the management of this major programme.

#### Management arrangements

2. Responsibility for the programme, as with all MOD capital works, is shared between MOD, who define requirements and provide and approve funding, and PSA, who design solutions, contract for and manage the construction works and account for expenditure. MOD, exceptionally, in April 1985 appointed a Trident Works Project Manager, reporting to the Chief of Fleet Support and CSSE, with responsibility for co-ordinating the various elements of the programme and ensuring completion to time and cost. He chairs a series of Headquarters committees on which both MOD and PSA are represented. These are supplemented by joint planning teams at local level. Within PSA responsibility for the programme rests with Directors of Works, supported by Group Managers, and below them project managers for particular elements of the work. PSA have detailed networks for control of the programme and a Trident-dedicated financial recording system to monitor and report costs during planning and construction and to meet MOD's information needs.

3. NAO noted that many improvements to the management of the programme had been introduced since 1984. Committee and reporting structures involving MOD, PSA and contractors are designed to ensure regular reviews of progress against time and cost to highlight potential problem areas; and MOD and PSA have formally defined their respective responsibilities for the projects in construction at Faslane and Coulport (the Clyde Submarine Base) in a joint Statement of Understanding. However PSA reviewed their strategy for management of the construction programme in 1986 because of delays in planning, on-site difficulties which put the programme in jeopardy, and a shortage within PSA of the specialist staff necessary to manage construction works of this size and complexity. Following consultation with the construction industry, PSA in February 1987 appointed a consultant Construction Programme Co-ordinator (CPC) to co-ordinate the construction works at Faslane and Coulport. Detailed reporting and working arrangements are being finalised with the CPC, who will administer the contracts and be responsible for co-ordination between contractors. PSA will retain primary responsibility for management and will continue

to contract directly with the construction companies. The estimated cost of the CPC services is currently some £12.2 million plus VAT but this will increase when further works requirements are settled. Approximately two-thirds of this cost will be attributable to Trident.

4. NAO concluded that although there was some doubt whether PSA had devoted sufficient resources to the programme in the early stages, there had been significant improvements during the last two years. Liaison between MOD and PSA, and the flow of financial and programme information, were generally good, although PSA are planning to improve the information they provide to MOD on resource costs. The committee and reporting structures for reviewing progress against time and cost appeared to be working effectively. At the time of NAO's examination the site management arrangements for the Clyde Submarine Base were still an area of some concern but this was before the CPC was appointed. It will be important that the contractual responsibilities and liabilities of the various parties involved in such a complex programme are clearly defined and that the operation of the novel CPC arrangements is closely monitored by the appropriate Headquarters Committee.

#### Programme costs

5. The total estimated cost of the Trident-attributable works programme is now £671 million (average 1986-87 prices), including PSA resource costs of some £75 million. This represents a real cost increase of £360 million (116 per cent) over the 1981 estimate, adjusted to take account of the effects of the decision to process UK missiles in US facilities at Kings Bay, Georgia. This results from increases in the estimated costs of individual works projects (£159 million) and PSA resources (£51 million), and the addition in 1984 of a specific works contingency to cover the many uncertainties in the programme (£202 million), partly offset by a reduction in the proportion of some projects attributed to Trident (£52 million). The contingency now represents 43 per cent of the estimated works cost. There has been no real cost increase in the total works programme budget since the establishment of a baseline budget following the 1984 review, which was the first point at which PSA had been able to gain a clear appreciation of what was required.

6. The contingency provision is high by comparison with other areas of the Trident programme. However many uncertainties remain. A number of works briefs have yet to be endorsed; many projects are still in the planning phase — at August 1986 48 per cent of work had yet to reach the Final Sketch Plans stage at which realistic costings can normally be produced for the first time; and only some 20 per cent of the programme by value had been put out to contract at the end of 1986, so the peak construction years are still to come. Moreover, local authority or public opposition might increase and hinder progress; nuclear safety requirements could add

further complications to design and construction programmes; and it may prove necessary to accelerate the construction programme in order to meet completion dates. MOD and PSA therefore believe that the high level of contingency is necessary to cover design, construction and other external uncertainties in the programme.

7. Each project is subject to the normal PSA project control procedures, subject to some modifications, and Treasury and Ministerial approval is required at certain planning stages, depending on the sums involved. MOD are responsible for the initial approval of the requirement but thereafter projects follow PSA's Plan of Work. This requires approval of cost estimates by both MOD and PSA at four key stage of development, ie Feasibility Study, Preliminary Sketch Plan, Final Sketch Plan and Pre-Tender Estimate. For Trident there have been some modifications to these arrangements to save time. Some two-thirds of contracts by value are in continuous planning, ie work has progressed in anticipation of approval by MOD so as to avoid delay; on others, reporting stages have been omitted or combined. NAO concluded that it would be difficult to establish how far this could have been avoided by an earlier start to the planning of projects.

8. NAO's examination showed that these relaxations of normal controls were compensated to some extent by a high degree of informal liaison, and that since the 1984 review, MOD and PSA had taken positive action to contain costs, in particular by rigorous scrutiny of works requirements and the development of joint MOD/PSA cost and requirements audits on certain projects. The success of those audits in identifying useful savings suggested either that the relaxation of normal procedures had led to a lack of economy, or that the audits should be applied more generally. Contracts had been let by competitive tender, with a few exceptions where no alternative suppliers were available, and contract prices so far were on average below the pre-tender estimates, possibly reflecting the current climate in the civil engineering

industry. Although cost control appeared to be generally satisfactory, a risk of cost escalation remains because of the many uncertainties and the early stages of the programme.

#### Progress to time

9. Exceptionally, PSA are reporting directly to MOD on progress during the course of individual contracts, with monitoring against critical dates on each. On some key projects facing very tight schedules, programmed time contingencies have been seriously eroded by the need to demonstrate that designs will meet nuclear safety requirements. Where possible the work is being rephased to contain overall slippage, if necessary by drawing further on contingency provisions. When MOD's Equipment Policy Committee reviewed the overall staff requirements in 1986 they were told that the approval process for works briefs and planning applications at the Clyde Submarine Base had placed a very heavy burden on resources in MOD and PSA, and a number of milestones had not been met until well after the due dates. Together with additional problems — asbestos contamination, political opposition from local authorities, nuclear safety requirements — this posed a significant threat to the availability of these facilities by the required dates. Progress on the Rosyth programme was generally satisfactory, although the degree of risk had increased because of a one year slippage in the commencement of planning.

10. Erosion of programme contingencies for key facilities before construction has commenced is a cause for concern. However, MOD and PSA expect the bulk of the programme to be completed on time and they are making every effort to minimise slippage on critical projects. Possible delays to the AWRE programme may reduce the pressure on the Works Programme at Coulport, but no slippage has been allowed so far. Contingency plans are being made to meet requirements should key facilities not be available on time.



## Appendix 4

### The Trident nuclear programme (paragraphs 3.25 to 3.29 refer)

1. NAO examined the arrangements for management and control of the nuclear element of the Trident programme and of the associated capital works not charged to the programme, and also action by MOD to overcome staff shortages in the nuclear area.

#### Warhead development and production

2. Although the US will supply the missile and associated SWS equipment, CERN is responsible for the UK warhead development and production. A feasibility study completed by CERN in early 1983 led to the approval by Ministers of the Staff Requirement for the warhead in 1984.

3. The CERN element of the Trident programme consists of four major areas: development, production, special (ie fissile) materials and capital items, although the last item accounts for only 5 per cent of the nuclear programme expenditure. Most of the development and production expenditure is incurred in the US under the arrangements described in paragraphs 4.1 to 4.10 of the main Report. NAO's examination concentrated on the arrangements for the third area, purchase of special materials, which is the largest element of UK expenditure.

4. Special materials are purchased to satisfy all Defence requirements and a proportion is attributed to the Trident programme in accordance with the criteria outlined in paragraph 1.6 of the main Report. NAO's examination showed that consideration was given to the purchase of special materials from the US on cost grounds. In 1982 Ministers decided after taking account of the possible options for procurement, together with political, economic and employment considerations, that a substantial proportion should be purchased in the UK. MOD's discounted cost comparison showed that this option was only marginally more expensive than US purchase.

5. MOD are purchasing special materials in the UK under fixed price contracts with a single source, British Nuclear Fuels plc. The main contract includes a price escalation formula and provides for two price reviews in the future against the risk of significant changes in world market prices; it also allows for the quantities ordered to be varied, and for premature termination. Another contract includes a target cost/incentive arrangement, the target cost being based on comparison with the cost of US purchase.

6. Purchasing from a monopoly UK supplier creates a danger of paying excessive prices; but, as noted in paragraphs 4 and 5 above, MOD have tested their contract prices against the cost of buying US materials.

#### Atomic Weapons Research Establishment (AWRE): Capital works

7. The new production and research facilities being constructed at AWRE are required for reasons other than

Trident but are nevertheless essential to the requirements of the Trident programme. NAO examined the history and the arrangements for management of these facilities, concentrating on those projects critical to Trident and associated safety measures. As with the Trident works programme, there are many individual projects for works and/or equipment. PSA are managing the major works projects but AWRE are managing others, for some works, plant and equipment, without PSA involvement. Generally PSA's works projects are more advanced, as indicated by the fact that of the estimated £270 million expenditure up to 31 March 1987 on projects critical to Trident, £218 million relates to PSA works, although PSA are responsible for only about half the total programme.

8. In response to a report in 1978 by an independent expert, Sir Edward Pochin, which highlighted deficiencies in existing ageing facilities at AWRE, MOD embarked on a major refurbishment of the Establishment in order to maintain a safe basic nuclear warhead production capability for future years. In particular, during 1980 the Secretary of State approved the provision of nine major new and improved facilities for processing plutonium and handling radioactive wastes to current health and safety standards, at an estimated cost of £134 million (at Autumn 1979 prices). Each facility, as with other capital works at the Establishment, was considered as a separate project; and, although arrangements were made to report regularly to Ministers on the nine projects, the work was not regarded as a capital programme as such.

9. By 1982, the process of studying the requirements in more detail and of refining cost estimates had revealed an increase in costs. Moreover, the decision to purchase the Trident system called for increased production capacity, ie the capital items charged to the Trident programme (paragraph 3 above), and for the improved facilities to start production two years earlier than the original plan. Ministerial approval was given to proceed at an estimated cost of between £260 million and £290 million for the nine major plutonium related projects (at Autumn 1981 prices). This approval recognised that tenders would have to be invited before detailed planning was complete and while much more still needed to be done to study and cost the requirements in detail. In practice, for instance, this has resulted in PSA following a policy of sequential contracting whereby structures are designed and built without a full appreciation of the equipment they will house. Ministers were fully appraised of the attendant risks and uncertainties of embarking on a large and complex programme on this basis but they were advised that there was no option but to proceed if the Trident timetable was to be met. A Parliamentary answer in the House of Commons in July 1982 gave a provisional estimate of the cost of the facilities, some of which were at an early stage of planning, as about £300 million over the decade.

10. By September 1985 the estimated cost had risen to £370 million (at Autumn 1985 prices) and slippage in



the Programme was forecast. In the light of concerns emerging from other projects, particularly those associated with the infra-structure for the new facilities, Ministers agreed that CERN should carry out a review covering a wider group of 32 AWRE capital and works projects estimated to cost £578 million (at Autumn 1985 prices), including those critical to Trident. The review, carried out in conjunction with PSA, took into account an earlier programme audit conducted by British Nuclear Fuels, and was completed in May 1986. It confirmed that there were difficulties arising from the risks mentioned in paragraph 9, particularly in relation to the complex fitting out stages for mechanical and electrical and specialist equipment. In addition changes in design requirements, revised nuclear safety standards and some contractual difficulties had contributed to cost overruns and delays. The problems centred upon two key projects, the Plutonium Processing Building and the Liquid Waste Treatment Plant, details of which were described in the 1985-86 PSA New Works Statement submitted to PAC.

11. According to the CERN review the total cost of the 32 projects was estimated to be between £836 million and £1,069 million (at Autumn 1985 prices) on a best and worst case basis. These estimates included projects not specifically critical to Trident in-service dates, and also some costs (consultants' fees and management contracts of £157 million) not included in earlier estimates for the nine plutonium related projects. They did not include MOD or PSA in-house resource costs. The "best case" cost of those projects critical to Trident was £657 million, and handover was expected to slip. These and earlier estimates were not directly comparable because of the introduction of projects not envisaged at the outset, while CERN's review was the first occasion on which the major projects related to the Trident capability were identified.

12. In June 1986 the Trident Group considered and generally endorsed CERN's proposals for improving programme management and reducing the slippage. CERN proposed to re-open discussions with British Nuclear Fuels to see what further lessons could be drawn from their experience of managing large nuclear capital projects and, in particular, any use made of prime contractors. CERN also examined the scope for introducing tighter contract incentives and extending the range of fixed price disciplines with the aim of transferring more risk to the contractors. He decided that 77 per cent of the total programme could be made subject to competitive fixed prices and that AWRE should seek to extend this as far as practicable in the management and early design contracts.

The CERN review also concluded that there was a need for improved project co-ordination and systems integration prior to Trident warhead production in the new facilities; that those projects critical to Trident could be monitored in the same way as, and in tandem with, the Trident programme; and that management arrangements between CSSE and CERN needed to be improved. In response to these issues CERN has appointed a Project Director (Facilities) at AWRE with

specific responsibility for the Trident related projects. To assist him CERN will use a co-ordinating contractor, since there is a shortage of suitably qualified engineers in the Government service to handle the complex interfaces between various nuclear plants and sophisticated computer control systems. A Facilities Integration Contractor has now been appointed following tenders from five companies.

14. A recent re-organisation of the CERN HQ structure has created a new Deputy Controller (NUC) post with single responsibility for all nuclear resources and the dependent projects. This re-organisation, together with the establishment in November 1986 of a Committee dealing with CERN's total contribution to the Trident programme, is intended to assist liaison and co-ordination between CSSE and CERN along with HQ oversight of the Trident programme. The Nuclear Facilities Management Board, formed at the beginning of 1987 and chaired by CERN, will concentrate on monitoring and control of the Trident related projects. Since July 1986, on the recommendation of the Trident Group, all reports by CSSE on Trident have included a section on the AWRE Capital Works Programme.

15. NAO took account of these developments in examining programme management and financial control towards the end of 1986. For PSA projects, arrangements were in many respects similar to those for the Trident works programme, with management by a joint MOD/PSA team, a hierarchy of MOD led committees and reporting structures and two Groups within PSA broken down into project management teams; the liaison arrangements have been recently strengthened. However there were some differences and NAO made the following observations:

- (a) there was nothing for AWRE works like the Statement of Understanding on responsibilities between MOD and PSA which has been drawn up for the Trident works programme, and responsibilities on the AWRE side were not always clearly defined, leading to some local liaison difficulties.
- (b) there was no plan for management of the AWRE works programme as a whole and therefore a lack of overall control of the programme and co-ordination of projects, as already recognised by CERN.
- (c) shortcomings in liaison between CERN and CSSE had been recognised and steps taken to introduce improvements.
- (d) each project estimate contained a contingency but there was no overall programme contingency as in the Trident works programme.
- (e) there were no "cost audits" (Appendix 3, paragraph 8) although independent appraisals had been carried out on individual projects.
- (f) the difficulties encountered and the cost escalation illustrate once again the dangers of departing from normal control procedures, although NAO recognised that this was a calculated decision by Ministers; particular features were

— sequential contracting, involving the letting of contracts for buildings before the plant

to be housed was designed, involving a risk of wrong building dimensions or interface problems later.

- the letting of contracts before completion of all aspects of the design, on the basis of Bills of Approximate Quantities which are repriced when drawings are issued for construction.

- a reduction in the number of discrete planning stages at which approval is sought to proceed.

(g) the risks associated with accelerating the start of the capital works have been reflected in uncertain estimates of cost and completion times. CERN sees the risk of delay in completion stemming from the complex fitting out stages and the interfaces between facilities — areas in which experienced engineering resources are limited in MOD.

(h) the nuclear works programme, though not formally party of the Trident programme, is clearly an additional source of financial risk.

#### **Staffing at AWRE**

16. In February 1985 MOD found it necessary to address the problem of recruitment and retention of staff at AWRE, including the associated factory at Burghfield. At that time AWRE had a 9 per cent shortfall, excluding any allowance for wastage, against their 1 April 1988 staff requirement. The shortfall included Professional and Technical grades, Science Grades and Craftsmen. This was despite intensive use of Civil Service recruitment methods and internal management action. The major risks in failing to build up the proper manpower capability were identified by MOD as being that the Trident warhead programme could fall behind the required timescale and that safety might be affected. The future critical manpower area at AWRE was considered to be the additional staff required to man the new production facilities, as without them the facilities could not be operated.

17. MOD identified the basic problem as being uncompetitive Civil Service pay rates. To overcome it MOD proposed special financial inducements and further beneficial administrative measures. These included further retraining, internal transfers, additional advertising, and employing recruits in less sensitive areas in advance of their positive vetting clearance.

18. Negotiations between MOD and Treasury eventually resulted in a Special Pay Addition of £1,000–£2,000 being approved in September 1985 for the lower and middle-grade non-industrial Professional and Technical and Scientific grades at AWRE and Burghfield. An allowance for industrials has recently been agreed by Treasury on the condition that MOD commission a value for money audit of the use of industrial labour at AWRE including productivity arrangements.

19. By April 1987 the shortfall of specialists and industrials as a percentage of the total staff requirement for all grades had fallen to 2.8 per cent. The progress report to Ministers in April 1987 showed a 4.4 per cent net rise in the number of specialists in the previous four months and concluded that, provided every effort continued to be made, there were good grounds for confidence that AWRE's April 1988 manning target for specialists, requiring a further net increase of 4.7 per cent, would be met on time. On industrials, there was confidence that non-craft numbers would be met but a sustained effort would be required to meet the target for craftsmen. Further measures have been taken to reduce losses of potential recruits.

20. The Trident Watch Committee, Trident Group and Nuclear Management Board are all aware of the staffing problem at AWRE and the effect the shortfall may have on the Trident programme. They have been kept regularly informed on the difficulties encountered and the progress of measures introduced to overcome the difficulty. The risk to the programme now appears to have been reduced but there may have been some detrimental effect in other parts of MOD through transfers of staff to AWRE.