



National Audit Office

## **MINISTRY OF DEFENCE**

# Providing Anti-Air Warfare Capability: the Type 45 Destroyer

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**MINISTRY OF DEFENCE**  
Providing Anti-Air Warfare Capability:  
the Type 45 Destroyer

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**10 March 2009**

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<b>SUMMARY</b>	<b>4</b>
<b>PART ONE</b> Providing the new capability required	<b>9</b>
<b>PART TWO</b> Procuring the new capability	<b>17</b>
<b>PART THREE</b> Risks to achieving the new capability	<b>23</b>
<b>APPENDIX</b> 1 Methodology	<b>27</b>
<b>GLOSSARY</b>	<b>29</b>



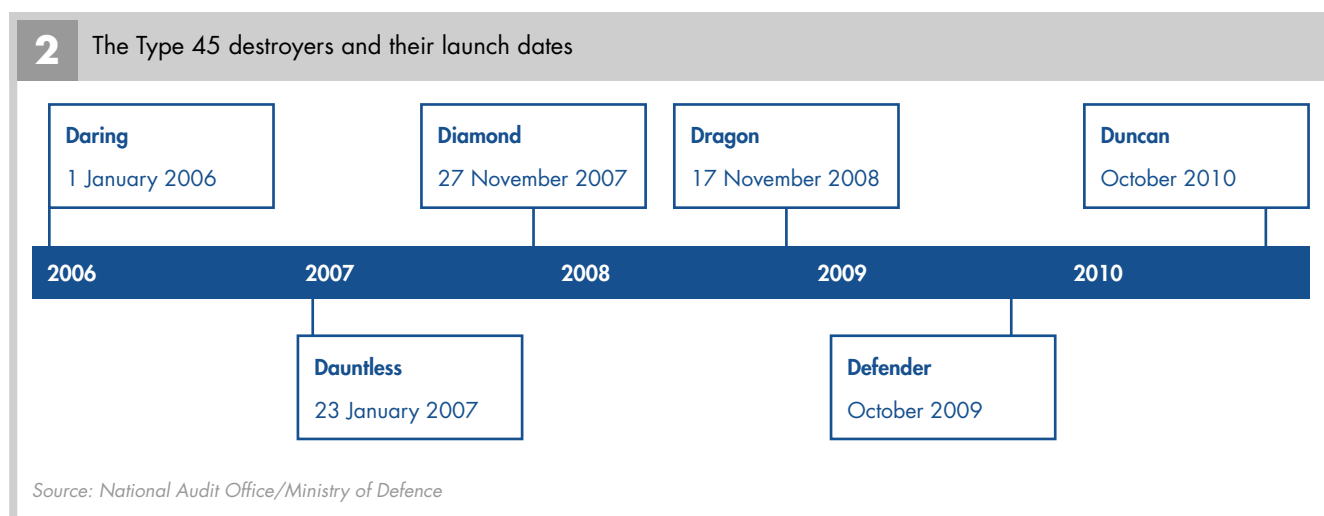
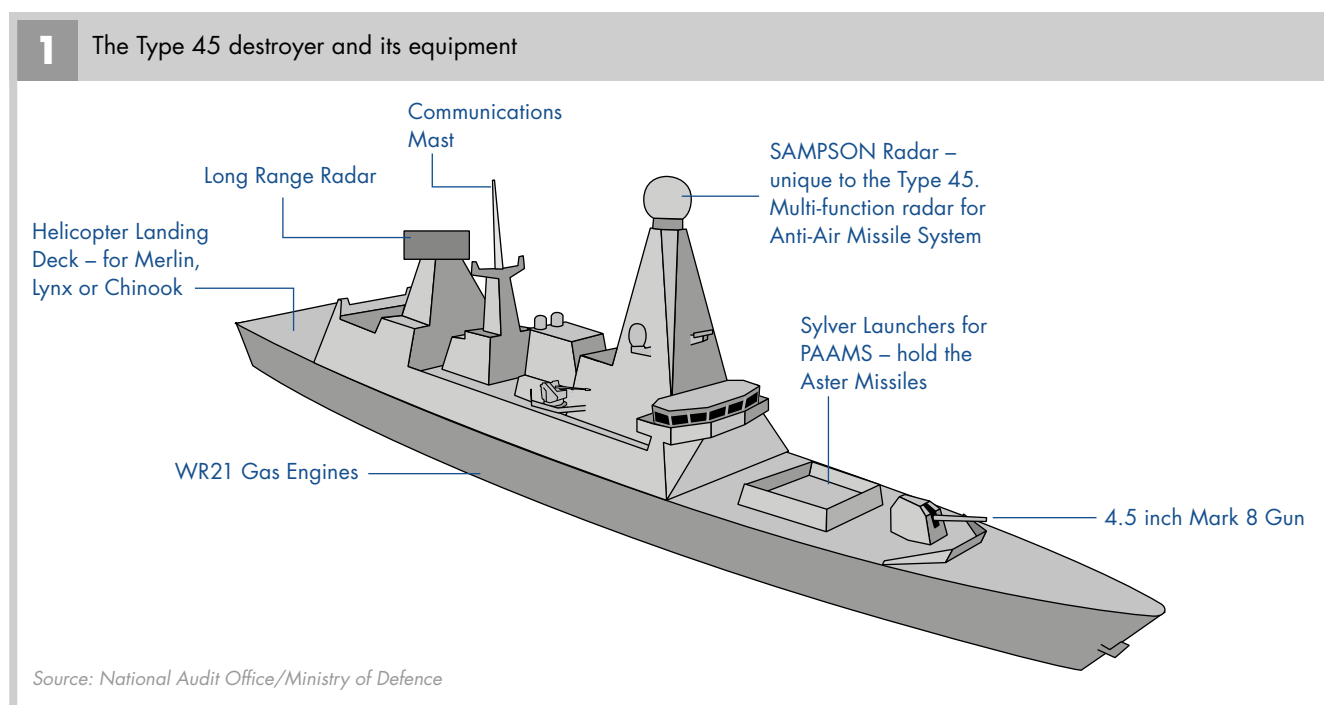
# SUMMARY

**1** The Ministry of Defence (the Department) is procuring a fleet of six Type 45 destroyers to replace the ageing Type 42 destroyers. The Type 45 destroyers will be fitted with the new Principal Anti-Air Missile System (PAAMS) able to engage multiple hostile aircraft or missiles simultaneously and, compared with the Type 42 destroyers, will have better accommodation for personnel, more fuel efficient engines, and be able to operate Lynx, Merlin and Chinook helicopters. **Figure 1** outlines its key equipments. The Type 45 destroyers anti-air warfare capability allows the ship to operate in a hostile environment, either to provide a protective umbrella over a force of landing ships, an aircraft carrier or a group of merchant ships, or to conduct a wide range of other tasks such as maintaining a United Kingdom presence, embargoes or supporting forces ashore.

**2** In July 2000 Defence Ministers approved expenditure of £5 billion (with a maximum acceptable cost of £5.47 billion) to procure six (out of a planned class of 12) Type 45 destroyers with the first ship to enter service in November 2007. The project has experienced significant cost increases and delays. The current forecast cost for the procurement of six ships is £6.46 billion (a 29 per cent increase compared with the most likely approved cost of £5 billion). The Major Projects Report records that the destroyer is now expected to enter service in November 2010 (36 months later than planned). The Department however, is working towards a more challenging “target” date for delivery of December 2009. We use this “target” date throughout the report. The contract was renegotiated in 2007 and management of the project is now much improved and no delays or cost increases have been reported since. The first of class Daring successfully completed contractor led sea trials in September 2008, and the fourth destroyer Dragon was launched two months later. The launch dates of the Type 45 destroyers are detailed in **Figure 2**.

3 Our report examines the impact of the problems on the project on the provision of anti-air warfare capability, the causes of the procurement difficulties, how the Department has overcome these, and whether the Department is managing all of the other elements – such as support and training – necessary for it to make full use of the equipment capability. It is a detailed case study examination of a project that features annually in our Major Projects Report and as such allows us to examine procurement and capability issues in much greater detail. Specifically we considered:

- a what capability has been available to the Department during the procurement of the Type 45 destroyers, and how it has set about managing the transition to the new class of ships;
- b how the Department has managed the procurement to date, including its ability to meet the original requirements for time, cost and capability, and what action it has taken to deal with problems where these have occurred;
- c how well prepared the Department is to support the class of Type 45 destroyers through their operational life as they come into service.



## The provision of anti-air capability

**4** The delays on the Type 45 destroyer project mean that the Department is still actively operating five Type 42 destroyers which offer a much more limited capability. Even allowing for the success of a number of cost reduction measures undertaken by the Department, we calculate that extending the life of the Type 42 destroyers to cover the delays to the Type 45s is costing a total of some £195 million. This is not an additional cost to the Department because operating costs for the Type 45 destroyers would have been incurred instead had they been delivered to their original timescales. The Department cannot yet estimate these operating costs with confidence.

**5** The Department plans to introduce the Type 45 destroyers into service between 2009 and 2013. The Department has always intended to introduce capabilities incrementally on ships after they have come into service. On current plans *Daring*, the first ship of class, will enter into service with the Anti-Air Warfare performance having been tested but before the missile is first fired from a destroyer and before the full on-board PAAMS training package is complete in mid 2011 (although the missiles will have been tested elsewhere). The Department believes that, if necessary, it could deploy *Daring* and make use of PAAMS when the ship enters service in 2009. It was always planned that several other equipments that contribute to providing the full capability envisaged for the Type 45 destroyers would be installed incrementally after *Daring* enters service. These equipments include communications and the United States' developed Co-operative Engagement Capability (CEC) which can provide a clearer picture of the battle space and improve the ability of a task force to undertake anti-air warfare operations, particularly in coalition with the United States. The current target date to install CEC is 2014 – five years after *Daring* enters service but before the new Carriers, which Type 45 destroyer will protect, are planned to be ready.

**6** The UK's current Aircraft Carrier capability is provided by the Invincible Class of Carriers HMS *Ark Royal* and HMS *Illustrious* which are planned to be retired in 2012 and 2015 respectively. This class, originally designed for Cold War anti-submarine warfare, operates helicopters and Harrier aircraft. In 2008, the Department confirmed that it will procure two new Aircraft Carriers. Part of the Type 45's role will be to protect the new Carriers.

**7** When the Type 45 destroyer project was approved in 2000, the Department planned to buy 12 ships. A reduction from 12 to eight ships was announced in 2004 and was attributed to a reduced threat, revised planning assumptions and a planned improved network capability (the intended introduction of CEC in 2014). In 2008, the Department decided not to procure a further two ships and instead to conclude the Type 45 build programme before the major Carrier build programme. Once the carriers are completed, the intention is to procure a new class of ships, with an air defence capability, called the Future Surface Combatant. This new project is in the early stages of procurement and is planned to come into service between 2018 and 2020. The Department's policy requirement is to have five ships available for tasking at any time. It will be challenging to meet this requirement, established when the Department intended to buy eight ships, with the reduced number of destroyers being procured. The Department judges however that the benefits of new technology and improved efficiency mean that it will be able to deliver the necessary capabilities with fewer ships. The Department is looking to optimise the way it supports the destroyers to maximise the time "at sea" and aims to have five available at varying states of readiness.

## Procurement

**8** In 1999 the Department signed a contract with MDBA to procure the PAAMS weapons system for the proposed fleet of destroyers. The following year the Department committed to procure six Type 45 destroyers from BVT (formerly BAE Systems). When the shipbuilding project was established, the Department's estimates of the extent of the work needed to complete the ship design and development, and of the initial costs and timescales involved were over-optimistic. The associated commercial arrangements did not reflect the risks and uncertainty remaining, project control and decision making were poor, governance structures were ineffective, and relationships between the Department and BVT broke down.

**9** In 2006, the Department undertook a far reaching review of the project and in 2007 the Department renegotiated the ship contract with BVT and established new, more effective ways of working with industry, including more extensive co-location. The Department also strengthened its governance arrangements.



**10** Early evidence suggests these actions have helped the project to progress more smoothly, and there have been no cost increases or further delays since the contract was renegotiated. Some risks to the project remain. Notably, the Department has separated responsibility for the delivery of the ships and PAAMS. These are now being managed by separate teams which specialise in destroyers and weapons respectively whereas before they were managed within one team. This separation aims to bring benefits to the Department through more coherent management of weapons, but could increase the difficulties of managing all aspects of the delivery and support of the Type 45 destroyer capability. The Department is aware of this risk and has developed a strategy to manage both projects coherently as two separate but aligned projects with a single senior champion.

**11** The Department is working to a detailed timetable for the delivery of the ships. This timetable has challenging “target” dates for all milestones, such as the destroyers entering into service. Corporate reporting, external reports such as the Major Projects Report and long term financial planning use later dates based on a “most likely” timescale calculated using a quantified analysis of the risks remaining to the project. The Department accepts that using two different dates could cause confusion, which we saw to a limited extent in the early stages of our work. The Department also monitors progress on the project and its ability to meet successfully the “target” or the “most likely” date. These dates are under review and will be revised according to how much risk remains in the project.

## Support and training

**12** The Department is developing support arrangements for when the Type 45 destroyers come into service. Learning from other defence projects, it intends to use BVT and MBDA to provide the bulk of the support using a commercial arrangement in which the Department specifies a level of availability it needs and pays industry to deliver it. The support arrangements are planned to be introduced in two phases reflecting the complexity of the ship and that 80 per cent of its systems are new. The Department is putting these arrangements in place later than originally planned, partly because of delays and difficulties with the procurement and a need to realign the level of funding to meet the ship’s introduction to operations. The Department has put interim arrangements in place to support the first ship Daring during its sea trials. These interim activities could be extended to provide support for the destroyers for operational use if the main support solution is late although such an extension would likely be costly and therefore used only as a fallback position.

**13** The Department is bringing in the capability taking into account the Defence Lines of Development. This approach aims to ensure that all elements of the capability such as the necessary training and infrastructure, not just the ships themselves, are introduced coherently. The Department has responded flexibly to the delays in the delivery of some training facilities, in particular by planning to run more training on board Daring during sea trials. Training more personnel on the ship creates a risk that there may not be enough room or time available on board the ship to train fully the companies for Daring and the second destroyer, Dauntless. The Department is investigating alternative training solutions.

## Conclusion on value for money

**14** The existing Type 42 destroyers provide only a limited capability. The replacement, the Type 45 destroyer is planned to offer a much greater capability but has experienced considerable delays of over two years and cost increases of £1.5 billion because of over-optimism about what could be achieved, inappropriate commercial arrangements and, in the early stages, poor project management. The Department has taken action to resolve these problems and the project is now more mature and making better progress. As the Department had always planned, several pieces of equipment will be fitted to the destroyers incrementally after they come into service meaning that the full capability will not be available until the middle of the next decade. The development of the long term support solution is running later than planned and the Department may have to extend interim support measures as a fall back measure which could have operational and cost implications. Taken together, these factors mean that, although the programme is on course to meet all Key User Requirements when the first of class enters into service, the Department has not yet demonstrated that it will be able to achieve the full range of benefits that the Department originally envisaged could be achieved from spending £6.5 billion procuring the Type 45 destroyer.

## Recommendations

In managing the project to a successful conclusion

**15 The Type 45 destroyer Programme Board formally assesses progress on the Defence Lines of Development. Progress on the overarching Defence Line of Development – inter-operability between the services and with other nations – is not specifically reported.** The Department should report progress against the inter-operability Line of Development to the Programme Board.

On designing support arrangements which deliver the required levels of ship availability cost-effectively

**16 The Department aims to deliver cost-effective solutions and avoid becoming trapped in costly and inflexible arrangements.** Its phased approach to the introduction of long-term support is intended to exploit its growing understanding of the relevant factors affecting cost and availability as the ships enter service. To make the most of this approach the Department should routinely communicate to all stakeholders the responsibilities, behaviours, motivations and expected contributions of the different parts of the Department and its industry partners involved in delivering and sustaining the capabilities offered by the Type 45 destroyer.

**17 The Department will need accurate and reliable data if it is to model effectively the trade-off between the different ways to sustain or enhance the capability and availability of the destroyers throughout their life.** Learning from its experience with the existing Type 42 destroyers, where it has a limited understanding of the combined costs of maintaining and operating the ships, the Department and its industry partners should develop a standardised method to gather this data.

**18 Many of the problems encountered during the Type 45 destroyer project stemmed from the Department's poor working relationship with industry.** The re-basing of the project in 2007 helped address the underlying issues and the relationship is now on a much firmer footing. The project team has already begun work to develop stronger relationships informally as the project enters into the support stage. The Department and its industry partners should build on this work, and undertake regular surveys to measure the strengths and weaknesses of the relationships between various parts of the Department involved and the industrial partners.

## Managing projects on a corporate level

**19** The Department is managing the project to a set of challenging “target” dates. These dates assume no risks will materialise and are earlier than those reported corporately. Corporate reporting, external reports such as the Major Projects Report and long term financial planning uses later dates based on “most likely” timescales calculated using a quantified analysis of the risks remaining to the project. **The use of two timelines can create a mismatch between planned timescales for the activity and the provision of funds for that activity.** When project teams make use of “target” and “most likely” dates the Department should:

- a** regularly review the risks outstanding on its procurement projects and assess whether any variance between challenging “target” dates and those reported corporately remains valid;
- b** manage all aspects of the delivery of a given capability to a single consistent timeline and communicate it to all responsible parties within the Department;
- c** explicitly include in corporate reports progress against any “target” dates used by teams in addition to corporately approved dates so that senior management have the fullest and most accurate information available about target dates; and
- d** corporate assurance processes and senior management reviews should focus on the success, or otherwise, of teams in mitigating risks and converging “target” and corporate management dates as projects mature.

# PART ONE

## Providing the new capability required

**1.1** The Type 45 destroyer is intended to form the backbone of the Royal Navy's air defence capability for the next thirty years. This section of the report examines the declining effectiveness of the existing Type 42 destroyers. It also describes the improvement in capability that the Type 45 destroyer aims to provide compared to the ageing Type 42s.

### Existing Anti-Air Warfare capability

**1.2** To operate safely at sea, the Royal Navy must protect its ships from attacks from the air. The United Kingdom's current air defence capability is provided primarily by the Type 42 destroyers. These ships were designed in the 1960s and came into service during the 1970s and 1980s. Each ship was intended to be in service for 25 years. The main weapon on board the Type 42 destroyer is Sea Dart which is capable of protecting a task force.

**1.3** The Type 42 destroyers are mainly used as Atlantic Patrol Ships, on exercises and occasionally as part of the Joint Rapid Reaction Force. The Department believes that while the Type 42 destroyers are capable of performing air defence tasks, they cannot cope with a large number of sophisticated threats simultaneously. Since the mid 1980s

the Department has initiated three separate projects to replace the Type 42 destroyers. Two projects, which preceded the current Type 45 destroyer project, were both cancelled before completion. **Figure 3** provides more details. The first attempt to procure a replacement was a multinational programme called the NATO Frigate Replacement for the 1990s. The second, known as Horizon, was a collaborative project with France and Italy. Horizon comprised not only the ship but also its major air defence capability in the form of the Principal Anti-Air Missile System. The project had an original in-service date of 2002, but it later slipped to 2004 and then to 2007 and was accompanied by escalation in cost. Each Navy had different requirements. The United Kingdom withdrew from the Horizon project in 1999 because costs were not acceptable to the United Kingdom and industry could not agree a Prime Contractor framework.

**1.4** The United Kingdom continued to collaborate with the French and Italians on the procurement of PAAMS. The result was two variants of the same PAAMS system: the United Kingdom variant uses the more powerful SAMPSON radar while the French and Italian version uses the EMPAR radar. The PAAMS system will provide the key anti-air warfare capability to be fitted on to the Type 45 destroyers.

### 3 Previous attempts to procure Anti-Air Warfare capability

Name of projects	Date	Procurement route	Reason for cancellation
NATO Frigate Replacement for the 1990s	1985 to 1989	Multinational: United Kingdom, United States, Canada, France, Germany, Italy, Spain and Netherlands	Different national requirements, spending limitations and timescales made consensus impossible
Horizon	1992 to 1999	United Kingdom, France and Italy	Industry unable to agree a Prime Contractor Structure to manage the programme and costs were unacceptable to the United Kingdom

Source: National Audit Office

## The cost of extending the life of the Type 42 destroyers

**1.5** When the Type 45 project began in 2000 the Royal Navy was still operating eleven Type 42 destroyers. The intention was to retire the Type 42s progressively as the Type 45s entered service from 2007. The delays on the Type 45 project have meant that the Department has had to extend the life of some of the Type 42 destroyers with the last one now planned to retire in 2013.

**1.6** We analysed the additional costs the Department has incurred by delaying the retirement of the Type 42 destroyers. The results are detailed in **Figure 4** and show the cost of extending the life of the Type 42 destroyers to be a total of some £195 million. This is not an additional cost to the Department because operating costs for the Type 45 destroyers would have been incurred instead had they been delivered to their original timescales. The Department cannot yet estimate these operating costs with confidence.

## Cost reduction measures on the Type 42 destroyers

**1.7** Without a number of cost cutting measures undertaken by the Department the costs would have exceeded £400 million. The cost reduction measures included:

- a** early retirement of three ships in 2005. These ships were not scheduled to go out of service until 2006 and 2007. Their retirement reduced the number of destroyers in the Navy to eight and saved £119 million. This figure includes savings in routine maintenance. The early retirement has also created a greater pool of spares. Increasingly, spare parts have been used from the growing number of other Type 42 destroyers that have been retired or taken out of service. This recycling has enabled further reductions in the costs of running on the remaining Type 42 destroyers;
- b** cancelling some aspects of deep maintenance, saving £93 million. This rundown helps to ensure that there is little or no useful life left in the ships when they are finally retired.

## The reducing capability of the Type 42 destroyers

**1.8** Today there are five active Type 42 destroyers currently in service from an original Fleet of 14, in 2008, a further three have been removed from active service early. These three could be made ready at a considerable but un-quantified cost if required. The age of the remaining destroyers and the scaled back maintenance regime means that the capability they provide is less robust and reducing against an increased level of threat compared with that faced when the Type 42s came into service in the 1970s and 1980s. The Type 42 destroyers will not be able to carry out their main role of an anti-air warfare capability beyond mid 2013 because the life of the Sea Dart missile system cannot be extended beyond this date. The following paragraphs explore each of these issues in more detail.

## Availability

**1.9** The Department measures the performance of the Type 42 destroyers by looking at whether the ships which are meant to be ready for operations are actually available to do so and are capable of carrying out their assigned tasks. The Department also measures how quickly ships are made ready to perform specific tasks (known as its readiness level). These measures are used to manage the overall availability of the fleet. This is important if the Royal Navy is to be able to plan effectively for tasking ships and managing manpower to meet operational requirements.

### 4 Costs of maintaining Type 42 destroyers beyond the expected retirement dates

	Cost (£m)
Deep maintenance	6.3
Planned maintenance	9.3
Casual – Unplanned maintenance	1.9
Manpower	73.7
Spares	59.2
Equipment	44.3
<b>Total</b>	<b>194.7</b>

Source: National Audit Office analysis of Ministry of Defence data

**1.10** Figure 5 shows that the availability of the Type 42 destroyers which are meant to be ready for operations has decreased slightly since 2000, while readiness levels have decreased much more. Both availability and readiness levels are very variable. Performance has improved since mid 2008, particularly with levels of readiness. This improvement reflects, in part, that three ships have been removed from active service at this time, creating additional spares.

## The number of defects reported

**1.11** The overall decline in performance reflects the age of the ships, their increasing obsolescence, reducing reliability and reduced funding for maintenance. A good indication of the effect of these problems is that the number of defects reported on board the destroyers, has been steadily increasing since 2000. There was a marked increase in defects reported between October 2006 and December 2008 from an average all time low of 190 defects reported per ship to a high of 399 defects per ship although this figure remained below 300 since September 2008.

## Sea Dart

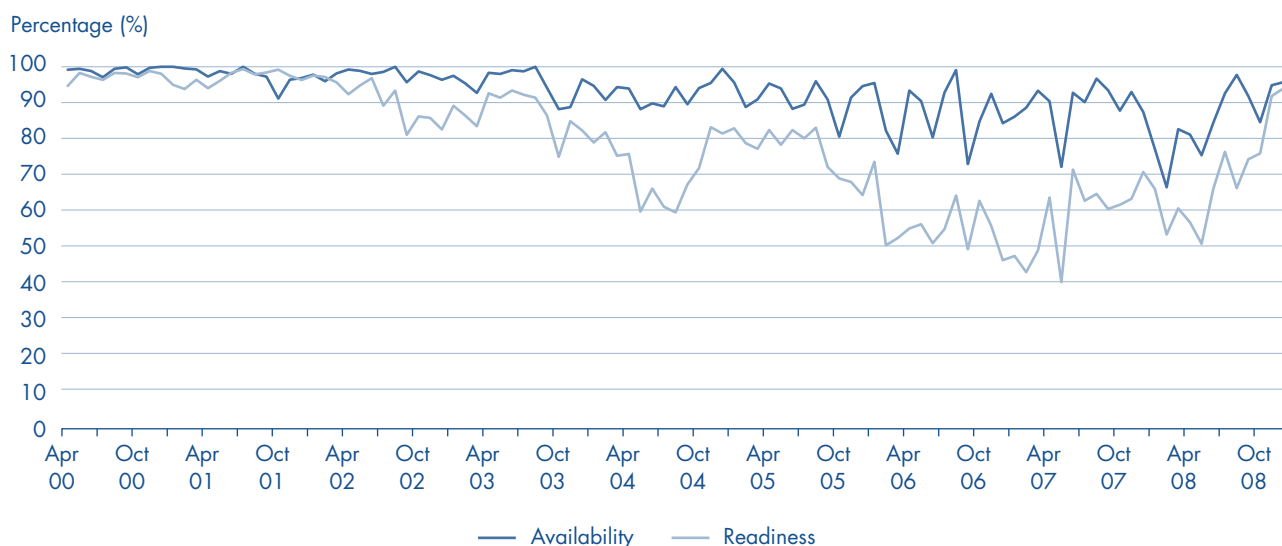
**1.12** The Sea Dart weapons system is the principal anti-air warfare system fitted on the Type 42 destroyer. Sea Dart is a medium range air defence missile which

entered service in the early 1970s and was designed to fight a Cold War threat of high diving missiles. Sea Dart is now approaching the end of its operational life, and the intention is that the system will be retired when the final Type 42 destroyer is retired. To save costs that would be otherwise incurred to support the system, Sea Dart was removed from two destroyers a year before they were taken out of service. Without their primary weapons systems these Type 42s could not be deployed in an air defence role.

## The capability provided by the new Type 45 destroyer

**1.13** The introduction of the Type 45 destroyer is planned to provide a much superior capability to that of the Type 42. The Type 45 destroyers' anti-air warfare capability allows the ship to operate in a hostile environment, either to provide a protective umbrella over a force of amphibious ships, an aircraft carrier or a group of merchant ships, or to conduct a wide range of other tasks such as maintaining a United Kingdom presence, embargo operations or supporting forces ashore. In particular, the SAMPSON radar being procured as part of PAAMS project can track over 1,000 airborne objects out to 250 kilometres and can engage several targets simultaneously. The capabilities of the Type 45 destroyer are compared with those of the older Type 42s in [Figure 6 overleaf](#).

**5** Trends in availability and readiness of the Type 42 destroyers since 2000



Source: Ministry of Defence

## Risks to the Type 45 destroyer capability

**1.14** The Type 45 destroyers are planned to enter service between 2009 and 2013. The Department has always intended to introduce capabilities incrementally on ships after they have come into service. On current plans, *Daring*, the first of class will enter service in December 2009, when it will meet all its defined Key User Requirements. There are, however, a number of risks both to achieving these dates and to delivering the full capability in the longer term. In the short term these include integrating the destroyer and PAAMS; and trialling and operating the Combat Management System. The Department and industry have taken a number of additional steps to mitigate these risks including constructing test facilities for the many elements of PAAMS. These are detailed in **Figure 7**.

**1.15** The first firing of PAAMS from a Type 45 destroyer is due to take place on *Dauntless*, second of class, in late 2010, nearly one year after *Daring*, the first of class destroyer has entered service. *Daring* is not scheduled to fire PAAMS until 2011. This timing is because the Department is using *Daring* to test the destroyer and its systems while *Dauntless* is subsequently used to test PAAMS. Once the final elements of PAAMS are delivered and the system tested the destroyer should obtain its Full Operating Capability in mid 2011. The Department believes that, if necessary, it could however deploy *Daring* and make use of PAAMS when the ship enters service in 2009. MBDA and the Department have tested the operational capability of PAAMS by test firing the missiles from a barge on firing ranges off the South of France. However, it has yet to be tested from the destroyer itself.

### 6 A comparison of Type 45 and Type 42 destroyers

Element	Type 45 destroyer	Type 42 destroyer
Efficiency	Greater fuel efficiency and operating range without being replenished meaning that it can cross the Atlantic and back without refuelling. This gives flexibility and permits a faster response in urgent situations.	At full power the Type 45 destroyer is nearly two and a half times more fuel efficient than the Type 42.
Defensive capability	Can extend its protective air-defence shield over British Forces engaged in a land battle.	Provides a protective shield which is optimised for maritime operations.
Weapons system	In an intensive attack, a Type 45 destroyer would be able to simultaneously track, engage and destroy more targets than the remaining Type 42 destroyers operating together.	Sea Dart system which will be retired in 2013.
Troop carrying capacity	Capacity to carry a maritime battle staff as well as putting troops ashore using its own boats or helicopter.	The Type 42 has no additional accommodation and has half the carrying capacity provided by the Type 45 destroyer's boats.
Helicopters	Can independently operate the Lynx, and Merlin and has flight deck space for a Chinook to land. The Merlin provides the anti-submarine warfare capability, thereby enhancing the Type 45's ability to deter or neutralise submarines.	Can operate the Lynx helicopter only. The Lynx entered service in the 1970s and is primarily used in anti-submarine warfare but can also deploy air to sea missiles.
Potential to upgrade	Designed to be more easily adapted and upgraded throughout its life to meet new, as yet unknown requirements and to counter emerging threats.	Reduced margins and an inflexible design make adding extra capabilities difficult.
Accommodation	Six-man cabins instead of large mess decks, more space for recreation and a purpose-built fitness centre.	The Type 42 destroyers suffer from cramped accommodation and few electrical points causing problems for safety and comfort.
Ship's Company	191	269

Source: Ministry of Defence

**1.16** There are seven specific pieces of equipment that contribute to providing the full capability envisaged for the Type 45 destroyers which are planned to be fitted incrementally after Daring is scheduled to enter service in December 2009. These include the Skynet 5 and Bowman communications systems.<sup>1</sup> The initial cost of integrating these seven equipments is estimated to be some £55 million. The Department is refining the full cost of installation, which is in addition to the Type 45 budget, though the Department judges that sufficient funds are available. The time it will take to integrate is uncertain until the Department completes its detailed assessment of how these capabilities will be installed. Without this equipment the destroyer will be less able to share information effectively with other military units. The Department will also need to support obsolete technologies increasing through-life costs.

**1.17** In the longer term, the destroyers will have a number of additional capabilities installed. **Figure 8 overleaf** provides a timeline detailing when key capabilities will be added to the destroyer to bring about full use. The Department is procuring the United States' developed Co-operative Engagement Capability (CEC). This project should link the combat systems and sensors on a number of ships to provide a clearer picture of the battle space, and aims to improve the ability of a task force to undertake anti-air warfare operations particularly in coalition with the United States. The enhanced capability provided by CEC mitigates in part the decrease in numbers of Type 45 destroyers. CEC will be fitted to all six Type 45 destroyers as well as ten Type 23 Frigates.

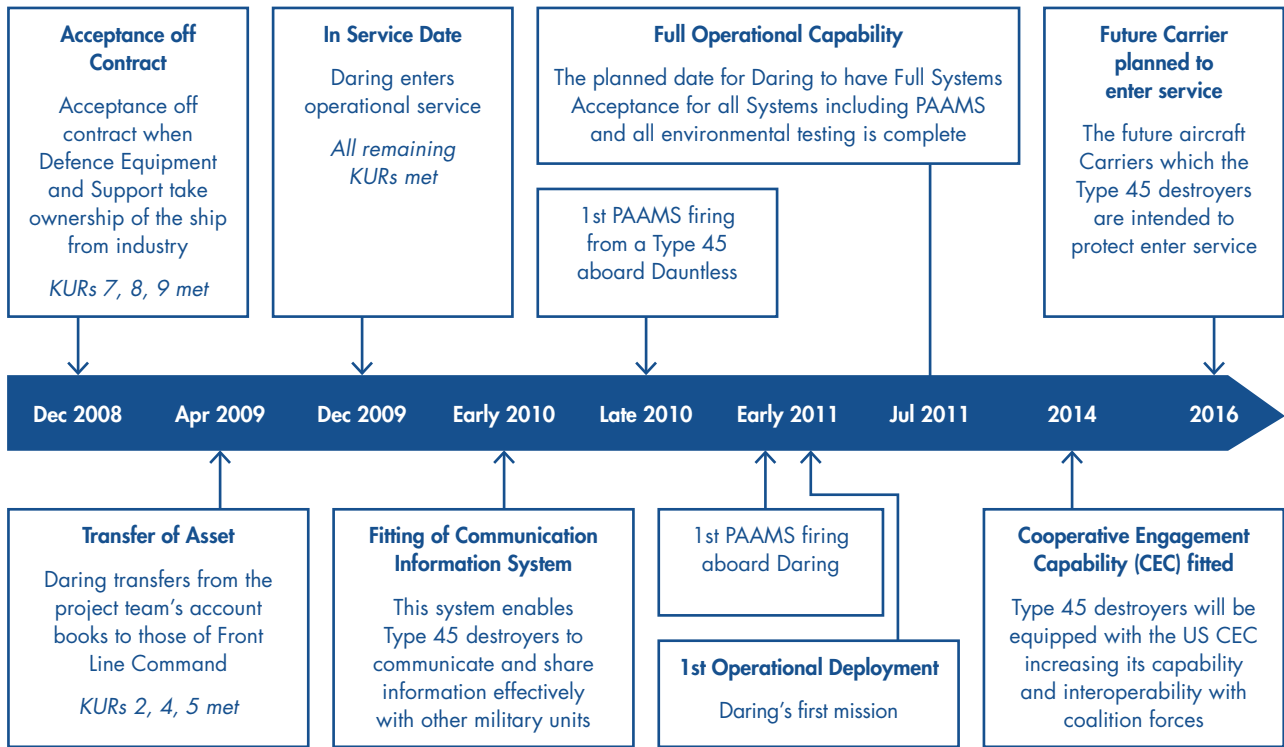
## 7 De-risking activities

Facility	De-risking activity
PAAMS Integration Facility at MBDA Bristol	<p>This facility brings together a detailed representation of the complete PAAMS system with the Type 45 Combat Management System to prove all the interfaces in a systematic way.</p> <p>The integration activities enabled the system to be brought together earlier than planned in the development programme, helping to solve many complex interfacing issues earlier than would otherwise have been the case. The facility remains in use as a venue to help demonstrate that the software updates resulting from further developments are effective.</p>
Contractor Development Facility	<p>This facility at Eskmeals, Cumbria is a sea level site featuring a complete PAAMS system and Type 45 Command System. The SAMPSON radar is sited on a tower at the same height above sea level as on the Type 45 to provide a representative test environment.</p> <p>The facility has been in use since January 2007 to conduct radar and PAAMS system level trials against aircraft and towed targets.</p>
Sea Trials Platform – Longbow	<p>The Sea Trials Platform, (known as Longbow) is the trials platform for the missile firings intended to prove the performance of PAAMS. Longbow is currently in the Mediterranean where it is undertaking the PAAMS firing trial programme.</p> <p>One of the three PAAMS system firings was successfully carried out at the end of June 2008 and two more are scheduled to follow. The Longbow trials contribute to the de-risking of the integration of PAAMS on board the Type 45.</p>
Maritime Integration Support Centre	<p>The Maritime Integration Support Centre at Portsdown contains a representation of the entire Type 45 Combat System and includes a full PAAMS system, Long Range Radar, Type 45 Combat Management System and other Combat System equipment.</p> <p>The main purpose of the facility has been to integrate all of the Type 45 combat system equipments in a controlled environment. The trials carried out to date have helped to progress the final stage of combat system integration on board Daring.</p>
Type 45 First of Class Daring	<p>The integration of the PAAMS system onto the Type 45 First of Class – Daring, and under the revised Six Ship Contract, a two phase process for this integration has been adopted.</p> <p>The first of these phases was completed to schedule in July 2008 as a result of all of the de-risking activities described above and MBDA intends to complete the second phase as planned at the end of September 2009.</p>

Source: National Audit Office

<sup>1</sup> The other five are Warship Automatic Identification System (WAIS); Warship Electronic Charting and Information System (WECDIS); Defence Information Infrastructure (DII); Joint Command & Control Support Programme (JC2SP); and HF 4KMA (Enhancements to a high frequency radio system).

**8** Time line to full use of the Type 45 destroyers



**Key User Requirements (KURs)**

<p><b>KUR 1</b></p> <p>Type 45, utilising PAAMS, shall be able to protect with a probability of escaping hit of X per cent all units operating within 6.5km against specified airborne threats</p>	<p><b>KUR 2</b></p> <p>Type 45 shall be capable of providing anti-air warfare situational awareness covering 1000 airborne objects against a departure/arrival rate of 500/hour</p>	<p><b>KUR 3</b></p> <p>Type 45 shall be able to provide close tactical control to at least four, fixed wing or groups of, aircraft</p>
<p><b>KUR 4</b></p> <p>Type 45 shall be able to operate both one Merlin and Lynx Mk8 helicopter, although not simultaneously</p>	<p><b>KUR 5</b></p> <p>Type 45 shall be able to operate an embarked military force of at least 30 deployable troops</p>	<p><b>KUR 6</b></p> <p>Type 45 shall carry a Medium Calibre Gun System of at least 114mm</p>
<p><b>KUR 7</b></p> <p>Type 45 shall be able to travel at least 3,000 nautical miles, operate for three days and return within 20 days unsupported</p>	<p><b>KUR 8</b></p> <p>Type 45 shall be able to be upgraded to incorporate new capabilities or expand extant capabilities</p>	<p><b>KUR 9</b></p> <p>Type 45 shall have a 70 per cent availability to contribute to operations over a period of at least 25 years at least 35 per cent of which must be spent at sea</p>

Source: National Audit Office/Ministry of Defence

**NOTES**

- 1 All dates specific to Type 45 are "target" dates.
- 2 Some elements of KUR 1 are classified.



**1.18** The Co-operative Engagement Capability has been delayed and the current target date for it to be installed onto the Type 45 destroyer is 2014, five years after Daring enters service. This date is before the new Carriers, which the Type 45 destroyer will protect, are planned to be ready. The estimated cost of procuring the CEC for the Type 45 destroyers will be in the range of £85 million to £125 million, and to support CEC on the Type 45 destroyers will cost approximately £80 million to £120 million throughout its life. The Department has allocated funding for the CEC project.

**1.19** The United Kingdom's current aircraft carrier capability is provided by the Invincible Class of Carriers HMS Ark Royal and HMS Illustrious which are planned to be retired in 2012 and 2015 respectively. This class, originally designed for Cold War anti-submarine warfare, operates helicopters and Harrier aircraft. In 2008, the Department confirmed that it will procure two new Aircraft Carriers as replacements for the Invincible class. The new Carriers and its aircraft are planned to be capable of operating in all weathers, day and night, flying strike missions, conducting offensive support for ground forces ashore and where necessary, providing force protection to the fleet. The Aircraft Carrier will also be capable of supporting the operation of helicopters in a wide variety of roles including land attack and ground support. Part of the Type 45 destroyer's role will be to provide a protective umbrella for the new Carriers.

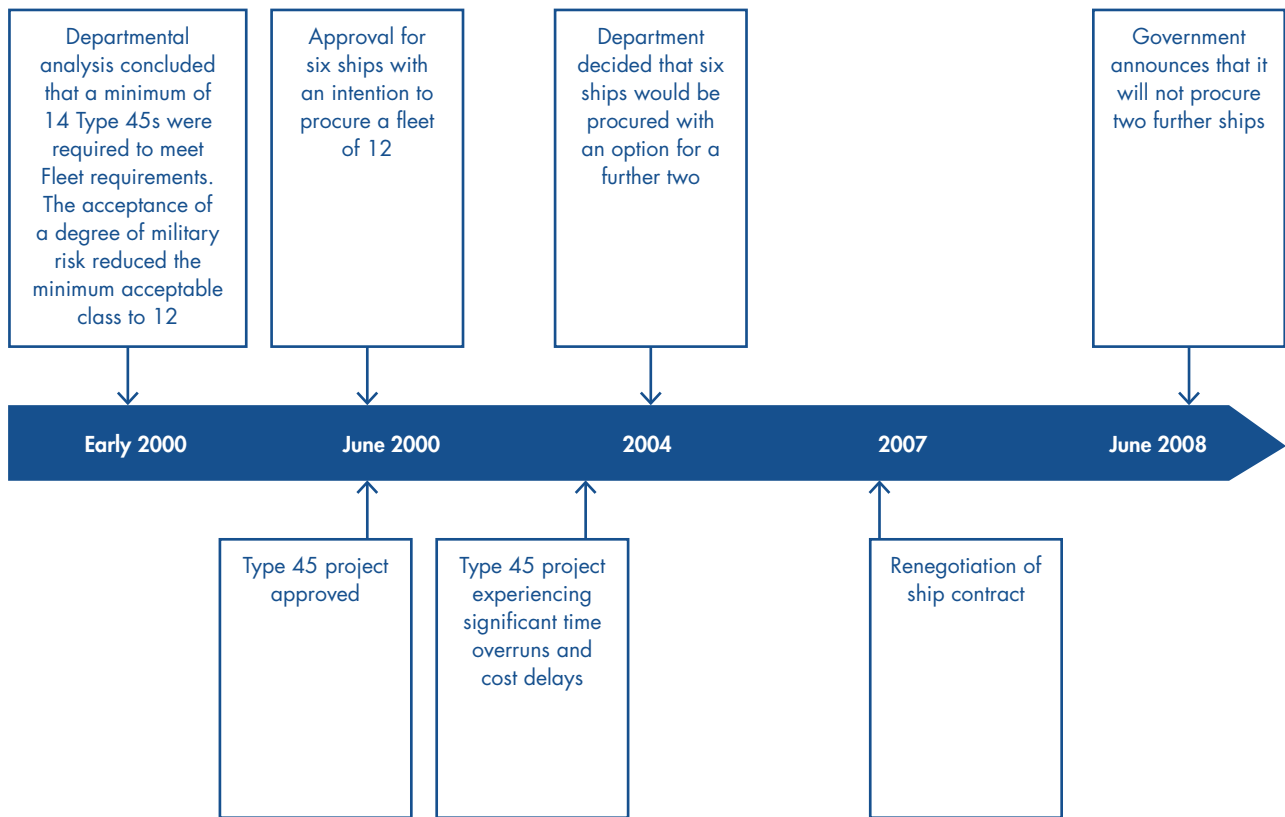
**1.20** When it is in service, each Type 45 destroyer should have met all of its key user requirements and, subject to a number of improvements to its communication and information systems and PAAMS being fully operational, will be deployable across the full range of maritime operations, from maritime security or policing through to more demanding high intensity war-fighting missions. Examples of current and recent operations for which the Type 45 destroyer should be able to deal with when it comes into service include maritime security in the Northern Arabian Gulf, anti-piracy patrols off the coast of North-East Africa, post-hurricane disaster relief and support in the Caribbean, or the evacuation of British nationals from a deteriorating situation (as seen in Lebanon in 2006). Additionally, Joint Operations such as small scale Counter Terrorism operations can be conducted from the Type 45 destroyer. The installation of CEC will enhance the Type 45 destroyer's air warfare capability through improved situational awareness, enabling it to operate with other CEC fitted units (most notably from the United States) in more demanding threat environments.

## Reductions in numbers of Type 45 destroyers being procured

**1.21** When the Type 45 destroyer project was approved in 2000, the Department planned to buy 12 ships, although funding was based on six initially. Four years later, the Department reduced the number of destroyers to be procured from 12 to eight because of a reduced threat, revised planning assumptions and a planned improved network capability. This improvement is intended to be provided by CEC in 2014. In 2008, the Department decided not to buy a further two ships beyond the six already on contract, and instead to conclude the Type 45 programme before the major Carrier programme. Once the Carriers are completed, the intention is to procure a new class of ships, called the Future Surface Combatant. This new project is still in the early stages of its procurement and is planned to come into service in between 2018 and 2020. **Figure 9 overleaf** shows the timing of the relevant decisions. The Department's policy requirement to have five Type 45 destroyers available for operational use remains unchanged. It will be more challenging to meet this requirement with the reduced number of destroyers being procured. But the Department judges that the benefits of new technology and improved efficiency mean that it will be able to deliver the necessary capability with fewer ships. It has prescribed that each ship must be available to go to sea at least 35 per cent of the time, and be ready to go to sea for a further 35 per cent. The Department is looking to optimise the way it supports the destroyers to maximise the time "at sea" and aims to have five available at varying states of readiness.

## 9

## Timeline showing the events leading to the reduction in number of ships to be procured from twelve to six



Source: National Audit Office/Ministry of Defence

# PART TWO

## Procuring the new capability

**2.1** In 2000 the Department placed a contract for the design, development, manufacture, integration and delivery of six Type 45 destroyers (to be fitted with PAAMS). The approved cost for the six ships and PAAMS was £5 billion (with a maximum acceptable cost of £5.47 billion) with the first ship due to enter service in November 2007. As successive Major Projects Reports have recorded, the project has experienced significant cost increases and delays with the current forecast cost being £6.46 billion (a 29 per cent increase compared with the most likely approved cost of £5 billion) and the first ship now planned to enter service in December 2009 (some 24 months later than originally planned). **Figure 10** outlines the cost increases and delays.

**10** Cost increases and delays on the Type 45 destroyer project (based on procuring six ships)

Year	In Service Date for first ship	Cost for six ships (£m)
Main Gate Approval	November 2007	5,000
MPR 2002	No change	+279
MPR 2003	No change	+267
MPR 2004	+ 18 months	+282
MPR 2005	No change	+125
MPR 2006	+ 7 months	+157
MPR 2007	+ 11 months	+354
MPR 2008	No change	No change
<b>Change since Approval</b>	<b>+ 36 months</b>	<b>+1,464</b>
Current Forecast	November 2010 <sup>1</sup>	6,464

Source: National Audit Office Major Projects Report 2000 to 2008

#### NOTE

<sup>1</sup> This date is the corporately reported "most likely" date which appears in the Major Projects Report. The Department is planning its delivery to a more challenging "target" date of December 2009.

**2.2** Recognising these problems, the Department re-assessed the project in 2006. As a result, the ship contract was renegotiated in 2007 and project management is now much improved. There have been no delays or cost increases reported since the Department took this action. The delivery of the ships is progressing well, with key milestones such as completion of sea trials, having been met. Most recently, the fourth destroyer Dragon was launched in November 2008 and in December 2008 ownership of Daring transferred from BVT to the Department and Dauntless completed her initial sea trials. This part of our report examines the causes underlying the poor cost and timescale performance of the procurement; whether the Department and its commercial partners have taken reasonable action to address the problems; and what risks remain.

### The commercial arrangements

**2.3** The current industrial arrangements for the procurement of the Type 45 destroyer are born out of the exit from the Horizon project in 1999. The United Kingdom withdrew from the project to pursue a larger destroyer programme and took control over the design and build of the Type 45 platform. The United Kingdom remained a member of the collaborative missile system procurement project (PAAMS) with the French and Italians.

**2.4** BVT – known as BAE Systems in 2000 – was contracted to be the design authority, and is responsible for the design, build and fit-out of the Type 45 ships. PAAMS is provided by the Department to BVT who will install the equipment. Integration of the PAAMS equipment remains the responsibility of MBDA. BVT builds each Type 45 destroyer in six blocks. Under the original arrangements, VT Group build and integrate the forward two blocks and the mast structures while BAE Systems build and integrate the four middle and rear blocks. The forward and rear halves are then integrated by BAE at Govan, near Glasgow.

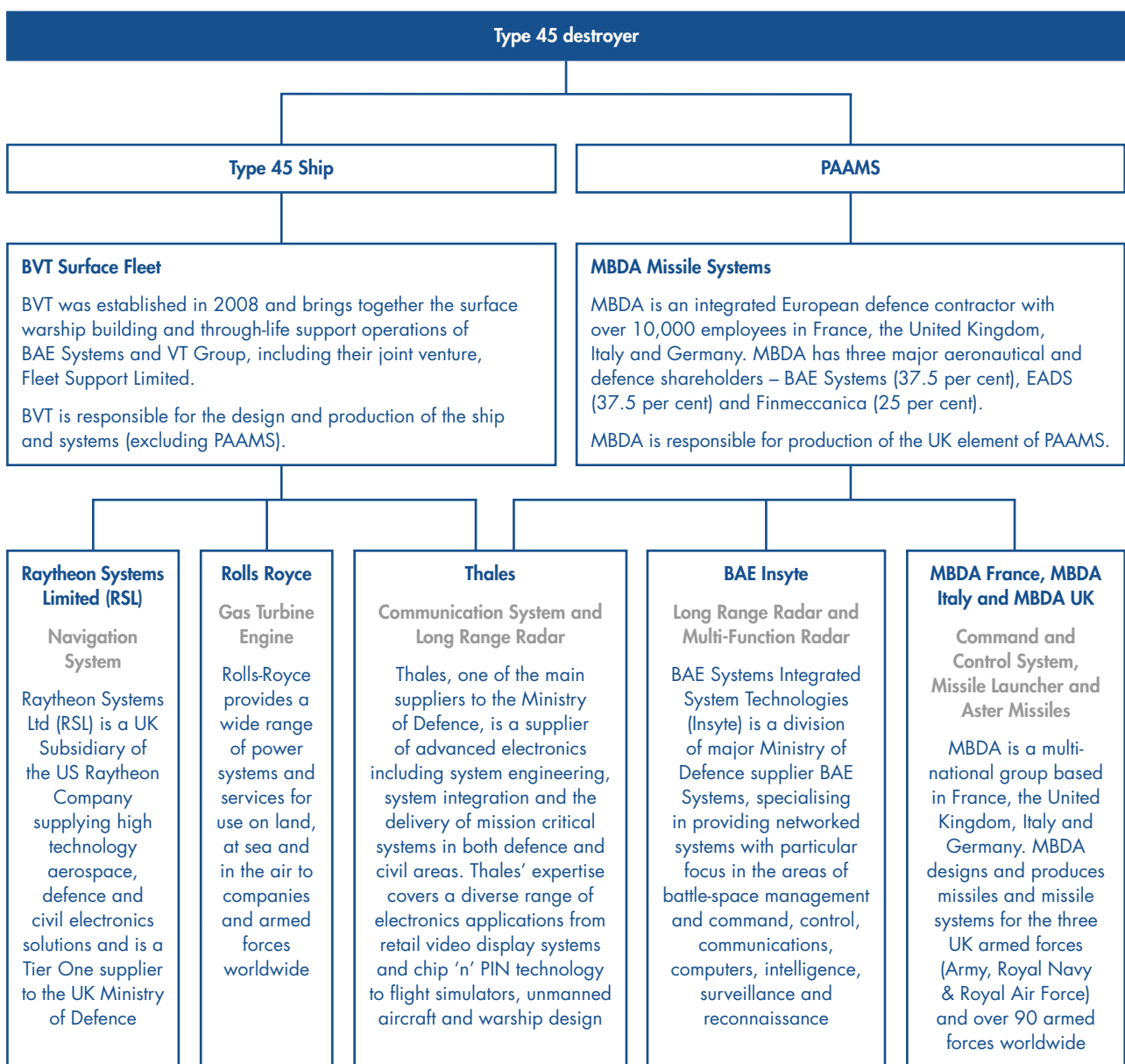
**2.5** In 2008, BAE Systems and VT Group came together in a joint venture to form BVT Surface Fleet Ltd which brings together BAE, VT Group, and their Fleet Support Ltd operation which provides ship repair, maintenance and engineering to the Royal Navy fleet. The procurement of the Type 45 destroyers has not been affected by this change.

**2.6** PAAMS is designed and built by MBDA under a tri-national agreement with the French, Italians and United Kingdom governments contracted through the French Defence Armaments Agency. The various contractual partners, their role in the Type 45 destroyer project and their general role in the defence industry are outlined in **Figure 11**.

### Over optimism when the main investment decision was made

**2.7** The timetable approved in 2000 to deliver the Type 45 destroyer project was based on the timeframe set out on the Horizon project from which the Department had earlier withdrawn, and was driven by the need to replace the ageing Type 42 destroyers (see Part One). Industrial partners needed early assurance that the project would proceed, so that they could begin to make the necessary investments in order to meet the planned timescales. We assessed

## 11 Contracting partners



Source: National Audit Office

whether the Type 45 destroyers were being procured for a reasonable price and which would be typical for such complex warships.

**2.8** This assessment was based on Historical Cost Trend Analysis. This technique uses historical outturn data to generate cost trends for specific classes of equipment, which allows an estimate to be compared with the trend in outturn cost of similar past projects. Recognising the difficulties inherent in estimating costs and timescales on complex defence equipment projects, the Department has, since 2005, required major equipment projects to include historical cost trend analysis to act as a check on the realism of cost estimates when the main investment decision is taken on projects.

**2.9** Our analysis of Type 45 destroyers shows that the actual cost of a Type 45 destroyer, excluding development costs, is broadly in line with what could be expected for similar types of destroyer. If development costs are included, the cost of the Type 45 is over £100 million more per ship than would be expected as shown in **Figure 12**. One particular issue affecting development costs is that the Department is now only procuring half the number of ships originally planned, meaning that the costs associated with the extensive development of a wide range of new systems, such as PAAMS, are not being spread as widely as expected.

**12** Cost per Type 45 destroyer compared to independent estimates<sup>1</sup>

Costs Per Ship	Excluding Development Costs (£m)	Including Development Costs (£m)
Actual Cost (adjusted for purposes of comparison) <sup>1</sup>	649	948
Independent cost analysis of a similar type of destroyer	643	813
Difference	+6	+135

Source: National Audit Office

NOTE

<sup>1</sup> Figures adjusted from that reported in the Major Projects Report to ensure comparability.

## The original project arrangements and subsequent improvements

**2.10** The Department and its commercial partners were over-optimistic in their predictions of the time and resources required to procure the first six ships, and did not establish the project on a suitable basis given the levels of risk and uncertainty and the immaturity of the design of the ships and the PAAMS missile system. There were particular problems with the commercial arrangements, inadequate project controls and ineffective governance arrangements.

**2.11** The problems are explored in more detail in **Figure 13 overleaf**. One key issue is that the original ship contract was for a fixed price but had many undefined elements. The contract also enabled industry to recover costs through claims for compensation. There were issues with the project management arrangements which had key processes missing and insufficient assurance over data, undermining the credibility of progress reports and risk analysis. Joint governance arrangements between the Department and industry were not sufficiently effective to resolve project difficulties on a timely basis. Recognising the difficulties on the project, the Department undertook a far-reaching review in 2006, which identified a way forward to reform the project, and the ship contract was consequently renegotiated in 2007. The Department elected to continue PAAMS contractual arrangements which are being re-aligned to the new ship contract. Figure 13 details the changes made to the commercial basis of the project, including the so-called “six ship contract” and the project control and the governance arrangements. Particular improvements were:

- greater use of incentivisation in the contract between the Department and BVT;
- more pragmatic sharing of risk between the Department and industry which gave the Department more control over trading time, cost and capability;
- the strengthening of the project management function, which led to improved project reporting and better use of information;
- better joint governance arrangements at all levels of the project, helping to foster an improved joint working culture. These new governance arrangements are mapped in **Figure 14 on page 22**.

**2.12** The revised arrangements reflect the increasing understanding of the project, certainty of the number of ships to be procured (which had fallen from a class of 12 ships to six) and an emphasis on collaborative working with risks allocated to those best able to manage them.

## 13 How weaknesses in the procurement framework impacted on the Type 45 Project, and how the Department has responded

### Weakness

### Impact on Project

#### Commercial Arrangements

The original contract was placed before commercial structures to support it had been built. There was uncertainty about the procurement strategy and numbers of ships to be built.

The Department intended to share design and construction work for the first three ships between two ship builders, BAE Systems Marine and Vosper Thornycroft, who were to form an Alliance to undertake this work. The companies did not agree to form the alliance, and as a result the Department took on more responsibility for design than intended. This introduced delays into the project at an early stage and removed competition from the procurement.

The pricing arrangements for the first three ships placed the majority of risks on to the contractor, increasing the possibility of price growth.

The Department set a fixed price for the first three ships, with a profit margin of under five per cent for BVT. Many requirements had not been specified or priced when the contract was placed. This left BVT at risk of cost growth.

The Department was responsible for delivering key equipment which left it open to claims for compensation if these were delayed.

BVT could claim compensation for delays on equipment such as the Gas Turbine Engines and PAAMS for which the Department was responsible. These and other equipments were delayed because of technical problems and BVT consequently made claims of £300 million.

#### Project Control

The Department was unable to verify the accuracy of key data and senior management did not have confidence in its accuracy.

The Department relied on BVT to provide data on project progress, cost and risks. BVT continued to be optimistic about project progress and the Department was therefore not well placed to challenge BVT's assumptions. The Department's accounting system contributed to errors in forecasting of costs.

The Department and industry did not have a common understanding of the project.

The Department did not have a single, high level overview of the whole project (including on and off-contract industry work). This increased the risk that decision making would not take into account the overall project status and objectives.

There were inadequate levels of staff within the Department's project team.

The Department's project management team lacked suitably qualified staff and relied on consultants.

The Department's internal communication was weak.

The Department's project management team was not able to communicate problems with the project effectively to senior management. It was unable to convince senior management that its proposals for revised cost and time limits were sufficiently robust for approval, leading to delays before the contract with the BVT could be renegotiated.

#### Governance

The joint management procedures between the Department and industry were seen as ineffective.

The inconsistent reporting between the Department and BVT undermined the role of the Joint Management Board attended by their senior staff. BVT believed that the Joint Management Board was "ineffective".

Source: National Audit Office

### How the Department has addressed the problem

The Department recognised that the original contract was not providing an appropriate framework for success and in 2007 agreed a new contract for six ships (the Six Ship Contract). This has set the project on a more sound commercial footing. The Department has revised the delivery arrangements and will now receive the ships from the Prime Contractor before they have been fully trialled and integrated, conducting these final stages with industry support. This change has allowed the Department to manage project risk better, bring forward the point of delivery of the ships and has contributed to a saving of £93 million.

The Six Ship Contract has reduced the risk on industry through the “Measure and Decide” approach. This allows the Department to trade certain capabilities (which have already been identified) for time and cost advantages. Under the arrangements BVT “measures” the time and cost of providing the full capability of these specified items and the Department “decides” whether the capability is worth the cost in time and money. This has transferred more of the risk to the Department but has controlled the cost of the project.

The new contract incentivises industry to deliver on time and to help reduce the risk of further delays. If delays occur, then BVT/the Department can jointly use a £90 million fund to pay for the cost of delays. If the ships are delivered on time, then payments from the £90 million – which decline per ship – are made to the contractor as a reward. The renegotiated contract, however, still allows BVT to claim for dislocation.

The Department has better access to BVT’s project information. The Department has people co-located with BVT who are able to report on progress. Monthly progress meetings between BVT and the Department are also held.

There is now agreement with industry on the assumptions for the project and key project documents, such as the master planning document for support arrangements, are kept updated and reviewed regularly. Senior management have access to project plans that cover all relevant aspects of the project.

The project team has better technically qualified staff. The team responsible for managing the procurement of PAAMS continues to have staff shortages.

There is evidence of good quality reports based on consistent information being provided at appropriate levels throughout the project and management teams, providing regular updates of project progress and clear markers for decisions and actions required.

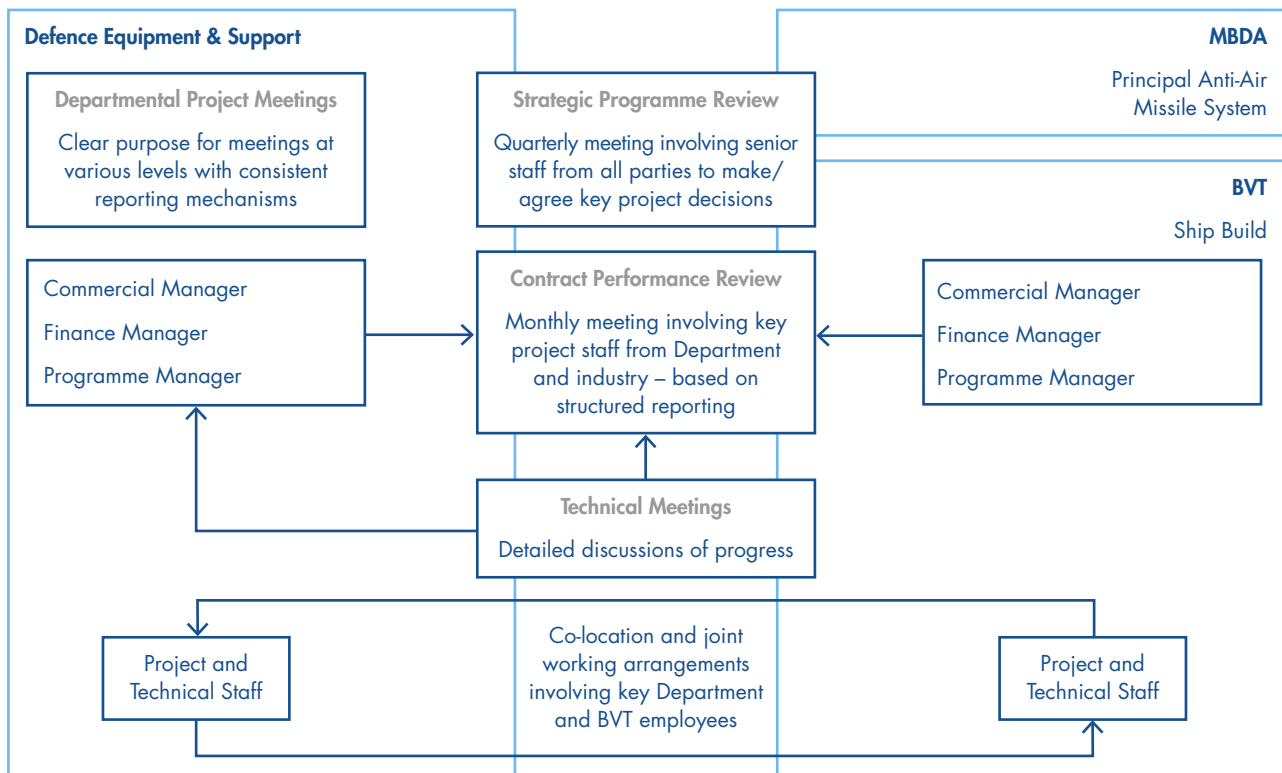
The Department and BVT appear to be working well together and the increasing use of co-location, particularly at senior levels, has helped to develop a positive joint working culture which could reduce the risk of further impacts on the time and cost of the project.

The Department has put a coherent governance structure in place for the project and introduced a Strategic Programme Review attended by the Department, BVT and MBDA. BVT and MBDA have also attended the more recent meetings of the Programme Board indicating improved communication.

The joint working arrangements with MBDA in relation to the PAAMS contract have remained similar throughout the project. There is no joint working or information sharing although MBDA attends the Strategic Programme Review. Historically the Department have enjoyed a good relationship with MBDA; more benefits may arise from building on this and from monitoring the strengths and weaknesses of the relationship on an ongoing basis.

Finally, the Department have implemented a more joined-up and coherent strategy for managing and reducing claims made by BVT against the Department.

## 14 New governance and communication arrangements for management of the ship-building project



Source: National Audit Office



# PART THREE

## Risks to achieving the new capability

**3.1** Introducing a major enhancement to the armed forces' capability such as the Type 45 destroyer involves considerably more than acquiring new equipment. The Department has therefore adopted an approach to ensure that all the elements required to deliver a given capability are put in place known as the "Lines of Development". The Lines of Development and progress against them are described in **Figure 15 overleaf**. This part of our report examines in detail the key logistics and training risks that could impact on the future capability of the destroyers as well as other risks to the project.

**3.2** Currently, the Department considers that all of the Defence Lines of Development will be ready to support the destroyers as required. There are, however, some issues with the first four of the Defence Lines of Development in Figure 15 that may limit the deployable capability if the Department's mitigating actions are not successful. The Defence Lines of Development are explored below.

### Equipment

**3.3** The changes made to the project following the 2006 review have placed it on a firmer footing than before. Paragraphs 1.14 to 1.18 outlined a number of technical and integration issues and the actions that the Department and industry have taken to mitigate them, but there are also a number of issues affecting the management of the project which could adversely affect delivery.

- In April 2008 the Department separated the Type 45 integrated project team and re-located the staff members responsible for managing PAAMS to the Complex Weapons group. This move brings greater coherence to the development, procurement and support of complex weapons such as missiles in line with the Defence Industrial Strategy, but it could increase the difficulties of managing all aspects of the delivery and support of the Type 45 destroyers as a whole. The Department is aware of this risk and has developed a strategy to manage both projects coherently as two separate but aligned projects.

The strategy allocates roles and responsibilities within both teams, and establishes areas where joint working is needed. There is also one single accountable senior person. It is too early to assess the effectiveness of these arrangements.

- The two PAAMS contracts for development and production still need to be adjusted to mirror the new delivery schedule under the Six Ship Contract. Achieving this change is made more complicated by the fact that PAAMS is a collaborative project, the commercial aspects of which are contracted through the French Defence Armaments Agency. Terms have been agreed for the changes needed to the development contract and discussions over the production contract are on-going. The Department does not expect these costs to exceed £15 million to £30 million and has allocated sufficient funding as part of the move to six ships.
- The Department is working to deliver the Type 45 destroyer capability to challenging "target" dates for all milestones, such as the destroyers entering into service. Corporate reporting, external reports such as the Major Projects Reports and long term financial planning use later dates based on "most likely" timescales, based on quantified analysis of the risks remaining to the project. The Department is aware that as the project milestones have a "target" and "most likely" date which are sometimes several months apart, there is a risk of confusion and of having to manage the funding profile across financial years. During our work some staff told us that they are planning to deliver support activities to the "most likely" date, although the majority are using the earlier "target" date. The Department is now confident that all staff are planning to the more optimistic date. The Department monitors the likelihood of achieving both the "target" and "most likely" date, and will revise them according to the amount of risk left in the project. The Department, has however, successfully met the earlier "target" date of Acceptance off Contract in December 2008.

## Logistics and support

**3.4** Traditionally, the Department has supported equipments by buying spare parts and other services from industry as required. Increasingly the Department is moving away from this model to contract with industry to provide a specified level of equipment availability, the intention being to incentivise industry to minimise the

cost of support by, for example, developing more reliable equipments which are easier to maintain. The Type 45 destroyers will be the first major type of warship to adopt this contracting for availability approach, which will mean the Department will only be directly responsible for about 15 per cent of support costs with the remainder managed by BVT (about 60 per cent) and MBDA (about 25 per cent).

### 15 The Defence Lines of Development and their function

Defence Line of Development	Function	Defence Lines of Development status
Equipment and Information	The ship, PAAMS, and all other systems on board.	As Part One shows, the project is making progress. Risks remain in the delivery of full capability (paragraphs 1.14 to 1.18). Key risks remaining to the delivery of the equipment Defence Line of Development are mainly related to PAAMS testing and integration; and the installation of the Communications and Information Systems (paragraphs 3.3).
Logistics	Design and development, acquisition and storage, transport, maintenance, evacuation, transport of personnel, and medical and health related support associated with Type 45. Much of this work will be contracted out to industry.	Key risk remaining: late development of the main support solution. Paragraphs 3.7 to 3.8
Infrastructure	Acquisition, development, management and disposal of all buildings, land, utilities and facility management required for the Type 45. These services are mainly provided by Defence Estates.	Key risk remaining: the development of an Aster capable loading facility at Portsmouth has still to be agreed and funded. It is expected to cost approximately £25 million and be ready in mid 2012. However, the project to build this new facility has not yet been approved or funding secured. In the short term, Dauntless, the first Type 45 to test fire an Aster missile, will have to use facilities at either Marchwood Military Port near Southampton or Glen Mallan near Glasgow. Marchwood has been close to or at full capacity although this may change as a result of the drawdown from Iraq, and using the alternative facility at Glen Mallan requires additional travel.
Training	Provides the means to practice and develop the effective use of the Type 45 platform by personnel.	Key risk remaining: the late delivery of some training packages for Dauntless and the later destroyers. Paragraphs 3.11 to 3.14
Personnel	The timely provision of sufficient, capable and motivated personnel by the Type 45 Manning Acceptance Committee and the Royal Navy.	Not rated to be at risk but there is a Naval Service wide risk created by an overall staffing shortfall. If manning of the ships goes as planned, however, all Type 45 destroyers will have a full on-board crew.
Concepts and doctrine	To design tactics and procedures to enable the Type 45 destroyer to undertake assigned operations.	Not rated to be at risk: draft guidance was issued November 2006, with a final version planned to be available nearer to Daring's entry into service. Modelling on the use of PAAMS will not be completed until after Daring enters service. It is under constant review as part of a continuous improvement exercise.
Organisation	How the operational and non-operational organisational relationships should be managed. Includes military force structures, MoD civilian organisational structures and Defence contractors providing support to the Type 45 platform.	Not rated to be at risk as organisational relationships are well understood.
Interoperability (an overarching theme)	The ability of United Kingdom Forces and, when appropriate, other nations to train, exercise and operate together effectively.	Not reported by the Type 45 project but potentially at risk because of the late delivery of CEC (which will help to deliver the maximum level of inter-operability with the United States).

Source: Ministry of Defence

**3.5** Past experience of introducing new types of warships suggests it is difficult to predict accurately before they enter service how much they will cost to support. For the Type 45 destroyers this difficulty is compounded by the complexity of the ships themselves and PAAMS, the number of new equipments being introduced – 80 per cent of the systems are new – and the adoption of a new commercial model. The Department has therefore adopted a staged approach which will enable it to gather data on cost and performance on the basis of early operational experience before putting long-term contracting for availability arrangements in place in 2013.

**3.6** Ahead of the two stage support arrangements, and reflecting the new commercial arrangements agreed in the Six Ship Contract, the Department will take ownership of Daring from BVT earlier during the trials process than previously planned. The revised arrangements were agreed to save time and cost for the Department by giving it greater control of management of risk to capability. The Department and its commercial partners have agreed interim support contracts worth £22 million for Daring and PAAMS lasting for one year.

## Development of long term support arrangements

**3.7** The Department faces a challenging timetable if it is to deliver its proposed strategy and have in place suitable arrangements to support Daring when it enters service. The challenges reflect a number of factors:

- The Department was focusing its efforts on resolving the difficulties with the procurement of the warship, and so was later in concentrating on support than planned.
- The Department needed to ensure that the support arrangements for the Type 45 destroyer were consistent with new arrangements being introduced over broadly similar timescales to support both other parts of the surface ship fleet (known as the Surface Ship Support Solution) and other complex weapons (known as the Complex Weapons Pipeline). The Surface Ship Support Solution is now becoming more mature, although there is now some uncertainty about how PAAMS will fit in with the rest of the Complex Weapons Pipeline. The Department's intention is that it will learn lessons from the introduction of the Type 45 destroyer which it can apply to its wider support initiatives.

- The achievability of support cost targets is uncertain. When the main investment decision was taken in 2000, the Department estimated that the cost of supporting each Type 45 destroyer should be £10 million per destroyer per annum less than the cost of supporting an existing Type 42 destroyer. This assessment was confirmed by further analysis in 2005. The differences between the Type 42 and Type 45 destroyers in terms of capability and complexity nevertheless suggest that the support costs of the older Type 42 may not be a wholly reliable indicator of these costs for the Type 45.

**3.8** The Department's intention is to start negotiations with industry for the support contracts for the Type 45 destroyer by the end of March 2009, to enable Daring to be properly supported if it enters operational service in December 2009. This is a challenging timetable based on the Department's "target" date. The availability of funding for support is based on the later "most likely" planning date. The Department is aware that if it meets the earlier date for delivery it will have to provide the necessary funding early to pay for the support solution.

**3.9** Alternatively, the Department could continue to use the existing interim support arrangements at a potential cost of £1 million per ship per month. The interim arrangements are only designed to support activities during trials. They would be able to provide a level of support for the ships for operational use, using the current contractual format, but doing so is likely to be costly. The Department considers the risk is manageable, particularly as Daring and subsequent ships will be alongside in Portsmouth for several months when they first enter service while equipments such as Bowman and Skynet are installed (see paragraph 1.16).

**3.10** Support cost data is held in an Integrated Cost Model operated by BVT, with the Department having access to the model as required. At present the Department has only limited resources available to enable it to fully understand and, if necessary, challenge the costs produced by the model. For example, from the analysis it has been able to undertake, the Department has raised concerns about the lack of formal validation and verification of the model. The majority of the costs from BVT have now been confirmed, but cost data on PAAMS is over a year old and will be updated in Spring 2009. The Department has recognised that it needs to commit more resource in this area and is recruiting a specialist.

## Training

**3.11** Having suitably trained personnel to operate and support the Type 45 destroyers from the time *Daring* enters service will be crucial to making the most of the capability they offer. As with any new type of warship, and particularly one as complex as the Type 45 destroyer with a significant number of new equipments, delivering training for the company of the first ship to enter service is complicated as the training must necessarily be designed while the ships and equipments are still being procured.

**3.12** Despite the steps taken by the Department, some risks remain to the availability of sufficient trained personnel as each of the six destroyers enters service between 2009 and 2013. These risks may be aggravated as some staff, though not all, told us in the summer of 2008 that they are planning to deliver training to the later “most likely” reported date rather than the more challenging “target” date being used by the Integrated Project Team (explained in paragraph 3.3). If the ships are delivered against these earlier dates (between 2009 and 2013) there is a risk that personnel may not have received their full training. The Department is, however, confident that all staff are now aware that training must be delivered to the earlier “target” date and our later work showed a much better understanding of the “target” date throughout the Department.

**3.13** In parallel with the planned use of existing training facilities, the Department has responded flexibly to the delays in the delivery of some of the training facilities, and has sought to mitigate the initial training risk by undertaking much of the training of the company for *Daring* and the second ship to enter service, *Dauntless*, on the ships themselves. Training on board ship is not unusual, although the Department intends to use cheaper synthetic training facilities, when ready, for the majority of the training for the Type 45 destroyers. Changing to on-board training in the interim creates a risk that the revised approach may not be wholly successful.

**3.14** A number of training risks have been identified including:

- the Maritime Composite Training System which will provide training for the weapons system operators (including using PAAMS) has been delayed by one year and is not now expected to be available until July 2010. The delay means that weapons training for the companies of *Daring* and *Dauntless* will have to be provided at existing facilities, and that suitably qualified and experienced staff will have to be made available to certify and endorse warfare operators following training on-board *Daring*.
- The training package for mechanical engineering has also been delayed. The Department is using similar fallback arrangements to weapons training.
- Training for personnel who will be responsible for maintaining PAAMS has been delayed while the Department decided whether to provide the training on simulators or using real equipment. The Department has now decided to use a mainly synthetic solution but, until these are on contract and can be developed, all training is carried out on board ship.

**3.15** Until the Department takes delivery of *Daring*, training for its company is being provided mainly by BVT as part of the six ship contract with a joint team comprising Royal Navy and industry. Our discussions with Royal Navy personnel indicate that this joint approach is working well. The Department is also forming a “super-squad” of trained personnel to provide flexibility in crewing between ships as each of the six ships are introduced into service and new crews trained and subsequently to cover for shortages. By mid 2009 the squad is planned to consist of approximately 130 junior ranks, although the Department plans to expand the squad to include more senior officers in future.

# APPENDIX ONE

## Methodology

**1** The aim of the study was to assess whether the Department was making good progress in renewing its sea-based anti-air warfare capability through the procurement of a class of Type 45 destroyers. Within this scope we considered:

- what capability has been available to the Department during the procurement of the Type 45 destroyers, and how it has set about managing the transition to the new class of ships;
- how the Department has managed the procurement to date, including its ability to meet the original requirements for time, cost and capability, and what action it has taken to deal with problems where these have occurred;
- how well prepared the Department is to support the Type 45 destroyers through their operational life as they come into service.

### Interviews and visits

**2** In order to assess the current state of the Type 45 project we conducted a number of interviews with stakeholders within the Department's Defence Equipment and Support unit, Royal Navy Headquarters, and industry partners (BVT Surface Fleet and MBDA).

**3** During our visits in Summer 2008 we conducted semi-structured interviews with senior management, project and commercial managers, staff responsible for putting in place the support solution for the class of Type 45 destroyers, and Royal Navy personnel involved in supporting or operating the new ships. We examined strategy and policy documentation related to the Type 45 capability, as well as the regular reports used by the Department's Integrated Project Team for project management and governance procedures, and internal reviews relevant to the performance of the project.

### Analysis of the Department's use of Type 42 destroyers

**4** The Department has continued to operate a number of Type 42 destroyers longer than originally planned. We analysed the Department's data to determine the cost of extending the life of these ships. We also reviewed Departmental information on availability and readiness levels for the Type 42 destroyers that are still in operation.

### Evaluation of costs of procuring Type 45 destroyer

**5** We commissioned Decision Analysis Services Ltd (DAS) to undertake a cost analysis of the original and revised estimates for the cost for the Type 45 destroyers to assess their realism. DAS undertook two separate exercises for this purpose:

- *A historical cost trend analysis* – using historical data for costs and displacement to provide a range of costs within which a programme of this scale at this time would be expected to fall;
- *Independent cost forecast* – this technique uses a modelling technique based on input values related to Quantity, Weight, Volume, Platform, Complexity and Date. Appropriate factors are calculated and then input into a model based on historical data to produce an expected cost figure for the project.

## TYPE 45 STAKEHOLDERS

Organisation	Role
Director Equipment Capability (Above Water Effect)	Project sponsor and single responsible owner for the Type 45 capability, involved in capability planning and overall programme direction
Destroyers Directorate	Project team responsible for managing the procurement and support of the Type 45 destroyers
Principal Anti-Air Missile System Integrated Project Team	Project team responsible for managing the procurement of the Principal Anti-Air Missile System to be installed on the Type 45 destroyers
Defence Lines of Development owners	Individuals responsible for putting in place arrangements that will provide through life capability for the Type 45 ships
BVT	Contractor responsible for production of six Type 45 destroyers
MBDA	Contractor responsible for production of UK element of Principal Anti-Air Missile System for installation onto the Type 45 destroyers
Capital Ships Integrated Project Team	Project team responsible for the continued operation of the Type 42 destroyers
Royal Navy	End users of the Type 42 and Type 45 destroyers

# GLOSSARY

<b>Aster</b>	Aster 15 and Aster 30 surface to air anti-aircraft and anti-missile missiles fired by the PAAMS system designed to be capable of intercepting a range of airborne targets including aircraft and supersonic sea skimming anti-ship missiles.
<b>Availability level</b>	A Department performance measure looking at whether the ships which are meant to be ready for operations are actually available to do so and are capable of carrying out their assigned tasks.
<b>Bowman</b>	Bowman is a tactical communications system designed to replace the existing Clansman family of radios used by the British armed forces, integrating digital voice and data technology to provide secure radio, telephone, intercom and tactical internet services in a modular and fully integrated system.
<b>BVT Surface Fleet</b>	The contractor responsible for production of the six Type 45 destroyers. BVT was established in early 2008 and brings together the surface warship building and through-life support operations of BAE Systems and VT Group, including their joint venture, Fleet Support Limited.
<b>Complex Weapons group</b>	Team responsible for managing the procurement and support of weapons including PAAMS.
<b>Complex Weapons Pipeline</b>	Envisaged procurement route for complex weapons.
<b>Contracting for availability</b>	A contract with industry to provide a specified level of equipment availability, the intention being to incentivise industry to minimise the cost of support by, for example, developing more reliable equipments which are easier to maintain.
<b>Co-operative Engagement Capability</b>	The United States' developed Co-operative Engagement Capability enables the combat systems and sensors on a number of ships to be linked to provide a clearer picture of the battle space and aims to improve the ability of a task force.
<b>Defence Lines of Development</b>	The Department has adopted an approach known as the "Lines of Development" to ensure that all the elements required to deliver a given capability are put in place. The lines of development are: Equipment, Logistics, Infrastructure, Training, Personnel, Concepts and Doctrine, Organisation and Interoperability.
<b>Historic Trend Analysis</b>	This type of analysis uses historical outturn data to generate cost trends for specific pieces of equipment, which allows an estimate to be plotted against similar past projects.
<b>Horizon project</b>	Horizon was a collaborative project with France and Italy to procure a replacement for the Royal Navy's Type 42 destroyers. The United Kingdom withdrew from the Horizon project in 1999.
<b>Integrated Project Team</b>	Each major project the Department enters into has its own Integrated Project Team that manages the funding of the project and engages with industry in order to develop solutions to the necessary capability requirements and to drive the programme forward.

<b>Key User Requirements</b>	These outline the requirements which the Department considers to be key to the achievement of Type 45's mission and are used to measure project performance.
<b>Main Gate Approval</b>	The point when the decision to proceed with the project is made.
<b>Maritime Composite Training System</b>	Synthetic training system which will provide training for the Type 45's weapons system operators (including using PAAMS).
<b>MBDA</b>	The contractor responsible for production of the UK element of PAAMS for installation onto the Type 45 destroyers.
<b>"Most likely" date</b>	The date by which it is most probable that a project milestone will be met as reported corporately and in the Major Projects Report. Also referred to as the 50 per cent date.
<b>Principal Anti-Air Missile System (PAAMS)</b>	The anti-air missile system being procured jointly by the UK, France and Italy consisting of the SAMPSON Radar, the command and control sub-system, the missile launching system and the Aster 15 and 30 Missiles. A Long Range Radar is also being procured under the umbrella of the PAAMS project.
<b>Readiness level</b>	A Department performance measure indicating whether ships are made ready for certain tasks within set timescales.
<b>SAMPSON</b>	The SAMPSON multi-function radar is being procured as part of the PAAMS project.
<b>Sea Dart</b>	A medium range area defence supersonic anti-aircraft missile used on the Type 42 destroyers.
<b>Six Ship Contract</b>	The revised contract for procurement of the Type 45 destroyers.
<b>Skynet 5</b>	The secure satellite communications system for the UK's armed forces worldwide.
<b>Surface Ship Support Solution</b>	The approach for the future maintenance and repair of surface warships.
<b>Synthetic Training Facilities</b>	Simulated training environments often involving computer-based training.
<b>"Target" date</b>	The intended date for a project milestone to be met.
<b>Task Group</b>	A group of fleet ships of varying types operating collectively to complete a mission.
<b>Tasking</b>	Allocation of missions to military units.
<b>Type 42 Destroyer</b>	The current destroyer that will be replaced by the Type 45s.



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