Ministry of Defence: Procurement Lessons for the Common New Generation Frigate
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Part 1: Introduction

1.1 The Common New Generation Frigate (CNGF) will follow on from the Type 23 Frigate as the United Kingdom's next major escort warship procurement and will replace the Type 42 Destroyer as the Royal Navy's primary air defence vessel for maritime operations. The primary role of the Common New Generation Frigate will be to provide local area air-defence for allied warships or merchant vessels in its company. Additionally, the vessel will have a general purpose capability to allow it both to defend itself and to undertake wider escort duties. An outline for the CNGF is shown at Figure 1.

1.2 The CNGF and many of its combat equipments will be procured through international collaboration with France and Italy, and the overall programme is likely to be one of the most complex warship procurements ever undertaken by the Ministry of Defence (the Department). When operational, the CNGF will be a very sophisticated and capable warship providing an area defence capability.
against missile and aircraft attack, whilst retaining good General Purpose characteristics.

1.3 Together with their French and Italian partners, the Department have had substantial influence over the procurement strategy for the CNGF. Under the terms of a Memorandum of Understanding, a Joint Project Office was established in 1993 to manage CNGF procurement, under the direction of a tri-national steering committee supported at working level by national focal points in each nation's Ministry of Defence. The tri-nationally agreed procurement strategy provides for the establishment of an International Joint Venture Company which will be contracted for the design and build of the CNGF ship platform, and for carrying forward the design of the Combat System. The company will also be responsible for integrating and installing individual equipments.

1.4 This is the second time that the Department have been substantially involved in the collaborative procurement of a frigate; the United Kingdom having been a member of the NATO Frigate For the 90's project in the 1980's. The project failed, primarily because it proved impracticable to harmonise national requirements and timescales between so many partner nations.

1.5 The Department told the National Audit Office that their involvement with the CNGF is strongly influenced by their recent experience of developing and procuring the Type 23 Frigate, although they have yet to carry out a formal review of the lessons learnt from that programme.

1.6 Nevertheless, there are broad lessons already in the public domain from that and previous procurement programmes that are of direct relevance to the CNGF. In the mid-1970's and again ten years later the Committee of Public Accounts made recommendations regarding the design and procurement of warships. In the 1990s they produced broad based recommendations in their report on Collaborative Projects and in their consideration of the Department's Major Project Statement that are also relevant. The relevant studies are listed at Appendix 1.

1.7 In so far as the United Kingdom is able to influence the course of the CNGF project when its partners, who have equal status and whose perceptions of what constitutes best practice may differ, it is important that these lessons and recommendations are taken into consideration in the design and procurement of the ship.

Scope of the National Audit Office examination

1.8 Against this background, the National Audit Office examined the extent to which the Department had applied lessons learnt from past procurement programmes in their strategy for the acquisition of the Common New Generation Frigate. Part 2 of the report reviews lessons learnt from previous United Kingdom warship programmes and Part 3 considers lessons which will specifically apply to the CNGF as a collaborative programme. Relevant recommendation or
observations from past Reports from the Committee of Public Accounts preface each section, or sub-section where appropriate. In carrying out their examination, the National Audit Office were assisted by Mr Marshall Meek, a Fellow and Past President of the Royal Institute of Naval Architects, and by Mr Andrew Moore of Cray Systems Limited.
Part 2: Lessons learnt from National Warship programmes

The identification and control of risk

The Department should put in place control procedures to identify and provide early warning of the factors likely to cause delay or add cost (PAC 5th Report 75/76).

2.1 This part of the report draws out lessons for the acquisition of the Common New Generation Frigate based, in large measure, on past reports from the Committee of Public Accounts.

2.2 The early identification of risk is essential for minimising cost increases and programme delay, and ensuring that warships as a whole will meet the Operational Requirement. These considerations apply whether procurement is national or collaborative, and are all the more important if development risk is high.

2.3 Development risk on the CNGF programme is comparable to, if not greater than, the Type 23. For example:

- the Tri-partite Memorandum of Understanding provides for a procurement time span of eleven years, leading to an in-Service date of 2002 for the First of Class. This compares with 12 years for the Type 23 Frigate. The CNGF programme, which includes the development and integration of several new equipments is, therefore, extremely tight;

- the CNGF will be equipped with a number of high value, software intensive, equipments that will be new to service. These will incur substantial development costs, which will be shared between the nations. Past experience suggests that software intensive systems are among the higher risk elements of development programmes. On the Type 23 Frigate for instance the original command system could not meet the requirement and had to be replaced.

- as the CNGF is a tri-national project the risk of delays in decision-making, arising both from sometimes intricate communication chains and differing national procurement approaches and priorities, is increased.

2.4 The Department’s procurement strategy is mindful of these risks and, since 1989, their equipment approval process has included formal risk assessment. As such, they have promoted a number of initiatives to minimise risk on the CNGF and overall the project will benefit from a formalised risk management strategy. Detailed arrangements are not laid down prescriptively by the
Department, but generally involve identifying areas of risk, assessing their likely impact, and defining strategies for their containment. The Department's risk management principles are rapidly gaining acceptance with collaborative partners, but specific management tools will be needed to ensure that risk is properly managed and controlled.

2.5 The CNGF Joint Project Office was explicitly given the risk management task and is shortly to be staffed by a dedicated risk management officer. The Department will expect the Joint Project Office to develop its own risk management strategy, and also to ensure that contractors have sound risk management plans. The Joint Project Office has appointed a contractor to develop a risk register. However, the effectiveness of the Joint Project Office will depend to a large extent on whether it can promote timely decision-making by the partners and industry through a clear demonstration of the potential effects of identified risk on the overall procurement programme.

2.6 Prior to the full assumption of these responsibilities by the Joint Project Office, risk management was co-ordinated within the United Kingdom project office with the assistance of a design support contractor. Planned milestones and procurement stages are now established in various levels of detail so that specific risks may be better identified. This, and supporting analysis, has greatly helped the United Kingdom to promote the realistic assessment and forward management of risk.

Key points

2.7

- Risk on the CNGF is comparable to, if not greater than, that on the Type 23. The Department have done much to promote risk management in the CNGF Joint Project Office. They will be looking to see that risk management tools are used in the Office's dealings with contractors;
- And in the National Audit Office's view, the effectiveness of the Joint Project Office will depend to a large extent on whether it can promote timely decision-making by the partners and potential effects of identified risk to the overall programme.

Establishing clear contractual terms

Adequate conditions covering both responsibilities and liabilities are agreed contractually in advance; that there is early notification of specifications for weapon fits to the shipbuilder; and that design changes during a contract are minimised (PAC 35th Report 84/85).

2.8 Clear contractual terms are essential in defining industry's responsibilities for delivering the overall requirement. There are, however, four areas where clarification is especially needed to avoid the risk of poor value for money. These areas concern: (a) design and engineering standards; (b) the provision of
Government Furnished Information, Facilities and Equipments; (c) equipment details noted to shipbuilders and (d) batch orders of long lead items.

(a) Design and engineering standards

We are interested to hear the Department's evidence that some commercial engineering standards are better than military ones and recommend that the Department undertake a review of the continuing need for some of the naval standards currently in use (PAC 30th Report 93/94).

2.9 The standards to which a vessel is designed can have a significant impact on the achievement of value for money. On the Landing Platform for Helicopters, for example, the Department were able to accept commercial rather than military standards for aspects of the hull and engineering systems, thus making for a cheaper design but without prejudicing personnel safety, functional requirements or quality. It is important, therefore, that where military standards are specified for the CNGF, they have been properly validated to ensure that they are strictly necessary.

2.10 The Tripartite Staff Requirement states that Standards accepted as necessary for the CNGF should be based on the least expensive of the United Kingdom, French or Italian Standards, leading to production of a common standard. However, the National Audit Office notes that the Department’s Naval Standards, which in many cases are not standards but advice, are not designed to be used as contractual clauses. It is therefore important for the CNGF that all engineering standards which may be used are subject to prior scrutiny by the Joint Project Office to ensure that the requirement can be accurately translated into the contractual specification for the ship.

(b) Provision of Government Furnished Information, Facilities and Equipments

2.11 Government Furnished Information Facilities & Equipments is provided to contractors either because they do not themselves own a technology, or because they do not have the necessary capability to implement the knowledge without assistance. Where a contractor perceives an unacceptable risk in using information provided by the customer, he will pass that risk back. On the Type 23 frigate programme, the Department necessarily provided specialist data to contractors, for example on radar echoing area, as government furnished information. Such data was essential to equipment development but, as it was provided by the Department, it resulted in significant exclusions from the shipbuilder's design responsibility.

2.12 It is important that the information needed by the International Joint Venture Company is given as far as possible on a "best endeavours" basis. Whilst the aim is to reduce governments' exposure to claims from the International Joint Venture Company should the information fail to be delivered on schedule, it is important that the Joint Project Office appraise the value of the risk, compared with the risk premium that the International Joint Venture Company proposes.
to charge, before entering into any commitment. The International Joint Venture Company will be made responsible for all aspects of hydrodynamic testing, and for finite element analysis and fatigue audits prior to the start of fabrication of the ships.

(c) Notification to shipbuilders of equipment details

We recommend that the Department provide clearer and fuller guidance [on systems, equipments and facilities] at the outset. We note that the Department are putting the lessons they have learnt into practice in the procurement of the Anglo-French-Italian Frigate (PAC 45th Report 1992-93).

2.13 On many major warship procurements the shipbuilder is made responsible for integrating equipments into the ship’s hull, on the basis of equipment details drawn up to meet the Department’s specifications. These details have to be sufficiently clear to allow the shipbuilder to carry out the responsibilities intended to be contractually placed on him. Additionally, equipment details that have been agreed with the shipbuilder should not be subject to change. This occurred on the Type 23 frigate, where to reduce costs the Department directed that a cheaper pump than that proposed by the lead shipbuilder should be fitted. The cheaper pumps proved unsatisfactory and were eventually sold for scrap.

2.14 For the CNGF, it is intended that the International Joint Venture Company will assume prime contractorship responsibilities for ship systems (such as pumps and propulsion). This means that the Company will be responsible, not only for integrating the systems, but also for ensuring that systems designs are fully compatible. For combat equipments (such as weapons and sensors), the Joint Project Office will develop a Combat System Model, and this will be handed over to the International Joint Venture Company when the ship design contract is placed. The Company would then be responsible for maintaining the Model, and for the subsequent integration and installation of the combat equipments.

2.15 It is important that when the Model is handed over, it is sufficiently mature so as to avoid transferring integration risk away from the International Joint Venture Company and back to the national partners. The intended advantages of making the International Joint Venture Company assume prime contractorship responsibilities would then be significantly compromised.

2.16 It is intended that where it can be shown to be cost effective, combat equipments will be procured by the International Joint Venture Company. For those few equipments procured as national variants, the risk will be offset, to some extent, by the Department’s intention that the International Joint Venture Company should establish, with the equipment manufacturers, agreed budgets for space, weight, power requirements and tolerances. Those budgets would then be underpinned by contractual Liquidated Damage clauses in the individual equipment contracts. However, it may not be possible to agree Liquidated Damage clauses which are of a sufficient size to remove all possibility of financial risk, since the size of such clauses acceptable to a
contractor are likely to be proportional to contract value. Big risks will not be accepted on small value contracts.

**(d) Batch ordering**

The MOD should maintain a dialogue with the warshipbuilders which should cover ways of improving value for money in warshipbuilding, including the greater use of batch orders. Such possibilities should be properly appraised and fully taken into account in determining policy and in individual decisions. (PAC 35th Report 84/85).

2.17 Batch ordering of the Type 23 Frigate and components supporting it resulted in significant cost savings, and tri-national co-ordination of orders for the CNGF have the potential for even larger economies. However, there is a risk, as occurred with the Type 23, that batches of long lead items which need to be purchased by one shipbuilder in advance of a ship order are subsequently transferred to another because the batch size exceeded the batch size of the original ship order. The items would then have to be provided to the second shipbuilder as Government Furnished Equipment, with the collaborative partners liable for late delivery and fitness for purpose. The Department expect the application of its competitive procurement strategy for its follow-on ships will ensure that United Kingdom yards will accept this risk.

**Key points**

2.18  
- design of the CNF should be supported realistic and unambiguous engineering standards. This will require careful choices between commercial and military standards, as well as between nations' differing Naval Standards. Such standards should be capable of accurate translation into contractual specifications;
- before agreeing contractual terms for items such as Government Furnished Information the costs and risks associated with alternative procurement strategies, ranging from passing all responsibility to industry to nations bearing all of the risk themselves, should be fully assessed to ensure that best value for money is achieved;
- the shipbuilder must have clear details of equipments to be integrated into the ship's hull. This lesson has been recognised on the CNGF, where it is intended that the International Joint Venture Company will progressively assume a large degree of prime contractorship responsibility; and
- batch ordering of long lead items may result in savings, but there is a risk involved in such items becoming Government Furnished Equipment.
Specifying combat equipment requirements

The Department should take steps to ensure that adequate time is built into the procurement process to take account of delays resulting from the need to secure agreement on requirements (PAC 10th Report 1992-93).

2.19 Unlike the Type 23 and other warship projects, the emphasis for the CNGF is firmly on an integrated combat capability of the ship. The CNGF Tripartite Staff Requirement requires such an approach to be taken by calling for a fully integrated Combat System in which its constituent equipments deliver more effective capability than if they were to operate autonomously. The collaborative partners have pursued a joint design methodology in such a way as to provide an optimum balance between performance, risk and through - life costs.

2.20 The design process for the CNGF places considerable emphasis on defining how equipments will operate to achieve overall combat capability. However, for the process to achieve its objectives there must be no ambiguity in the definition of interfaces and performance. This means that the way in which each equipment contributes to the overall system has to be specified to a very high level of detail. In January 1994, the collaborative partners issued a Tripartite Statement of Functional Need for the overall Combat System which is now being expanded into detailed sub-system specifications.

2.21 There is, however, considerable pressure to accelerate the design process in view of the tight procurement timetable. Additionally, for some equipments, specifications based on technical solutions proposed by contractors have already been issued. In the case of the CNGF Principal Anti-Air Missile System (PAAMS), project definition work proceeded in advance of full agreement on functional detail. This has led to differing interpretations as to whether the work resulting from project definition can satisfy the Tripartite Staff Requirement. Specifically, the Department do not accept that the contractor's technical solution, as proposed in the Project Definition Report, for the PAAMS multi-function radar will meet the requirement. They are currently working with France and Italy to reduce risks and agree a satisfactory way forward and are considering a two radar solution, under which France and Italy will fit the EMPAR and the United Kingdom the SAMPSON multi-function radars.

2.22 For other equipments, the Department are pressing for full agreement on functional detail before contracts for project definition are let to contractors. This is most notably the case with the CNGF Combat Management System on which project definition work was originally scheduled to begin in March 1994. Invitations to tender were issued in December 1994, but placement of project definition contracts will depend largely on the outcome of negotiations for the Principal Anti-Air Missile System.

1 PAAMS will provide local area air protection against a full range of aircraft and air, submarine, surface and land launched missiles detected and tracked by long range and multi function radars. These threats will then be intercepted by vertically-launched missiles from CNGF
2.23 The Department recognise, however, that delay on the Combat Management System, which lies on the critical path of the overall programme, will impose timetable penalties for procurement of the CNGF. Nevertheless, the principle underlying the Department's policy is that the specification must be sufficiently refined to ensure that the contractor's proposals will satisfy the operational requirement without unduly hampering his flexibility to arrive at a design solution.

2.24 The top down approach applied to the design of the CNGF Combat System is intended to produce clear acceptance criteria for individual equipment fits. Many weapon equipment systems are, however, likely to contain new technology; and there is also a risk that acceptance criteria for systems involving novel processes may not be properly defined. This occurred on the surveillance and target indication radar for the Type 23 Frigate, where acceptance criteria were unable to demonstrate that the requirement had been met.

Key points

2.25 - Equipments will be designed for the CNGF as a total Combat System. This approach should help to ensure that timetable and system integration problems are minimised; and

- Combat System design places considerable emphasis on defining how equipments are intended to operate to achieve the ships' planned fighting capability, and how they will be accepted as fit for purpose. This needs to be applied to all equipment development on the CNGF.

Co-ordinating shipbuilding and combat system programmes

The problems with co-ordination of ship and weapon programmes could prove an obstacle to prime contractorship for major warships (PAC 5th Report 75/76).

The Department should, as a matter of urgency, tackle the problem of achieving better co-ordination of ship and combat system programmes (PAC 35th Report 84/85).

2.26 The achievement of a warship procurement programme depends crucially on a realistic timetable for development and production, in which the interdependence between ship and equipment timetables is clearly understood and planned for. None of the risk reduction measures adopted will be successful without such an understanding. The National Audit Office, together with their consultants, have studied several warship procurement programmes undertaken by a number of NATO countries and have produced Figure 2 which sets out the key stages for integrating ship and combat equipments and suggests the likely range of time necessary for each.
(a) Dependence of the Ship Programme on Equipment Timescales

2.27 A fundamental principle assumed in Figure 2 overleaf is that the definition of all Combat System elements should be completed before detailed design of the ship platform commences although this can extend total elapsed time. Under initial plans four major CNGF equipments would still have been at the project definition stage when detailed platform design began. This posed significant potential risk to the cost effective introduction of the First of Class vessel: for instance if changes in the weight of equipment under development affected ship stability. However, during preliminary risk reduction work by the Joint Project Office and building on the lessons from the Type 23 Frigate programme these problems were identified and the scheduled significantly revised to ensure that all project definition work is completed and non development items are selected before the commencement of the detailed design of the ship.

2.28 Moreover, it is now intended that the combined contract for the detailed design and construction of the ship and the full scale development and production of the associated Combat System Elements will be delayed until agreement is reached on the second supplement to the project's Memorandum of Understanding planned for October 1997. Current plans are to transfer the responsibility for ship, Combat System Design and most Combat System Elements to the International Joint Venture Company at this point. The Department believe this will leave the Company free to balance the risks associated with starting production ahead of the completion of detailed design, but secure in the knowledge that project definition work had already been undertaken.

2.29 A consequence of the reprogramming to reduce risk is to increase pressure on the In-Service Date of 2002 for the First of Class. The Type 23 Frigate programme had an elapsed time of 12 years from the beginning of concept studies to the First of Class entering service. The CNGF programme has a planned elapsed time of 11.2 years from the feasibility stage. In the National Audit Office's view, this is an extremely optimistic time scale given that the CNGF is a collaborative programme, compared with the range of 8 years 9 months to 15 years assumed in the model at Figure 2 which is, itself, based on a national procurement programme.

(b) Dependence of equipment programmes on ship platform availability

2.30 For equipments to operate as intended, they must be set to work and then trialled at sea. However, the dependence of these activities on the construction and launch of ships' hulls can be much reduced by use of a Shore Development Facility. Such a facility incorporates the actual in-service components of a warship's Combat System, and through simulation and stimulation provides an accurate representation of how equipments will perform at sea. The use of a Shore Development Facility was a major success on the Type 23 Frigate programme, reducing the time intended to set equipments to work and carry out sea trials. It will also reduce the reliance on ship time at sea for software, sensor and weapons updates. For the Type 23, the Department estimate that this could save six years of ships' operational life across the Class as a whole.
Figure 2: Warship Procurement Timetable

- **Combat System**
  - Feasibility Studies: 12-18 months
  - Funding Submissions: 9-18 months
  - Project Definition: 12-24 months
  - Development Contracts: 18-30 months
  - Production Contracts: 18-30 months
  - Combat Systems Integration: 18-36 months
  - First of Class Trials: 18-24 months
  - Flapped Time From Start of Feasibility To First of Class Entering Service: Shortest: 8 years, 9 months Longest: 15 years

- **Platform and Ship Systems**
  - Feasibility Studies: 9-18 months
  - Platform and Systems Design, Competition for Lead Shipbuilder: 18-24 months
  - Build Hull and Instal Major Items: 18-30 months
  - Production of Long Lead Platform Items

N.B. The timetable assumes no delays due to late delivery of long lead items.

Source: National Audit Office Consultant

This figure suggests that, for a modern warship, there could be an elapsed time of between 8 years, 9 months and 15 years from the start of the feasibility to entering service. This model allows no time for delays resulting from the difficulties of managing a multinational programme. The shorter timescales are for relatively simple warships with few, if any, developments included. The longest timescale is for complex, high capacity warships, with several, large new developments. The CNGF is a multinational programme of a complex warship with several new developments incorporated. The programme plan is based upon an anticipated elapsed time of 11.2 years which would appear, from this model, to be marginally optimistic for a purely national programme and very optimistic for the multinational programme that it is.
2.31 Drawing on the success of the Type 23 Shore Development Facility, the CNGF will have a similar arrangement. However, the Department intend a different approach in that the latter will test only fully developed equipments. The Shore Integration Facility will be designed, built and managed by industry. As it will not be government furnished, the collaborative partners will not be contractually liable for delays to equipment development programmes arising from late deliveries of the facility.

2.32 The Shore Integration Facility represents a major risk reduction measure to the First-of-Class ships by seeking to resolve integration difficulties well before they can prejudice the ship programme. Moreover, this will be achieved in a shore-based environment where resources can be applied more cost-effectively than at sea. Additionally, the use of a Software Integration Platform is being examined by the Combat Management System contractors as a means of assessing operational software prior to transfer to the Shore Integration Facility.

Key points

2.33 • Project definition on all weapon equipments will now be completed before detailed warship design and build contracts commence. Nevertheless, the planned In-Service date of 2002 is very optimistic and will require careful management if it is to be achieved; and

• the CNGF will have a Shore Integration Facility, but unlike that for the Type 23 this will be built and run by industry. This will reduce the liability of the joint partners for equipment delays. To minimise integration problems, a shore based Software Integration Platform is also being considered.

Planning for future operations and maintenance

We recommend that the Department seek to ensure that adequate time is available in future procurements for the assessment of life-cycle costs and the drawing up of acceptable reliability and maintainability criteria [PAC 30th Report 1993-94].

2.34 The life of a warship class from conception to final disposal can last forty years. It is therefore prudent to consider, at the beginning of the development stage, how ships' in-service costs and availability may be affected by their original design specifications. A key feature of this analysis is 'life-cycle costing', which looks at the costs of operating and maintaining equipments through their expected period in service. Such analysis should be supported by contractors' demonstration that the equipments they are supplying meet specified reliability and maintainability criteria, thus reducing the risk of expensive and time-consuming repairs. On the contract for the Landing Platform for Helicopters, timescale constraints prevented the Department from carrying out a full life-cycle costing exercise, or from specifying reliability and maintainability targets for the whole ship. The Department acknowledge that
they do not yet have systems in place to analyse the potential total of through-life costs of the Ship Class.

2.35 Life-cycle costing, reliability and maintainability issues have already been considered by the national partners on the CNGF, and modelling at the whole warship level has been carried out to assess likely costs and availability in service. It is important that if in-service support costs are to be minimised, that the International Joint Venture Company are contracted to refine this process in respect of individual equipment components for which they will be the Design Authority.

2.36 Another factor which may result in increased in-service costs and reduced availability is the need to incorporate new or updated equipments to keep the warship militarily relevant during its operational life. However, the risks involved in integrating new equipments will be greatly reduced if the original design makes allowances for this. For the CNGF, the Tripartite Staff Requirement makes provision for weight, vertical centre of gravity and accommodation margins. These margins together will facilitate possible future demands on the ship to accommodate and man additional equipment. However, great care will be needed at the design stage to ensure that these planned margins are not consumed before the ship enters operational service, as has happened on some United Kingdom warship programmes.

2.37 In the past, inadequate financial provision has been made for maintenance and operation manuals for new platform equipments. Because of its international procurement, the CNGF is likely to incorporate a far higher proportion of new-to-Service platform equipments than a purely national procurement. The adoption of Integrated Logistic Support principles should ensure that early financial provision is made for the production of maintenance manuals which, in the United Kingdom’s case, should be in English.

Key points

2.38 • to protect against the risks of unacceptable repair, maintenance and running costs, and of reduced availability during ships’ period in service, life-cycle costing procedures and reliability/maintainability criteria must be established at an early stage of development. This risk has been recognised on the programme for the CNGF by the adoption of Integrated Logistic Support principles;

• the design of the CNGF will incorporate predefined growth margins to allow for possible future demands while in service. But it is important to ensure that these are not consumed during the design stage; and

• early provision must also be made for maintenance and operations manuals to be fully available when the ships enter service.
Part 3: Lessons applicable to CNGF as a collaborative programme

3.1 In this part of their Report, the National Audit Office identify lessons which apply specifically to the CNGF as a collaborative programme. These cover the sharing of work between national industries, the incorporation of national variants into the overall design, and the transfer to national contractors of follow-on production orders.

Cost and workshare provisions

In collaborative projects the Department should press partner nations to accept contractual arrangements which, for example, maximise the use of competition, taut contracting, and the concept of prime contractorship. The area where most progress needs to be made is in the appointment of an existing contractor rather than a specially-formed international consortium to act as prime contractor (PAC 6th Report 1991/2).

The Public Accounts Committee supported in principle the twin objectives of minimising costs and securing an equitable workshare for the United Kingdom. Where these objectives were incompatible, they considered it important for the Department to determine in advance the weight and priority to be given to each (PAC 35th Report 85/86).

3.2 The CNGF Memorandum of Understanding states as a prime objective that contracts should be let through competition where appropriate. Moreover, consideration affecting the work sharing arrangements on the programme will be the achievement of value for money. As a general principle, therefore, formal worksharing is not defined as a requirement, but will broadly equate to cost share through the duration of the programme, with the aim of achieving an overall balance over the whole life of the programme. Consideration will also be given to balancing the quality of work given to the industries of the three Nations.

3.3 The Nations will share, equally, the cost of development of the programme, the procurement of common equipment for the First of Class ships for each Nation, and the operating costs of the project offices. Significantly, the Memorandum states that the costs and work share of follow-on ships and their equipments will be in proportion to off-take.
3.4 These arrangements for contracting work and cost sharing may be contrasted with those on another collaborative programme examined by the Committee of Public Accounts (14th Report 90/91) and by the House of Commons Defence Committee (6th Report 91/92). Under the Memorandum of Understanding for this programme precise work share targets have to be met at every stage. This has been rigidly interpreted by both industry and nations to include equipments selected through competition. These arrangements have constrained the efficient management of the project, and have inhibited the cost effective allocation of work with equipment contracts often awarded to specially created four-nation consortia whose partners in some cases produce very minor parts of equipments. An industrial estimate based on one equipment suggests this practice adds about 30 per cent to costs.

3.5 The collaborative partners are aware this risk has some potential for CNGF during the development and First of Class production phases. They are taking steps to guard against it in their choice of competing consortia undertaking project definition of major systems.

3.6 However, the problem for the United Kingdom will come with follow-on ship orders where, in addition to its First of Class, it is at present foreseen that the United Kingdom will ultimately require 11 vessels compared with the Italian five and the French three (though those requirements may change over the life of the programme). Under the terms of the Memorandum of Understanding British industry will expect to have a 65 per cent work share of all that production but based on the experience of only 33.3 per cent of the development and production of the First of Class. This situation could give rise to the cost of transferring technology and construction expertise to United Kingdom shipyards, as well as additional tooling and design company support costs, which will have to be set against any savings identified from putting United Kingdom construction work out to competition. Such considerations are discussed further at paragraphs 3.16 to 3.25.

3.7 Any piecemeal transfer of production information may also result in the enforced formation of international manufacturing consortia to meet workshare targets at a point where there is little scope left in the programme to juggle work share - thus adding further cost.
Key points

3.8 • in collaborative programmes the concepts of minimum cost and equitable workshare are not easily compatible;

• the CNGF Memorandum of Understanding is an improvement on that for certain earlier collaborative programmes in that it will promote more efficient contractual arrangements and thereby reduce the cost of development and the cost of the three First of Class ships;

• the greatest risk in the programme lies in development and production of the three First of Class ships. In achieving an agreement based on a one third cost share for these two phases, the Department should acquire its first CNGF at a cost far lower than could have been achieved under a national procurement; but

• the United Kingdom may exercise its right to its full work share in building follow on ships, if the Department can demonstrate that there is advantage in so doing. However, when the time comes to make a firm decision on how best to place production orders, the Department will need to consider the effect which technology transfer costs, which could be substantial, will have on the overall value for money offered by alternative routes; and

• the cost of technology transfer could be significant and should, therefore, be included in the overall investment appraisal for all collaborative programmes and weighed against the savings arising from collaborative development.

The integration of national variants

3.9 The United Kingdom and France envisage somewhat different operational roles for their respective vessels. Thus, whilst the three nations have signed a tri-partite agreement and the majority of weapons and equipments will be common, it seems likely that certain equipments will be procured separately by individual nations for fitting to their own ships. For example:

• the main Anti-Air Missile System was originally to have been developed as part of the Family of Anti-Air Missile Systems; a merging of the United Kingdom and Franco Italian requirements. However, the Department considered that the radar originally proposed for the missile system was unlikely to meet the agreed requirement. They were also concerned that the system would be procured without the full benefit of competition. The programme is now proceeding as the Principal Anti-Air Missile System, a collaborative venture which allows the integration of alternative national radars. There is to be one system incorporating two multi-function radars, but the system as a whole is to be developed and managed by one Prime contractor under one contract, and who will take responsibility for the full system, including its two multi-function radars;
national equipment variants generally will be procured under separate contractual arrangements and delivered as Government Furnished Equipment for installation aboard each nation’s ships. As currently envisaged, national variants are expected to make up a small proportion of the total and their introduction is actively discouraged by the nations. However, the Department will procure their own torpedoes, torpedo defence systems, helicopter facilities, including ammunition stowage, and communications intercept systems.

3.10 Despite the possible separate development of these equipments, the International Joint Venture Company will still be responsible for their integration with the ship platform. It is intended that this will be achieved through the Company assuming responsibility for overall Combat System Design. This will be a complex task and will be additional to the International Joint Venture Company’s overall design responsibility on the common programme. The risks associated with this will be reflected through a premium within the overall price which the Company intends to charge.

3.11 In order to meet their responsibilities for overall design, it is fundamental that the International Joint Venture Company will need to have a very clear idea of the equipments that are being developed under separate procurement arrangements. This will be essential before commencing detailed design of the ship platform that will have to integrate the various equipments, since national variations may result in significant differences in weight and in the resulting geometry of the ship. This principle of design practice has already been adopted by certain other NATO navies. For example, development on the United States Arleigh Burke Destroyer did not begin until the intended weapon fits requirements were clear. For their Patrol Frigate, the Canadians followed, to a very large extent, the same policy.

Key points

3.12 • a prime contractor will be responsible for the design and construction of the first three CNGF platforms, and for the configuration and installation of equipment systems. There are, however, several major equipments that may be procured under separate programmes, either as collaborative ventures or as national variants;

• it is essential that the Joint Venture Company has a clear understanding of all the equipments to be provided as national variants before commencing detailed design of the ships’ platform;

• the prime contractor’s assumption of integration risk in respect of these separate procurements will be reflected by a premium in the price which they propose to charge for the programme. The Department should look carefully at this premium and assess whether it offers best overall value for money given the prospect that, in practice, programme constraints may result in at least part of the risk being borne by the collaborative partners.
Competing follow-on orders

3.13 The design definition contract to be let towards the end of 1995 to the International Joint Venture Company will be followed by the detailed design and build contract for the three national First of Class vessels. Orders for follow-on national ships - eleven are currently envisaged for the United Kingdom, five for Italy and three for France - will be placed with shipyards of their respective nations. In the United Kingdom's case, follow-on orders will be competed.

3.14 Competition significantly reduced the prices the Department paid to shipbuilders for constructing Type 23 Frigates. However, if shipbuilders are to win orders for follow-on ships, they must take account of factors, such as the cost of transferring design and build information from the lead yard, when forming their bids.

3.15 The transfer of design information from one shipbuilder to another is traditionally a difficult area. Liquidated damages may be enforced on the lead shipbuilder for late delivery of acceptable information. However, in their report "The 1991 Statement on Major Defence Projects", the National Audit Office recently drew attention to the fact that, as the liquidated damages clause in the lead yard services contract had to be related to the total value of that contract, the liquidated damages that could be recovered were far outweighed by the delay and dislocation payments which the Department had to make to the follow-on shipbuilder for the Royal Navy's second Auxiliary Oiler Replenishment vessel.

3.16 For a collaborative warship programme such as the CNGF, there are considerations which may make design transfer even more complex. Firstly, the International Joint Venture Company is a consortium which includes separate national shipbuilders. The Department do not yet know how design work will be managed between the International Joint Venture Company and its three parent companies. Design work will have to be co-ordinated, and the International Joint Venture Company may elect to use computer aided design systems that allow for long-distance design conferencing - the shipbuilding members of the Company already have compatible systems.

3.17 However, these systems are also intended to interlink with computer aided manufacturing systems which derive production information from the computerised designs. As such, there may be a risk that designs tailored for optimum build performance in one shipyard will not be equally efficient in another, even if design philosophies and data are compatible. This risk, whilst a feature of a national follow-on build programme, is magnified in the case of CNGF because of the potentially complex work sharing arrangements between the three countries.

3.18 Secondly, whilst some consideration has been given by the International Joint Venture Company to sharing production work on the three First of Class vessels, this is not necessarily on a ship by ship basis but by building and transporting modules between the shipbuilders. The feasibility and value for money of such
arrangements have yet to be demonstrated. If they came to fruition, they could represent a very complex environment for the United Kingdom's follow-on build competitions. Although not wishing to rule out any initiatives at this stage, the Department believe that the most likely scenario is that such arrangements will be uneconomic, and that modules will be limited to equipments and sub-systems.

3.19 Such considerations obviously affect the strategy for follow-on orders. Production information transferred to the United Kingdom from the CNGF Design Authority may be orientated towards production of each ship in a number of different locations, and may require much work to standardise the information in a form suitable for production at a single national yard. Additionally, when follow-on orders are placed, no one shipyard within the United Kingdom will have had the experience of building every module of the complete ship.

3.20 As a result the arrangements for follow-on orders for the CNGF may be very much more complex than those for the Type 23, and will require a considerable degree of planning. To assure, as far as is practicable, the conditions for good competition the Department have already announced their intention of negotiating for United Kingdom candidate shipyards to be provided with progressive and timely access to design information.

3.21 The CNGF Memorandum of Understanding requires the tri-national partners to secure from Contractors and Sub-contractors, and from their own government organisations, sufficient intellectual property rights to technical information to support national follow-on orders. Securing these rights is essential for unfettered competition of production contracts.

3.22 The Memorandum recognises three different classes of intellectual property rights:

(a) Foreground Rights, that is to technical information directly generated by contracts let for development work;

(b) Category I Contractors' Background Rights these apply to technical information required for development work but solely owned by the contractor or his sub-contractor, prior to contract. Such information must be made available free of charge to the project for subsequent use in competitively awarded contracts; and

(c) Category II Contractors' Background Rights these apply to technical information that is owned by bodies other than the development contractor or his sub-contractors, and which the latter have been using under licence. Such background rights cannot be assigned for the use of any other contractor without the agreement of the licensor.

3.23 The problem with the second category of Background Rights is that the licensor may be unwilling to extend the licence to any contract bidder. This would be especially true of technical information whose release may have strategic
implications for the licensor. For example, information which could allow a major competitor to enter his market. There is no realistic way round this problem, and it can be ameliorated only by discovering whether the licensor is likely to have any objections to any potential licensees, and registering that objection as part of any contract appraisal process.

Key points

3.24 • the costs of transfer of build information must be taken into account when follow-on orders are competed. However, there are additional considerations which relate to the CNGF:

• technical information transferred from the International Joint Venture Company, in which design responsibility will be shared, may contain large elements that require much work to make them suitable for individual national yards.

Additionally, no one shipbuilder within the Joint Venture Company will have had the experience of building every module of the complete ship. The Department intend, therefore, to ensure that United Kingdom candidate shipyards are provided with progressive and timely access to design information;

• national follow-on orders will require governments to secure intellectual property rights from contractors and sub-contractors involved in development work; and where there may be restrictions to the unreserved use of Background intellectual property rights, for example where this is owned by third parties who may not be willing to licence it to any contract bidder, this should be formally recorded and considered as part of the follow-on contract appraisal.
Part 4: Overall conclusion

4.1 Lessons learnt from past United Kingdom warship projects have major implications for the procurement of the CNGF not only for the Department, but also for industry. Additionally, there are separate considerations which apply to the CNGF as a collaborative programme.

4.2 The National Audit Office's review of the CNGF project to date shows that the Department are acting upon the majority of the lessons that have been highlighted by the Committee of Public Accounts and the Defence Committee in their reports on warship building and other procurements over the last 20 years. Industry is being treated as a full partner in the procurement of the CNGF, and will be contracted to bear much of the procurement risk. In turn, the Department and their collaborative partners are putting in place arrangements to monitor, and as far as possible, minimise risk on the overall programme. When operational, the ship should provide a most effective area defence capability.

4.3 There are two areas, however, which in the National Audit Office's view continue to give cause for concern: the project timetable and the work share arrangements.

Timetable

4.4 Modern warship production techniques may require elements of the ship design to be frozen much earlier than in the past and modular construction may well require the delivery of equipments for ship fitting at an earlier stage. This, in turn, places greater emphasis on the requirement for equipments to be fully defined before detailed design of the ship begins. The National Audit Office note that there is no slack in the overall development programme for the CNGF and that the planned in-service date of 2002 may be overly optimistic.

Industrial work share

4.5 The National Audit Office note that that the CNGF Memorandum of Understanding follows the Committee of Public Accounts recommendation that trade-offs between minimising costs and securing an equitable work share should be determined in advance. The agreed principal for CNGF is to be value for money. However, this will be subject to an agreement that work share should broadly equate to cost share throughout the programme.

4.6 The National Audit Office consider that there is a risk, if not managed carefully, that work share considerations could cause significant difficulties, as they have done on another collaborative programme, and seriously inhibit the cost effectiveness of the programme. It is essential that Industry and the
collaborative partners work together to ensure that workshare arrangements are addressed at the broadest level so that a pragmatic mechanism which recognises the political realities and achieves value for money is agreed.
Appendix 1

Relevant PAC and HCDC reports

PAC 5 Report 1975/76 - Procurement Executive (Sea Systems)
PAC 35 Report 1984/85 - Design & Procurement of Warships
PAC 14 Report 1990/91 - The European Fighter Aircraft
PAC 6 Report 1991/92 - European Fighter Aircraft
PAC 30 Report 1993/94 - The Award of the Contract for the Landing Platform for Helicopters
HCDC 6 Report 1991/92 - European Fighter Aircraft
Appendix 2

Glossary

Board Margin
Expressed as a weight in tonnes. The Board Margin is a figure set by the Admiralty Board at the commencement of ship design to allow for the weight of extra equipment that the Board may wish to fit during a ship’s lifetime.

Best Endeavours
A basis for contracting which relieves the Department or the contractors of liability for the failure of a third party - provided best endeavours have been used in attempting to secure the latter’s performance.

Combat System
The Combat system comprises the ship’s weapons, sensors, electronic warfare system, passive and active decoys, communications and internal and external data links.

Command System
The system which controls and co-ordinates the Combat System.

Cost Plus Contract
A contract priced by reference to the Government’s profit formula which reimburses a contractor for the costs he has actually incurred plus a percentage for profits.

Design Authority
The government or commercial authority responsible for the detailed design of equipment to approved specifications and for certifying that the design complies with the specifications.

Design Involvement Contract
A contract placed with industry for its assistance in directed tasks related to the design and development of equipments.

Deployment Liability
The areas and roles in which equipments are specified for use.

Fatigue Life
The life of an equipment component prior to its likely failure arising from repeated application of low level stresses.

Feasibility Study
A study undertaken to establish that there are no major technical, cost or programme factors that might prevent the satisfactory development and construction of proposed equipments.

Finite Element Analysis
A complex computer modelling technique which can be used to help to predict the stress distribution in complicated structures.

Government Specified to be used by a contractor in his Furnished procurement of a particular equipment, and for Equipment/ which government assumes liability in the case of Information defects or late delivery.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Liquidated Damages</td>
<td>A contractually agreed level of damages which will be paid by a contractor in the event of his failure to fulfil a specific contract requirement. The level of Liquidated Damages must not exceed a figure which is commensurate with the damage likely to be sustained.</td>
</tr>
<tr>
<td>Long Lead Materials</td>
<td>Item or component parts of an equipment which, because of the time taken to procure them, need to be ordered in advance of the main equipment to meet its stated delivery date.</td>
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<tr>
<td>Memorandum of Understanding</td>
<td>An international agreement which commits the collaborative partner nations to a stage of the procurement process, and defines the arrangements for that stage.</td>
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<tr>
<td>Modular Construction</td>
<td>Construction of warships in discrete blocks ('modules') which can be fitted out before being assembled together.</td>
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<tr>
<td>Novation</td>
<td>A legal device whereby rights and responsibilities of one party to a contract are transferred to another.</td>
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<tr>
<td>Operational Analysis</td>
<td>The processing of facts and probabilities into patterns relevant to the likely consequences of alternative operational scenarios.</td>
</tr>
<tr>
<td>Production Investment</td>
<td>For some equipments, the procurement phase covering essential no-recurring pre-production activities and the definition and development of product support services.</td>
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<tr>
<td>Project Definition</td>
<td>An investigation, normally by industry, of sufficient depth to explore areas of technical uncertainty in a Staff Requirement.</td>
</tr>
<tr>
<td>Redundancy</td>
<td>The margin inherent in equipment design to provide pickup or additional capacity.</td>
</tr>
<tr>
<td>Ship Husbandry</td>
<td>That aspect of ship upkeep relating to cleaning, corrosion control and painting; term is most usually applied to in-service activities by Ship and Base personnel.</td>
</tr>
<tr>
<td>Staff Requirement</td>
<td>A detailed statement, usually prepared after a Feasibility Study, describing the function and performance of a proposed new equipment, and the environment in which it is to operate.</td>
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