National Audit Office

MINISTRY OF DEFENCE

Hercules C-130 Tactical Fixed Wing Airlift Capability

REPORT BY THE COMPTROLLER AND AUDITOR GENERAL | HC 627 Session 2007-2008 | 27 June 2008

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SUMMARY

1 Transport aircraft are vital for both strategic and tactical tasks to support national security objectives, military exercises and training, and humanitarian aid. Strategic tasks are predominantly the transport of people and equipment long distances from the United Kingdom worldwide while tactical tasks are usually short flights within theatre. The Ministry of Defence's key tactical airlift assets are its 43 Hercules aircraft, although they are also used for some strategic tasks. It costs the Ministry of Defence (the Department) £245 million annually to operate and maintain the current Hercules fleet.

2 Operating at a high tempo and in harsh environmental conditions in Afghanistan and Iraq is taking a toll on many parts of the aircraft and in particular on the underbelly and propellers. Four Hercules have been lost during current operations, the most recent in August 2007. Recuperation funds from the Treasury have contributed towards the purchase of two additional C-17 aircraft to increase the Department's capacity for long range airlift rather than replacement Hercules.

3 Over the next decade the Department faces a period of transition. It is consolidating all fixed wing air transport aircraft on a single base at RAF Brize Norton. The Hercules C-130K fleet will be retired, the specialist operations role will be transferred to the newer Hercules C-130J fleet and the A400M will be introduced into service.

4 This report examines the Department's current performance in providing sufficient Hercules to support the full range of airlift tasks; assesses the future risk to Hercules availability and capability and considers ways in which the Department can become more efficient in its use of existing aircraft to increase its airlift capacity. Appendices 1 and 2 describe our methodology in full.

Overall conclusion

5 The Department is meeting the requirement for Hercules aircraft to be deployed in Afghanistan and Iraq, despite a declining fleet size resulting from the retirement of the Hercules C-130K aircraft and losses on operations. This performance has been achieved through collaborative working and innovations to fleet planning, especially in allocating tasks for the Hercules aircraft and prioritising the fitting of new equipment to increase availability. The current nature and scale of operations is reflected in the increasing cost of running and maintaining the Hercules fleet. There are also difficulties with the provision of spares in the Hercules C-130J fleet. With the continued focus on operations, there has been a reduction in aircrew training and non-operational airlift tasks in support of wider Defence activities.

6 Going forward, there are significant risks for the Department because demand for tactical fixed wing airlift is likely to remain high in the near future. The specialist operations role must be transferred to the Hercules C-130J whose service life is being reduced by the intensity of current operational flying. These factors will restrict the Department's ability to provide sufficient airlift to the Armed Forces. The problem is exacerbated by the late delivery of the A400M aircraft which is intended to replace the older Hercules C-130Ks when they retire in 2012. If availability of Hercules aircraft is reduced as a result of these changes to the fleet, opportunities for training will be limited, potentially eroding aircrew skills and restricting their ability to operate the Hercules in the wide variety of operational situations that may occur in the future. Extra aircraft could be purchased, leased or chartered but cost and restrictions around their use may prevent this from being a realistic and affordable option. There are some low cost or cost neutral solutions which the Department could undertake to improve availability of the newer aircraft and increase training; but these may not be sufficient to cover the likely shortfall.

Findings

Our main findings are as follows:

On meeting current operational requirements

7 Most nations do not have sufficient airlift assets to meet all their requirements and the United Kingdom is no exception. The Department has put in place a number of processes to assign Hercules aircraft to best match the needs of Defence as a whole. It has brought together all the parties with a role in providing or using Hercules aircraft into pan-Departmental working groups to prioritise tasks. Two groups, the Air Allocation Committee and the Commitments Area Requirements and Availability of Air Transport Team have successfully contributed to ensuring that the highest priority, for aircraft to be deployed on operations, was met despite a declining fleet size.

8 This requirement for aircraft in Afghanistan and Iraq has been achieved even with an increasing need for maintenance and upgrade of equipment on the fleet. The Department has to balance operational imperatives with risk and, with the creation of the Capability Delivery Steering Group, has formalised the process for prioritising upgrades to minimise the impact on availability and maintenance time. It has continually updated the fleet with equipment such as defensive aids. Once the decision to upgrade the Hercules has been approved, the Department and industry have responded well to fit the equipment to the first aircraft in a timely manner. The Department has continued to fit these equipments on to other Hercules and forecasts that the modifications will be completed with the minimum of delay and impact on availability.

9 Aircraft on operations in Afghanistan and Iraq are available to fly planned missions at least 85 per cent of the time, which is in excess of both the expected level and that achieved in the United Kingdom, although the flying is more severe and the environmental conditions are harsh. The Hercules was originally acquired for a tactical role but historically it has been used to transport people and equipment long distances from the United Kingdom. Before 2003, flights averaged three hours in duration. Now they are predominantly used for short flights in theatre, of just over one and a half hours long, and are performing more than double the number of take-offs and landings. Airstrips are often unpaved, making the aircraft more susceptible to damage from rocks and other debris, and the fleet is being used extensively to airdrop heavy supplies, increasing the stresses on the airframe.

10 The Department has obtained over 3,000 flying hours from other nations' spare airlift assets in exchange for air-to-air refuelling services or strategic airlift. Where feasible it has also purchased airlift from the commercial market. These additional sources of airlift did not however prevent a decline in non-operational tasks and training and exercises.

11 The Department's focus on operations in Afghanistan and Iraq has led to a decrease in availability of Hercules for training and other air transport flights. On operations in Afghanistan and Iraq aircrews are flying 60 hours per month on average, whereas pilots in the United Kingdom are typically flying fewer than 13 hours a month. The Department is concentrating on training that is considered essential to prepare crews for flying on operations, so the amount of training for other conditions and manoeuvres is restricted. When the number of aircraft available is fewer than expected it is the non-operational tasks and training and exercises that are cancelled. There has been a tenfold increase in the number of training flights cancelled in 2007 compared to 2005. Simulators for both aircraft variants have limitations, particularly because their software has not kept pace with aircraft modifications, especially defensive aids, and they are therefore not able to replicate flying the Hercules accurately. All these factors are contributing to the erosion of the skills base and currency of the Hercules aircrews.

12 Under the current system, RAF Lyneham determines how many Hercules it can make available (offer) for air transport tasks on a given day. This 'offer' is not always driven by the number of aircraft required for planned Defence activities. A high degree of certainty on the minimum number of available aircraft is important as it is not always possible to arrange the required cargo, crew, passengers and flight clearances for tasking at short notice. Inevitably, there will always be some unexpected variations but only on ten per cent of occasions does the number of aircraft actually available to perform the agreed tasks for the day match exactly the number that was originally predicted to be available. The Department often has more aircraft available than predicted, and is not always able to make best use of these extra aircraft.

13 The total cost to the Department to operate and maintain the Hercules fleet has risen from £212 million in 2002-03 to £245 million in 2007-08. The increasing costs of maintenance and upgrade reflect the age of the aircraft; the change from longer to shorter flying tasks and greater numbers of sorties. Funds from Treasury reserves for fuel; cost of flying; upgraded equipment and maintenance directly resulting from operating in Afghanistan and Iraq have increased significantly from £9.5 million in 2002-03 to £92.7 million in 2007-08.

On managing future risks to the availability and capability of the fleet

14 While the Department is meeting current operational requirements there are significant risks to the availability of the tactical fixed wing airlift capability in the future. Delivering this capability involves more than managing the existing Hercules aircraft and acquiring new ones. For example, training, personnel, infrastructure and logistics also need to be put in place and associated risks managed coherently.

15 Fatigue, which decreases the life span of the wings, is accumulating more rapidly on the aircraft than in the past. The cost of recovering the wings has caused the Department to retire nine of the older Hercules C-130K aircraft early, with a further five being retired as intended at their extended out of service date of 2010. These retirements have resulted in a planned gap in capability. Nine will continue to fly, and of these, five will have their wings replaced at a cost of £15.3 million to ensure that they have sufficient life to last until 2012.

16 The Department has enhanced its systems for monitoring the fatigue on the newer Hercules C-130J. The full results will be available in 2013. Given the significant stresses to which the aircraft are being subjected on operations, initial indications suggest that the worst affected Hercules C-130Js may need their centre wings replaced or refurbished from 2012 in order to reach their planned out of service date of 2030. This requirement combined with other activities to upgrade the fleet will further reduce availability around 2012. The Department will also need to identify an appropriate source of funding for a re-winging programme.

17 The United Kingdom was the first customer for the Hercules C-130J. At the time of purchase of the aircraft and their initial spares, there was no previous history of spares usage and predictions assumed a single operating base and fewer flying hours. With real experience of spares use, in different operational circumstances than originally assumed, spares estimates have proved inaccurate. The resultant shortages have not been allowed to affect the aircraft deployed in Afghanistan and Iraq. Under the Department's plans it will cost less than £8 million to rectify these problems.

18 The first batch of the new A400M aircraft is unlikely to be delivered to the United Kingdom before the end of 2011. To mitigate this risk in part, the Department has extended the service life of the Hercules C-130K until the end of 2012 at the cost of £41 million. A400M is a collaborative European procurement managed by the Organisation for Joint Cooperation in Armaments. The Department does not have a direct contractual relationship with Airbus Military and this limited influence makes it difficult for the Department to plan further mitigation strategies effectively to help them sustain airlift at current levels.

19 Originally the Department's strategy for consolidating all fixed wing tactical aircraft at RAF Brize Norton involved relocating part of the Hercules fleet only, keeping the remainder at RAF Lyneham. This would have created two main operating bases and caused significant logistical difficulties. The entire Hercules fleet and all related support and RAF maintenance activity will now be moved to RAF Brize Norton. The Department has not yet quantified the impact on the Hercules Integrated Operational Support contract. For example, there may be a lack of repair bays, insufficient parking space for aircraft and aircraft may have to be towed some distance to the repair hangars.

20 The Department is developing a comprehensive and combined overview of the key issues which affect the delivery of military capability (training, equipment, personnel, information, concepts and doctrine, organisation, infrastructure and logistics) for the Hercules fleet. It has created the Strategic Mobility – Capability Planning Group which aims to provide an overview along the lines described above, but this Group is still in its infancy. The Department must therefore ensure that its decisions in the short term are coherent if it is to make best use of its limited resources.

Recommendations

On maximising opportunities to increase tactical airlift capacity and capability

a Operational flying is high intensity, but crews are training on average fewer than 13 hours a month on aircraft when posted back to the United Kingdom. The Hercules simulators have not kept pace with aircraft modifications, especially defensive aids and so they are not able to replicate flying conditions accurately.

- **The Department should prioritise resources to install the necessary software on the Hercules C-130J simulator at the cost of £4.25 million to increase the hours crews spend training, reducing the erosion of the skill base, and increase its flexibility to divert aircraft to undertake additional tasks.** For example, by using the simulator intensively the Department could provide an additional 300 days of aircraft availability – the equivalent of one aircraft per year for other purposes.

b On average a Hercules C-130J can be unavailable to fly due to a lack of spare parts for 24 days a year.

- **The Department has identified pinch points in spares provision and it should take forward the actions it has identified to resolve these problems. It should now develop meaningful performance data to provide assurance that there are no other fundamental problems with the supply chain.** If the Department can improve the provision of spares for the Hercules C-130J to the same levels as the Hercules C-130K, then the fleet would be available for an extra 168 aircraft days in a year.

c The Department spent £130 million on chartering additional airlift in 2007-08.

- **It should ascertain how much of this charter work could have been undertaken by Hercules aircraft and analyse whether it would be better placed in using some of that money to increase the availability of its own Hercules aircraft**. For example, if the Department were to build an all-weather natural runway at RAF Keevil, Wiltshire, instead of landing on a beach it could reduce the time aircraft need washing to remove salt water. This runway would cost approximately £2 million, but would save around £230,000 per annum and provide 41 extra days of Hercules availability to undertake Defence tasks.

d Repair and maintenance is taking up to 25 per cent longer on some parts of the Hercules fleet. A Departmental review has identified a shortfall in engineering staff. In response, an additional 54 personnel are being provided to RAF Lyneham with individuals drawn from less operationally-loaded units.

- **This re-deployment has been effective to date but is only a temporary solution and the Department needs to provide the levels of personnel recommended in the review if it is to support current levels of flying.** Aircraft will always need some additional maintenance beyond that routinely scheduled, but the RAF estimates that additional engineering personnel could release an additional 300 days of aircraft availability for other purposes.

e The Department is not able to make good use of aircraft that become available 'last minute' because there is insufficient time for crews, flight paths and cargos to be arranged.

- **The Department should refine its system for tasking Hercules to allow users to take advantage of additional aircraft as they become fit to fly.** As a result the Department could achieve efficiencies in its allocation process, by reducing the number of tasks which have to be re-assigned or cancelled, and satisfy more bids for Hercules flights.

f Analysis of the rate of accumulation of fatigue on the Hercules C-130J fleet shows that some aircraft's wings may reach the end of their life as early as 2012.

- **The Department should complete its investigation into the most cost-effective method for extending the life of the Hercules C-130J wings.** By assessing the practicalities of changing the method of fleet management to mitigate accumulation of fatigue and the feasibility, cost, funding and source for procuring new centre wings or refurbishing existing "J" wings, the Department will be able to mitigate the risk to availability of Hercules C-130Js.

On managing future risks to the availability and capability of the fleet

g Previously, there has not been a means of providing comprehensive insight into the key issues, which affect both the Hercules aircraft and the personnel who fly and support it, and the level and nature of the risk the Department is managing.

- **This shortfall is now being addressed by the Strategic Mobility – Capability Planning Group, which is still in its infancy but tasked with developing the requisite means for managing the key issues.** By having a single group actively considering training, equipment, personnel, information, concepts and doctrine, organisation, infrastructure and logistics, the Department should improve the visibility of the risks, manage them more coherently and identify opportunities to increase availability.

h Delays to the introduction of A400M aircraft could prevent the Department sustaining current levels of tactical airlift. One potential solution is to halt the retirement of the remaining Hercules C-130Ks in 2010 but there is a point at which measures to extend the life of these aircraft, including major depth repair and re-winging, are not practical or economic. Other options include sourcing additional airlift by lease, purchase or charter or re-balancing the way the fleet is used for example, maintaining permanent bases overseas.

- **The Department should determine the costs and benefits of extending the life of the Hercules C-130Ks compared to alternative solutions to cover this capability gap. Progress on the A400M procurement should determine the trigger dates for the sourcing of funds and submission of a business case to the Investment Approvals Board so that the solution can be introduced within the necessary timescales.** If the Department's decision making and funding processes are sufficiently agile then these measures can be implemented without a significant reduction in the availability of Hercules aircraft.

PART ONE

Introduction

1.1 The Hercules is one element of the Department's air transport fleet. It makes up 60 per cent of the Department's current air transport assets. **Figure 1** describes the various aircraft that provide fixed wing airlift.

1.2 Since 1954, Lockheed Martin has built more than 2,200 Hercules aircraft, making it the most widely used military transport aircraft. It is currently operated by more than 60 of the world's air forces. The aircraft are used for a variety of purposes but primarily for movement of personnel and freight. It is capable of carrying up to 92 ground troops, 64 paratroopers, 74 stretcher cases or a variety of vehicles and freight up to 20 tons in weight over distances of up to 4,600 miles, at speeds in excess of 370 knots. The Hercules aircraft is frequently described as the "workhorse" of the Royal Air Force, and carries 14 per cent of all air cargo and passengers transported by the Department annually.

The fleet

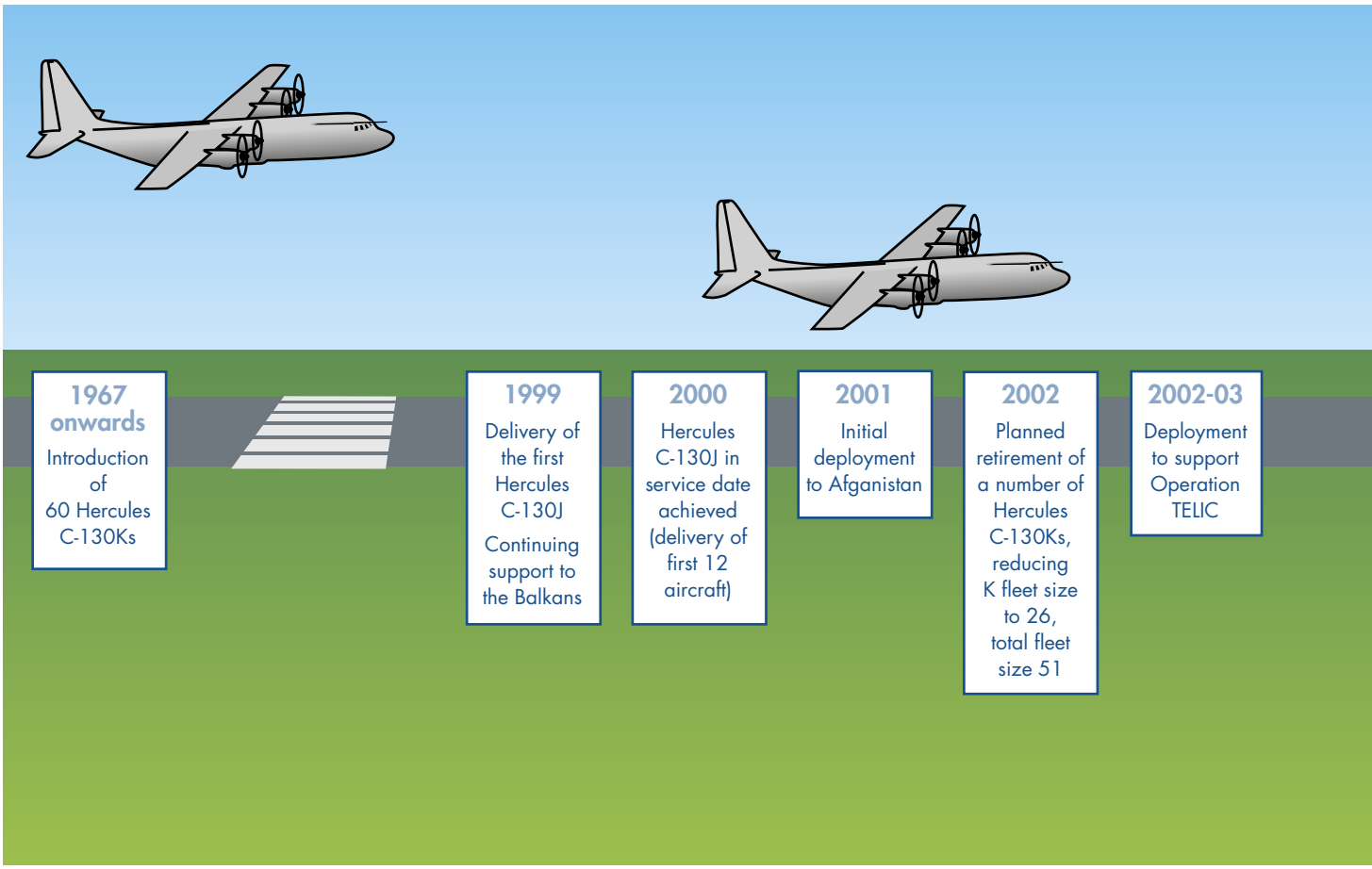
1.3 The RAF has operated the aircraft for over 40 years **(see timeline at Figure 2 overleaf)**. Currently the fleet is based at RAF Lyneham, although the aircraft and all related support and maintenance activity will transfer to RAF Brize Norton from 2011, and comprises two variants: the "K" and newer "J" models. There are 19 Hercules C-130K aircraft which entered into service in 1967. They are crewed by two pilots, a navigator, a flight engineer and a loadmaster. The 24 Hercules C-130Js entered service in 1999, are crewed by two pilots and the loadmaster and compared to the Hercules C-130K, it is a more modern aircraft. The "J" incorporates a digital flight deck (removing the need for a navigator and a flight engineer), an integrated avionics system, new engines and propellers.

1 Types of fixed wing airlift

Aircraft type	Total fleet in 2007-08	Ownership	Capability
C-17 Globemaster	5 (6th to be delivered in June 2008)	4 aircraft are leased and will be purchased outright in 2008. One is owned	Passengers and freight
Hercules C-130K	19	Owned	Passengers and freight
Hercules C-130J	24	Owned	Passengers and freight
Tristar	9	Owned	Passengers (3 aircraft), Passengers and tanker (2 aircraft), Passengers, freight and tanker (4 aircraft)
VC-10	16	Owned	Passengers, freight and tanker (10 aircraft), Tanker, limited passengers (6 aircraft)
Total	**73**		

Source: Ministry of Defence

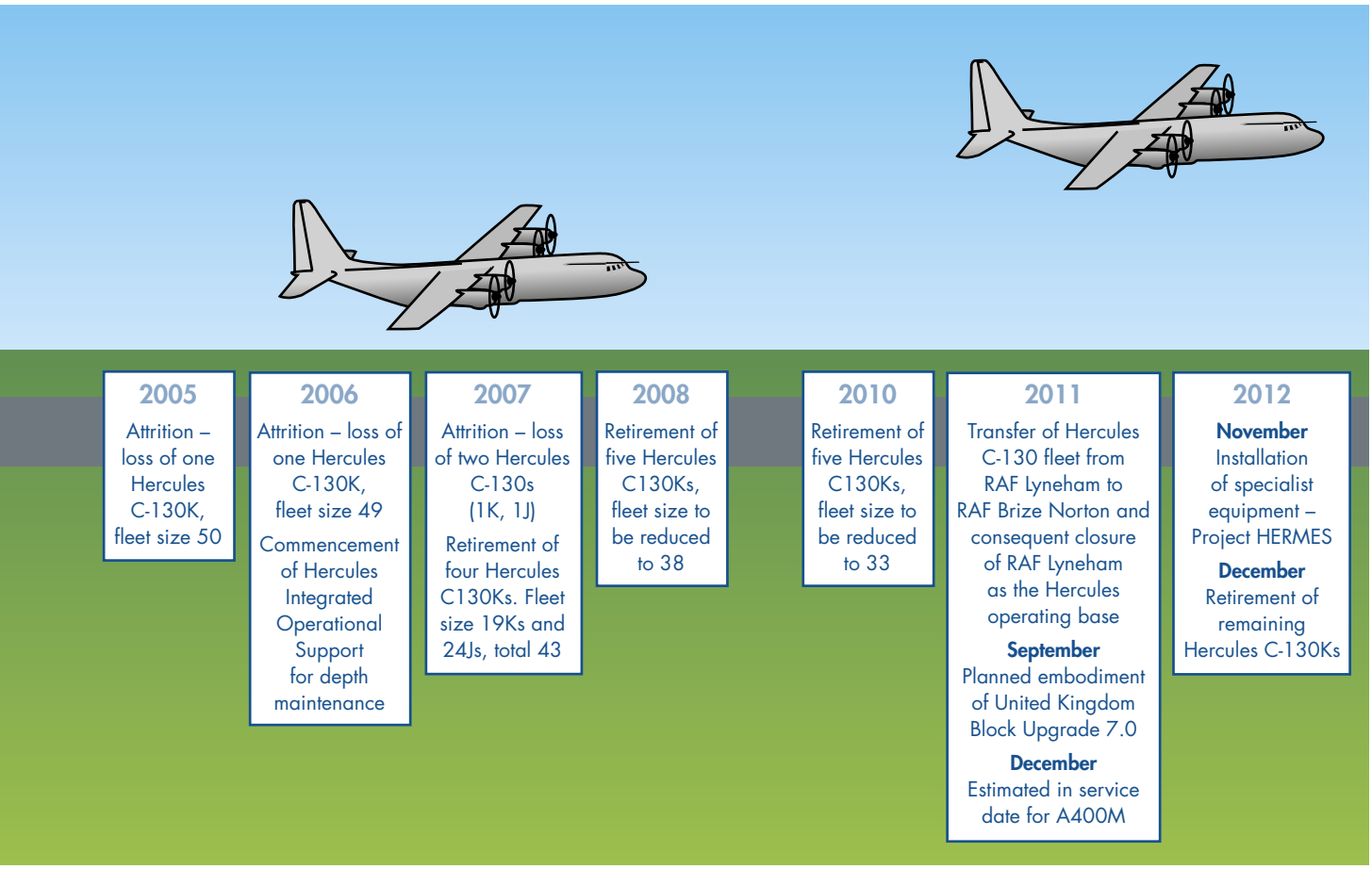
2 Key events in the operational history of the United Kingdom's Hercules fleet



1.4 Generally aircraft deployed in support of operations in Afghanistan and Iraq fulfil a predominantly tactical role – transporting troops and equipment within theatre. These aircraft can be used for strategic transport to and from the United Kingdom where there is military need or spare capacity. When predominantly UK-based, aircraft are used also for training and equipment testing.

Stakeholders in the Hercules fleet

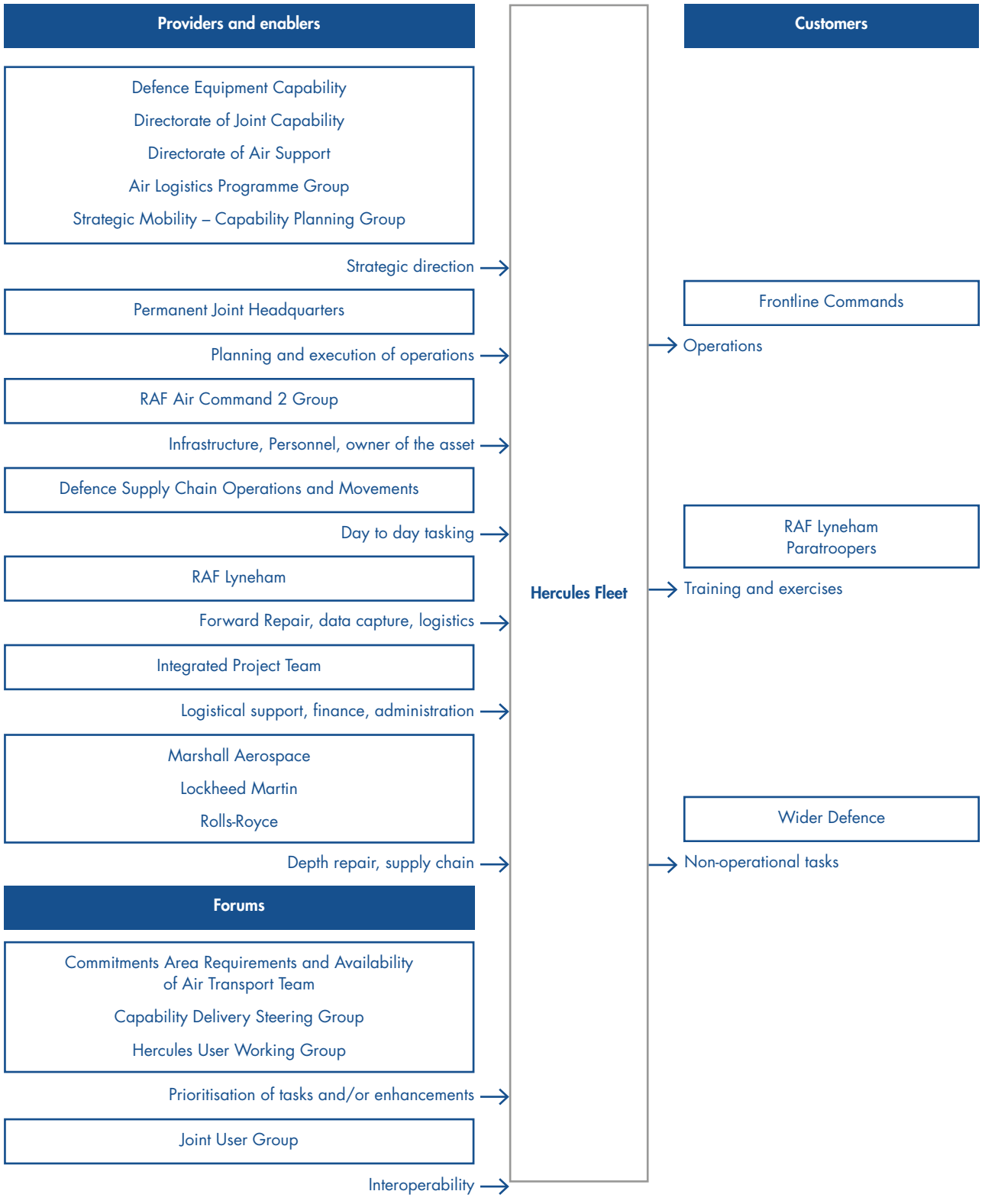
1.5 **Figure 3 on page 12** shows that there are a number of Departmental organisations and forums that have a role in managing the Hercules fleet. Groups like the Capability Delivery Steering Group and the Commitments Area Requirements and Availability of Air Transport Team, both established in 2007, have improved information sharing within the Department and decisions are being made with fuller knowledge of the issues and for the benefit of United Kingdom Defence as a whole.



How the Hercules are maintained

1.6 Maintenance work on the Hercules fleet is divided between repair and basic maintenance work conducted at RAF Lyneham – known as forward maintenance; and more substantial maintenance conducted at Marshall Aerospace – known as depth maintenance **(Figure 4 on page 13)**. The current arrangements were put in place in April 2006 when the Department, Marshall Aerospace, Lockheed Martin and Rolls-Royce agreed the Hercules Integrated Operational Support contract whereby industry is paid to make aircraft available for use, as opposed to being paid for spare parts and repair. The contract was signed in May 2006. **Figure 5 on page 13** sets out the responsibilities of each of the key players involved in the partnering arrangement under this contract. Co-location of the staff from the Department and industry, at Marshall Aerospace's site in Cambridge and at RAF Lyneham, has been central to enabling more effective team working to resolve issues.

3 Stakeholders in the Hercules fleet



Source: National Audit Office

4 Types of maintenance and repair

Forward Maintenance at RAF Lyneham

Type of work	Base 1 for Hercules C-130Ks	Primary/Primary Star for Hercules C-130Js	Preparation/recovery	Wash
Description	Basic scheduled maintenance. Occurs every 304 days or at 500 flying hours (whichever occurs first)	Basic scheduled maintenance. Primary occurs every 274 days. Primary Star occurs every 548 days	Maintenance required to prepare an aircraft to be deployed to theatre and repair damage caused while in theatre on its return to the United Kingdom	Washes occur every 70 days and on return from theatre. Required after landing on a beach airstrip to remove salt water.

Depth Maintenance at Marshall Aerospace

Type of work	Minor/minor star[1]	Major[2]	Modifications	Emergent work/repair
Description	Intensive scheduled maintenance. Minor occurs every 20 months for Ks and 3 years for the J. Minor star occurs every 3 years for the K and 6 years for the J	Intensive scheduled maintenance. Occurs every 6 years for the K and 12 years for Js[3]	Capability enhancements. Where feasible these occur as part of scheduled major or minor maintenance	Additional work found to be required when the aircraft is stripped apart in its scheduled standard depth maintenance

Source: National Audit Office

NOTES

1 This is referred to as Base 2 and 3 for the Hercules C-130K.

2 This is referred to as Base 4 for the Hercules C-130K.

3 In 2007 the Department reviewed the maintenance scheduled for the Hercules C-130J which resulted in an extension of the times between 'major' depth maintenance from nine years to 12 years.

5 The Hercules Integrated Operational Support Team

Marshall Aerospace Prime Contractor	Lockheed Martin	Rolls-Royce	Hercules Integrated Project Team	Hercules Force Headquarters RAF Lyneham
C-130K Design Authority	C-130J Design Authority	Engine technical support	Engineering, supply, financial, administration and commercial specialists who provide logistic support	Various Hercules C-130 "experts", such as engineers, planners and logisticians, work together to make aircraft available for use
Service integrator and coordinator				
Leads partnership activities				
Aircraft maintenance	Inventory provisioning	Engine repair and overhaul, including Propulsion Bay management and operations		
C-130K consumable spares and those that are shared with the J variant (that is can be fitted to either aircraft)	C-130J specific consumables	Engine spares provisioning and supply		
	Repairable parts supply and repair			

Source: National Audit Office

PART TWO

Current performance

2.1 It costs the Department around £980 million a year to provide airlift. £245 million is spent on the Hercules fleet, which is a critical asset in supporting operations, national security objectives, military exercises and training, and humanitarian relief. The Hercules is used extensively by the Armed Forces and demand for aircraft usually exceeds supply. This Part of the report examines the Department's performance in providing Hercules aircraft for military use and assesses the impact of operations on its role and those involved in flying and supporting the aircraft. It shows that current operational needs are being met under testing conditions but the Hercules fleet is being stretched. The Department has been innovative and is involving a broad range of stakeholders to prioritise the use of the available fleet to meet the demands made on it. Performance has been sustained despite reducing numbers of aircraft and extensive maintenance and upgrade programmes. But operating at such a high tempo is already having a negative impact on the fleet and personnel.

Meeting operational requirements in Afghanistan and Iraq

2.2 In tasking the Hercules fleet, the Department has given the highest priority to the provision of airlift for operations in Afghanistan and Iraq. As a result the quantity of aircraft required for deployment overseas is always delivered. When not deployed on operations the aircraft are either undergoing maintenance, repair or upgrade, or used for training and other military tasks such as freight and passenger movement and equipment testing.

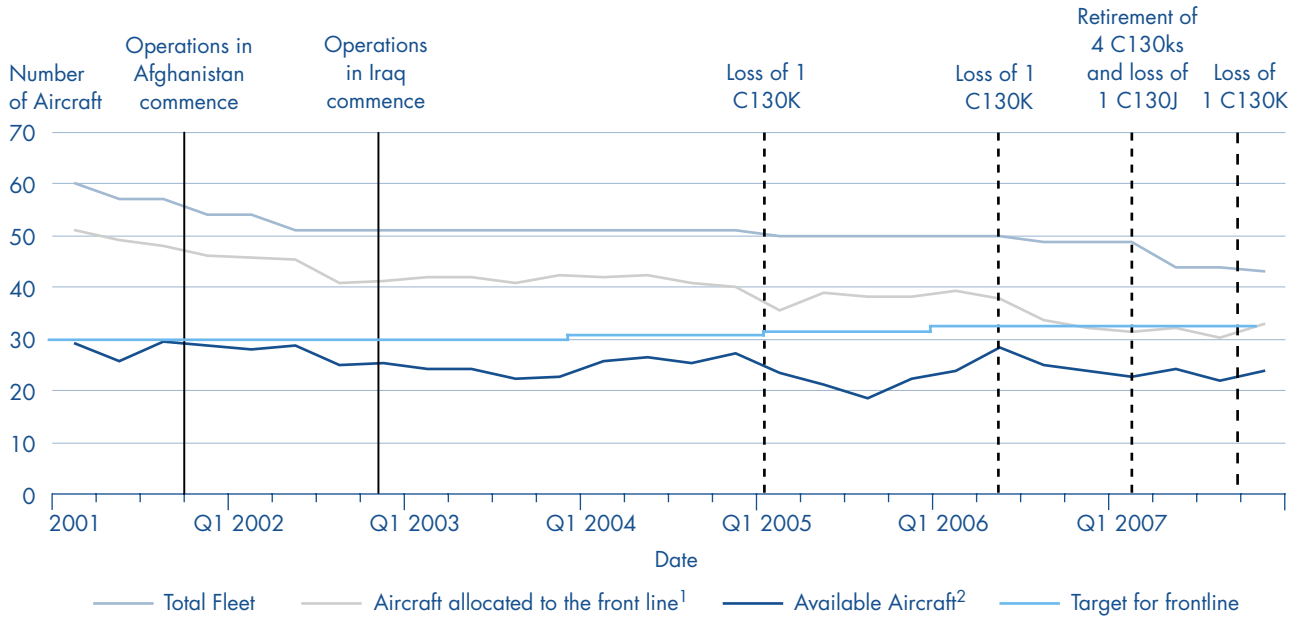
Availability of the Hercules fleet

2.3 As **Figure 6** shows, the Department has almost always met its target for aircraft allocated to the frontline. Recognising the fact that aircraft either on operations or at an RAF base will not always be serviceable (some will require repair because of faults arising or planned operational maintenance), the Department expects that between 75 and 80 per cent of Hercules will be ready to fly on any given day. The number of aircraft capable of carrying out a planned mission varies widely from day to day, but the average has remained fairly constant, despite a declining fleet size due to the retirement of the Hercules C-130K aircraft and losses on operations (Appendix 3).

Availability on operations

2.4 In spring 2007, the Department recognised that the provision of sufficient Hercules to the frontline was being adversely affected by the loss of three aircraft (a fourth was lost in August 2007) and ongoing maintenance and capability upgrade work. It therefore created the Commitments Area Requirements and Availability of Air Transport Team to manage the medium to long term prioritisation and use of the Hercules fleet. This forum has maximised the use of the RAF air transport and air-to-air refuelling fleets for the benefit of Defence as a whole **(Figure 7)**. The Department has replicated this good practice by forming a committee for Maritime aircraft.

6 Hercules C-130 fleet size and availability



Source: National Audit Office analysis of Departmental data

NOTES

1 This covers all aircraft that are either on operations or at an RAF base, including those that are undergoing either scheduled or unscheduled maintenance or awaiting personnel or parts.

2 This includes all aircraft that are ready to fly on any given day.

7 The Commitments Area Requirements and Availability of Air Transport Team

Background

- Based on two existing models for Battlefield Helicopters and Land Environment Support and Fighting Systems;
- Broad membership of senior stakeholders including the Director of Equipment Capability of Expeditionary Logistics Support, the Integrated Project Team in Defence Equipment and Support; Directorate of Special Forces, RAF Air Command 2 Group; Defence Supply Chain Operations and Movements and RAF Lyneham;
- Chaired by the Directorate of Joint Capability which helps to ensure that Defence needs as a whole are the key focus.

Function

- To arbitrate between the competing requirements for Hercules;
- To assess the impact of several factors on availability including maintenance, the need to install capability enhancements, and conduct trials;
- To enhance awareness of air transport issues throughout the Department.

An example of the Commitments Area Requirements and Availability of Air Transport Team at work

Meeting 1: 28 March 2007. The Commitments Area Requirements and Availability of Air Transport Team identified an emerging requirement to deploy an additional Hercules in support of operations in Afghanistan. After discussion within the forum, it emerged that a similar specialist operations requirement was also emerging, and that it might be possible, with suitable agreement from each stakeholder group, to deploy one aircraft to meet both requirements. The Commitments Area Requirements and Availability of Air Transport Team instructed personnel from the two Directorates concerned to explore if a mutually beneficial agreement could be reached.

Meeting 2: 17 July 2007. It did prove possible to deploy a single aircraft to meet both requirements. However, it remained important to determine whether or not the arrangements were satisfactory and that the operational needs were being met. At this point the aircraft had only been deployed for a few weeks, and so it was too early to decide. Accordingly, the Commitments Area Requirements and Availability of Air Transport Team instructed the Directorate of Joint Capability to review the situation at the end of July.

Meeting 3: 9 October 2007. Directorate of Joint Capability reported that the situation had been reviewed and was satisfactory. The coordination of requirements led to both users' needs being met, while minimising the number of Hercules aircraft and service personnel deployed.

Source: Ministry of Defence

2.5 Our analysis also shows that the Department has managed to increase the number of aircraft available for flying duties in Afghanistan and Iraq. Aircraft are more likely to be available for tasking while on operations than when based in the United Kingdom. Between April 2007 and January 2008[1], 85 per cent of the Hercules C-130J (compared with 72 per cent in the United Kingdom) and 94 per cent (compared to 75 per cent in the United Kingdom) of the Hercules C-130K were available to fly planned missions while deployed on operations. These differences reflect:

- the fact that the engineering complement is fully staffed at 100 per cent of the requirement for operations. Prioritising personnel in this way leads to gaps in manpower in the United Kingdom. In addition, engineers based in the United Kingdom support a greater range of engineering activities, including the preparation and recovery of aircraft to and from operations, and are required to undertake other duties around the RAF base, such as guarding and training for operational deployment.
- the need to balance operational imperatives and risk. Occasionally deployed aircraft may be deemed available to fly with a known minor fault if this is not considered to pose a risk to safety. For aircraft that are not on operations, it is likely that the task is less urgent and the aircraft will be repaired first.

Obtaining additional military airlift

2.6 In addition to its own aircraft, the Department has provided airlift by using other nations' aircraft in return for air-to-air refuelling or strategic lift services. The Movements Control Centre Europe co-ordinates the use of spare air and sea lift assets belonging to 15 nations (the United Kingdom, Belgium, Canada, Denmark, France, Germany, Hungary, Italy, Latvia, Netherlands, Norway, Slovenia, Spain, Sweden and Turkey). It is based on a 'Hercules flying hour' and member nations can be in credit or debit by up to 500 Hercules hours, as long as they are in credit once every three years. For example, by providing a C-17 for one hour to another nation the Department can claim back seven hours of Hercules flying time.

2.7 The Department has been a net provider of airlift hours to the Movements Control Centre Europe which has increased its airlift capacity and limited the scale of its bill for charter aircraft. Ongoing operational demand has meant that the United Kingdom now uses more hours than it provides; in 2007 the Department used 3,407 'Hercules hours' while providing just 3,162.

The impact of difficult environmental and operational conditions

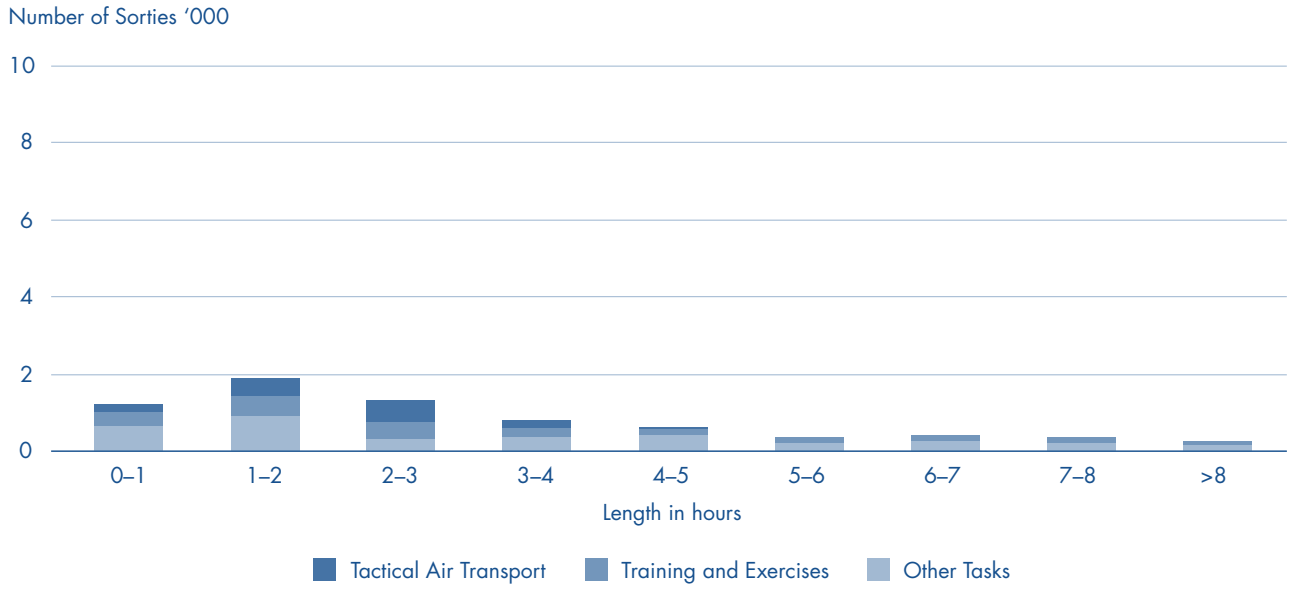
Changes to the role of the Hercules fleet and how it is flown

2.8 Despite being procured for tactical airlift, historically the Hercules fleet has been used predominantly in a strategic role to transport people and equipment long distances to and from the United Kingdom, operating from purpose built airfields. Operational needs in Afghanistan and Iraq mean that more recently the Hercules has been used more in a tactical role, operating over shorter distances between bases in theatre. Flying is also more severe with steep take-offs and landings, night flying and airdrop operations. In 2007, 70 per cent of all flights were short range transit tasks (under two hours in duration), instead of the planned 14 per cent when the aircraft were procured. Long range flights of more than five hours were undertaken on three per cent of occasions which is a marked contrast to the originally anticipated 28 per cent.

2.9 Our analysis of aircraft usage in **Figures 8 and 9** shows that, although the range of the length of sorties has always been wide, the proportions are changing. Hence in 2000 nearly half of all sorties were longer than three hours, but in 2007 less than a quarter lasted this long. The Hercules has also been undertaking more airdrop tasks to relieve the demands on Chinook helicopters; the Hercules fleet has dropped an average of 123 tonnes of stores per month since July 2007, whereas in the same period from July 2006 it had dropped just 21 tonnes per month.

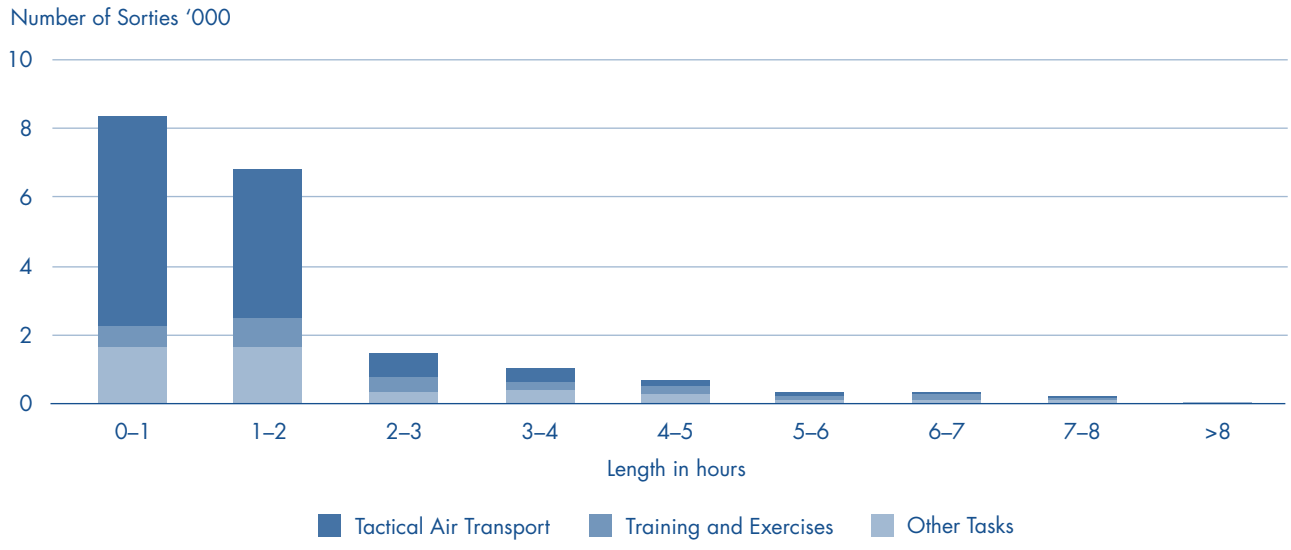
1 Data prior to April 2007 contained four aircraft awaiting retirement which would have made the sample less representative.

8 Sortie duration in 2000



Source: National Audit Office analysis of Departmental data

9 Sortie duration in 2007



Source: National Audit Office analysis of Departmental data

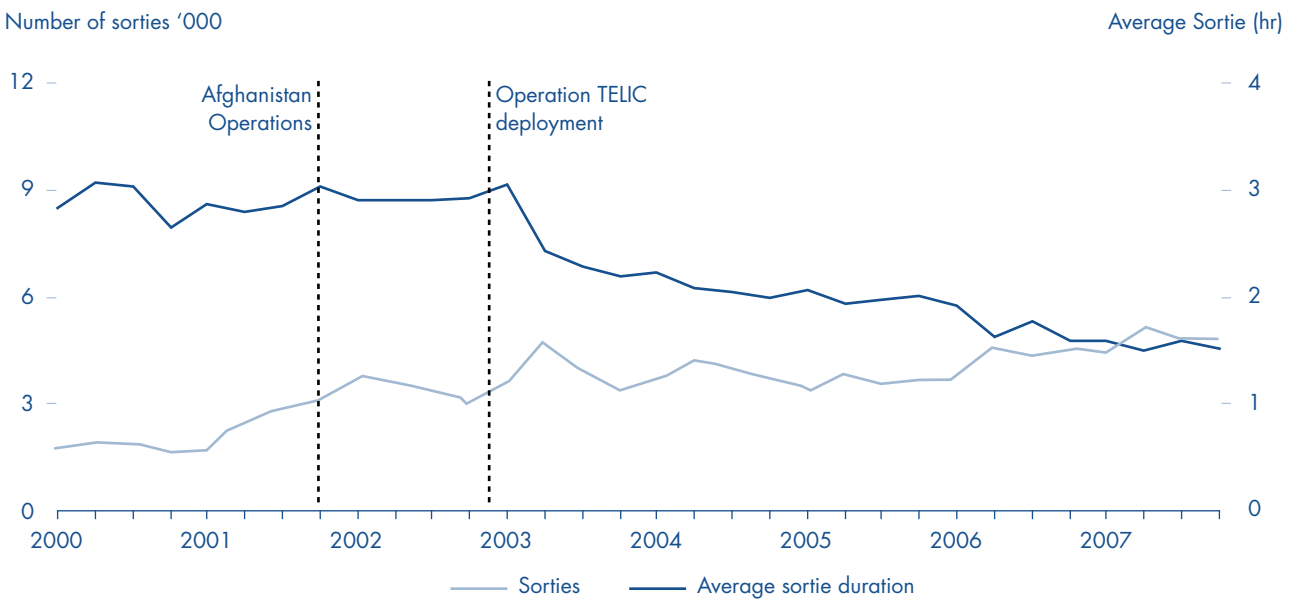
2.10 The number of sorties flown has more than doubled. As **Figure 10** shows, this corresponds to the Department's increasing presence in Afghanistan and Iraq since late 2001. The greater number of short sorties has nearly halved the average sortie duration from nearly three hours in the years prior to 2003, to just over one and a half hours in 2007.

2.11 The Department sets a target for the maximum annual number of hours to be flown by the Hercules fleet based on planned Defence activity. As **Figure 11** demonstrates, the Hercules fleet has not achieved this target since 2003, largely because of the Department's decision to use the Hercules fleet to fly shorter sorties on operations. In summer 2007 the Department agreed a new realistic level of 30,160 hours and it will continue to reduce this target as aircraft are retired. Although the Department has been slow in refining the target, the contracts to support the Hercules fleet reflect the reduced average sortie lengths and the changed operational environment.

Landing conditions

2.12 The environment in which the Hercules fleet is flying has also changed in recent years. The percentage of all landings on an unpaved strip has risen from four per cent in 2003 to 14 per cent in 2007. This trend is particularly noticeable in Afghanistan, as **Figure 12** demonstrates. Operating from unpaved strips means that the aircraft are more susceptible to damage as rocks are thrown up into the landing gear, fuselage and propellers. Furthermore the unevenness of the surface can cause damage to the landing gear itself. The paving of the strip at Camp Bastion in 2007 led to a small reduction, from a peak of 40 per cent, in the proportion of unpaved landings by the end of the year.

10 Number of sorties and average sortie duration for the Hercules fleet



Source: National Audit Office analysis of Departmental data

11 Maximum annual flying hours for the Hercules fleet

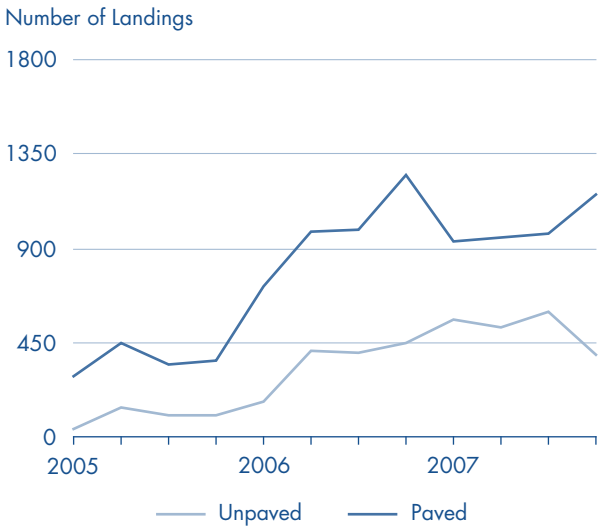
Year	2000	2001	2002	2003	2004	2005	2006	2007
Target flying hours	37,458	37,458	37,458	37,458	34,958	34,958	34,958	34,958[1]
Achieved flying hours	20,815	29,926	40,108	38,631	32,632	28,420	29,497	29,820

Source: National Audit Office analysis of Departmental data

NOTE

1 The Department has agreed a new level of flying hours of 30,160 in Summer 2007.

12 The number of landings on paved and unpaved air strips as part of operations in Afghanistan



Source: National Audit Office analysis of Departmental data

Depth repair and maintenance

2.13 The harsh environment and severity of flying on operations is increasing maintenance work on the Hercules fleet **(Figure 13)**. The Hercules C-130K heavily deployed on operations requires 25 per cent more time in maintenance and depth repair than its predominantly UK-based counterpart. Surface damage as a result of operations is easily identified. However the amount of deeper structural damage directly attributable to flying in theatre is difficult to quantify because such damage is also a function of the age of an aircraft. As the Hercules C-130Ks have been in-service for over 40 years, age may be a greater determinant of the amount of unscheduled repair which emerges when the airframe is stripped down.

13 A Year in the Life – the number of days aircraft spent under each status across the Hercules fleet (see also Appendix 4: maintenance case studies)

Status	Hercules C-130K heavily deployed on operations[1] (days)	Hercules C-130K predominantly UK-based (days)	Hercules C-130J heavily deployed on operations[1] (days)	Hercules C-130J predominantly UK-based (days)
Operations	106	0	143	11
Non-operations flying	32	151	57	167
Available but not flown	8	33	19	41
Scheduled maintenance	138	67	33	47
Other repair activity	50	60	43	56
Unscheduled maintenance	21	41	40	28
Awaiting spares	4	6	29	13
Not worked (awaiting resource/facilities)	6	7	1	2

Source: National Audit Office analysis of Departmental data

NOTE

1 Aircraft will be assigned non-operational tasks as well as roles on operations and so they will spend time in the United Kingdom.

2.14 Currently the Hercules C-130J aircraft heavily deployed on operations do not require as much depth repair and maintenance as the Hercules C-130Ks similarly deployed. However, analysis by the Department of the time taken to recover an aircraft that has returned from deployment in Afghanistan or Iraq shows that the average turnaround time for this activity has increased from eight days in May 2007 to 15 days in November 2007. This increase indicates that the maintenance burden caused by operations is rising. The Department's long-term commitment in Afghanistan and continued presence elsewhere in the Middle East will perpetuate this problem. It intends to reduce the additional effort by including some tasks normally undertaken in "recovery" into scheduled maintenance at the RAF base. This will reduce the amount of strip and re-build activity in the United Kingdom.

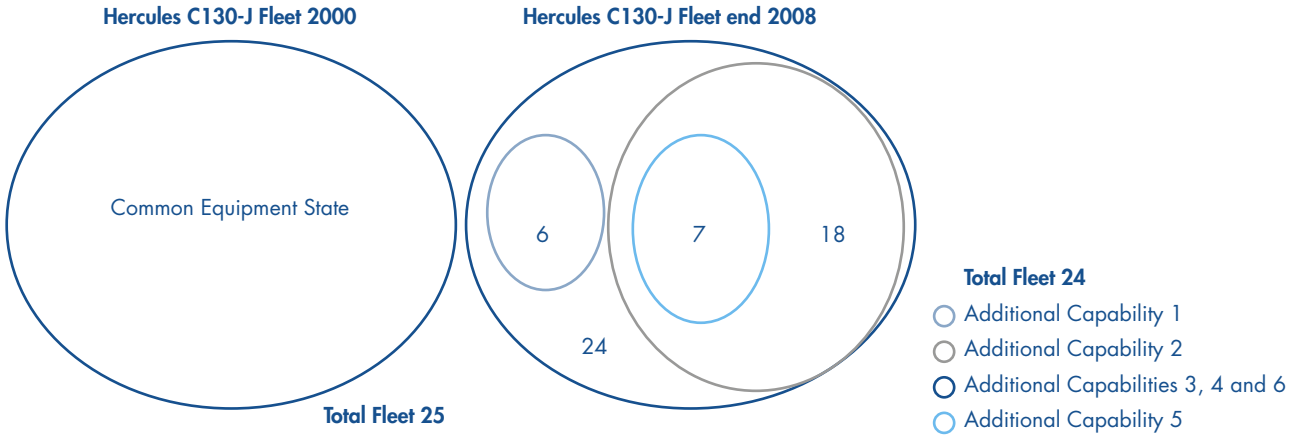
Upgrading some of the fleet to meet the demands of operations in Afghanistan and Iraq

2.15 The Department has reacted quickly to upgrade some of the fleet to meet the demands of operations in Afghanistan and Iraq. **Figure 14** shows how the Department has enhanced the capabilities of the existing Hercules C130J fleet and created more aircraft that are able to be used in theatre. The Department has combined the fitting of these enhancements, such as defensive aids, with its scheduled maintenance as much as possible to reduce the number of times the aircraft is stripped and rebuilt and limit the total time in repair. **Figure 15** illustrates how responsive the Department has been when fitting new enhancements, taking on average just over three months from approval to installation on the first aircraft.

2.16 Since 2007, the Capability Delivery Steering Group has managed Urgent Operational Requirements, force protection, and flight safety modifications. It has broad membership from across the Department and focuses on prioritising the installation of the equipment. Operational imperatives have to be balanced with risk, in particular to ensure the enhancements are fitted at the appropriate time without adversely affecting the number of aircraft available to fly. Prioritising the upgrades can be challenging, given the number and wide range of enhancements which are desired by the frontline operators, and military judgement and experience are brought to bear. The Group produces a "Capability Requirements Table", listing the equipments in priority order, which is used as a planning tool for availability and maintenance. It considers how to minimise the potential effect on availability and maintenance of both longer-term funded programmes as well as unfunded aspirations for upgrades.

14 Fleet composition

Additional equipment has been installed on aircraft in the Hercules C-130J fleet since its introduction in 1999. Adding this equipment has increased the capability of the aircraft. These capabilities cannot be specified as this information is classified.



Source: Ministry of Defence

15 Capability insertion

Capability Reference[1]	Source of funding	Date of decision	Date of approval	Date of first fit on aircraft	Number of months between approval and first fit
1	The Treasury[2]	December 2001	January 2002	February 2002	1
	The Department[3]	April 2007	August 2007	November 2007	3
2	The Treasury	December 2006	February 2007	October 2007	8
3	The Department	July 2005	August 2005	August 2005	0
4	The Treasury	March 2006	July 2006	November 2006	4
	The Department	April 2007	August 2007	January 2008	5
5	The Treasury	July 2007	September 2007	December 2007	3
6	The Treasury	May 2006	May 2006	July 2006	2

Source: National Audit Office analysis of Departmental data

NOTES

1 These capabilities cannot be specified as this information is classified.

2 Treasury funded upgrades are Urgent Operational Requirements for operations in Afghanistan and Iraq.

3 The Department funded upgrades are part of the ten year spending plan to improve the general capability and maintain aircraft currency.

The cost of operating the Hercules fleet

2.17 As **Figure 16 overleaf** demonstrates, the total cost to the Department to operate and maintain the fleet is rising. The increasing costs of equipment and support reflect the age of the aircraft; the change in the nature of flying tasks to sorties of shorter duration and the fact that the Hercules now undertake almost twice the number of sorties they did in 2002-03. As with any aircraft the Department has also had to pay for the upgrade of the equipment to prevent it becoming obsolete (paragraph 2.16).

2.18 The costs of running and basing the fleet at RAF Lyneham have decreased since May 2006. This reduction is in part due to the Hercules Integrated Operational Support contract because the responsibility for some of the more minor repair and maintenance activity, which had previously been undertaken by Service personnel, has been transferred to industry.

2.19 Prior to the signing of the Hercules Integrated Operational Support contract in May 2006, the Department had numerous agreements for spares and repair. It did not have clear visibility of the total costs of repairing, maintaining and upgrading the fleet because it switched money between budget lines in order to overcome short-term funding issues.

2.20 The Department is moving towards long-term support contracts for many of its major equipments whereby it partners with industry to deliver a given level of equipment availability. In its assessment for the Hercules, the Department estimated that a partnered contract would provide £170 million savings on the cost of support over the remaining life of the fleet against the 'as is' benchmark. On this basis the Department entered into the new arrangements for Hercules support. It measures the benefits of its partnering with industry through Key Performance Indicators, including the percentage of available aircraft and Priming Equipment Packs, which are intended to contain the parts that require repair/replacement most frequently in the initial 30 days of operation. To date industry has consistently met its targets. The Hercules Integrated Operational Support contract is a 24 year financial commitment, with a fixed price for 5 years; it accounted for £69 million of the total expenditure on equipment and support in 2007-08.

16 The cost of operating and maintaining the Hercules fleet

	2002-03 (£ million)	2003-04 (£ million)	2004-05 (£ million)	2005-06 (£ million)	2006-07 (£ million)	2007-08 (£ million)
Defence Equipment and Support[1]	71.33	79.92	85.67	104.65	112.62	125.85
RAF Lyneham[2]	140.42	143.25	140.45	146.83	121.44	119.24
Total costs met by the Department	**211.75**	**223.17**	**226.12**	**251.48**	**234.06**	**245.09**
Number of aircraft	51	51	50	50	44	43
Cost per aircraft	4.15	4.38	4.52	5.03	5.32	5.7
Additional costs met through the Conflict Prevention Fund[3]	9.54	11.36	13.74	18.29	30.51	92.72
Total operating and maintenance costs	**221.29**	**234.53**	**239.86**	**269.77**	**264.57**	**337.81**

Source: National Audit Office analysis of Departmental data

NOTES

1 Equipment and Support costs include deep repair and upgrades, simulators, avionics and defensive aids.

2 RAF Lyneham includes costs relating to personnel, infrastructure, fuel and forward support and logistics costs.

3 Recently re-named the Treasury's Reserve for Operations and Peace Keeping.

2.21 The current scale of operations means the Department's request for resources from the Conflict Prevention Fund (now known as the Treasury's Reserve for Operations and Peacekeeping) has increased significantly from £9.54 million in 2002-03 to £92.72 million in 2007-08. These funds contribute towards fuel, the cost of flying, additional capability for operational tasks and expenditure on maintenance on the Hercules fleet directly resulting from operating in Afghanistan and Iraq. Over 60 per cent of the expenditure in 2007-08 was to upgrade the aircraft with equipment such as defensive aids.

The impact of operational requirements on other tasks and personnel

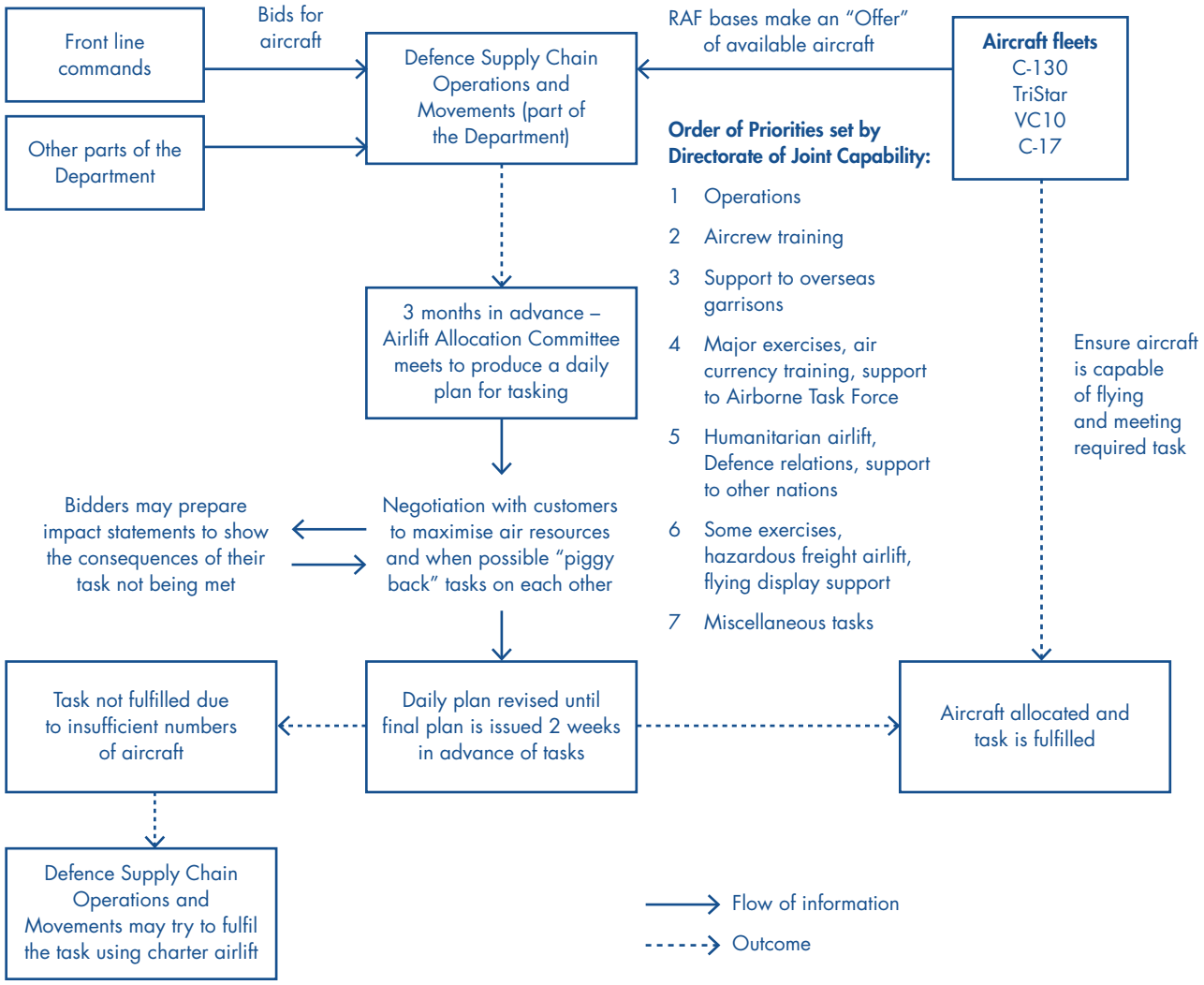
Tasking Hercules aircraft

2.22 There is a clear system of prioritisation, set by the Directorate of Joint Capability, for the tasking of all air transport aircraft. At the tri-Service Airlift Allocation Committee, chaired by Defence Supply Chain Operations and Movements, the attendees consider the full range of demands for Hercules aircraft and then prioritise bids for the benefit of Defence as a whole and to the best effect.

2.23 The Airlift Allocation Committee always assigns a number of Hercules aircraft to operations in Afghanistan and Iraq, routine depth maintenance and upgrade and other long standing commitments like the garrison in the Falkland Islands. With the remaining aircraft, Defence Supply Chain Operations and Movements encourage flexibility and where possible facilitate the achievement of more tasks by having various customers combine their bids. The allocation of aircraft can be re-prioritised by Defence Supply Chain Operations and Movements following the submission of "impact statements" from the bidder which show the consequence of their demand for aircraft not being met in full. **Figure 17** outlines the tasking process.

2.24 Meeting operational requirements is stretching the Hercules fleet. Most nations do not have sufficient airlift assets to meet all their requirements and the United Kingdom is no exception. Where feasible Defence Supply Chain Operations and Movements go to the commercial market to charter airlift and expenditure has increased extensively over the last three years: rising from £22.9 million in 2004-05 and £23.7 million in 2005-06, to £69.3 million in 2006-07 and £130 million in 2007-08.

17 The Hercules tasking process



Source: National Audit Office

2.25 Reflecting continuing operational demand for the aircraft, **Figure 18** shows that there has been a decline in the use of the Hercules for non-operational tasks and to undertake tasks such as training and exercises since late 2002. There will always be some unexpected variations between the estimate of the number of Hercules that will be available to Defence on any given day – the 'offer' – and those actually available, but non-operational tasking will be cancelled with regularity if the predicted 'offer' is not accurate.

2.26 Our analysis demonstrates that the number of Hercules offered coincides with the number available on the day in only ten per cent of cases **(Figure 19)**. Over 80 per cent of the time RAF Lyneham makes, at the last minute, more aircraft available than it 'offers' because under the current system it is better for aircraft to be idle than to have to cancel planned non-operational tasks.

2.27 Aircraft must be made ready to fly early enough in the day in order to complete a planned non-operational task. Success is measured on an aircraft being capable of flying a non-operational task rather than on actual completion of a task. This may mean that aircraft are repaired within agreed time limits but too late in the day for the Department to usefully assign them a task because there is insufficient time for crews, flight paths and cargos to be arranged.

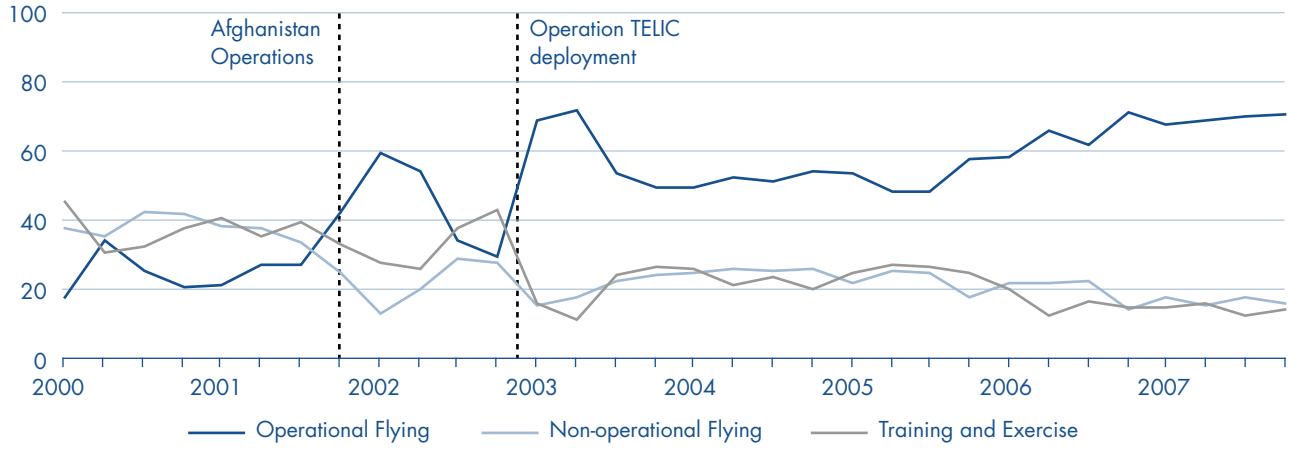
2.28 Furthermore the Department still does not regularly meet planned completion dates for aircraft repair. Although it plans when aircraft enter maintenance to achieve a steady throughput, with one aircraft going into repair as another leaves, so that delays do not affect the overall number of aircraft at the frontline, some aircraft at RAF Lyneham will reach the point where they will be unable to fly until they have been maintained.

2.29 Setting a target for an 'offer' which is driven by the mandated demand would reduce the likelihood of RAF Lyneham making conservative estimates of the number of aircraft it could make available and push the Department and industry to be timely in completing repair. If the Department could reduce the variability between the 'offer' and actual availability and improve certainty on the duration of depth maintenance then it would be able to undertake more non-operational tasks with its existing Hercules aircraft. It would also make its tasking process to satisfy demands for the aircraft more efficient **(Figure 20)**.

Delays to non-operational flights

2.30 The proportion of non-operational flights from RAF Lyneham that are delayed has increased from 14 per cent in 2002 to 48 per cent in 2007. The high utilisation and low level of spare aircraft at RAF Lyneham means that disruption cannot be absorbed and delays kept to a minimum, because it is not possible to shuffle flying tasks among the fleet and make use of spare aircraft.

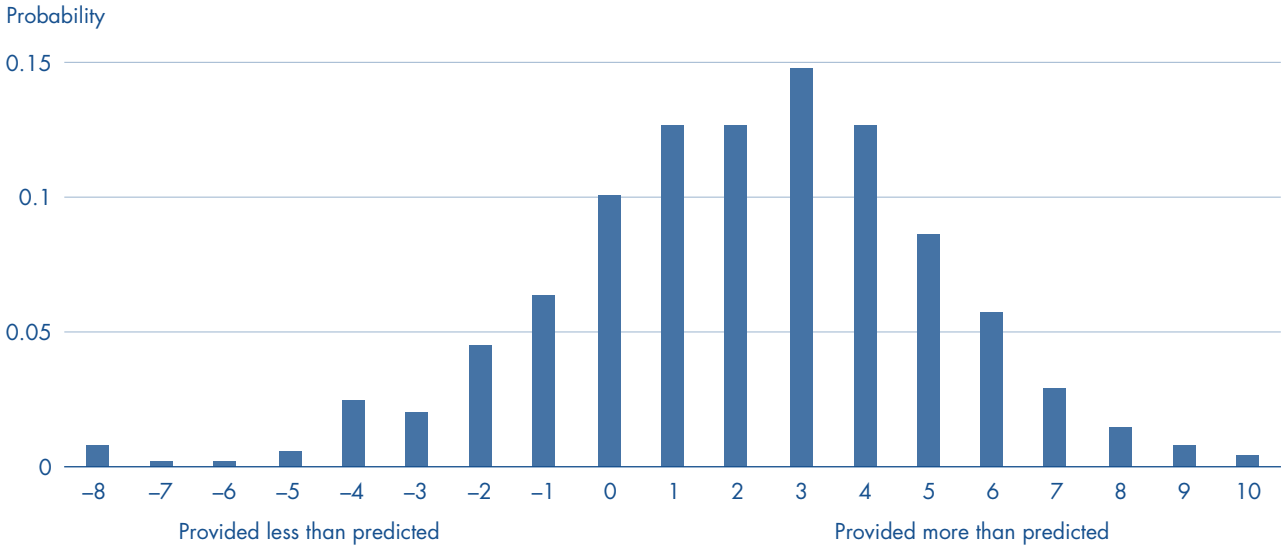
18 Type of sorties



Source: National Audit Office analysis of Departmental data

19 RAF Lyneham's 'offer' of Hercules aircraft

There is frequently a deviation between the number of aircraft RAF Lyneham 'offers' in advance and the number of aircraft that are available on the day.



Source: National Audit Office analysis of Departmental data

20 Potential improvements to the 'offer' process

- Raising the baseline 'offer' but defining a degree of confidence with which it will be met. By understanding the chance of "under-delivery", Defence Supply Chain Operations and Movements can allocate appropriate tasks to the aircraft RAF Lyneham are least confident about making available.
- Building up the offer through a series of "check points", rather than stating the final 'offer' at a single point in time. For example, RAF Lyneham could start with a baseline 'offer' of X aircraft, adding another Y aircraft at 14 days before the task day and an additional Z aircraft seven days before task day and so on, before the day of operations. Progress on planning for crews, flight paths and cargo can be made as aircraft become more certain and in addition formalising the concept of "late availability" aircraft could incentivise more innovative behaviour, such as tasks that are not time specific, for example freighting equipment from A to B or a list of training tasks that could be undertaken at short notice.

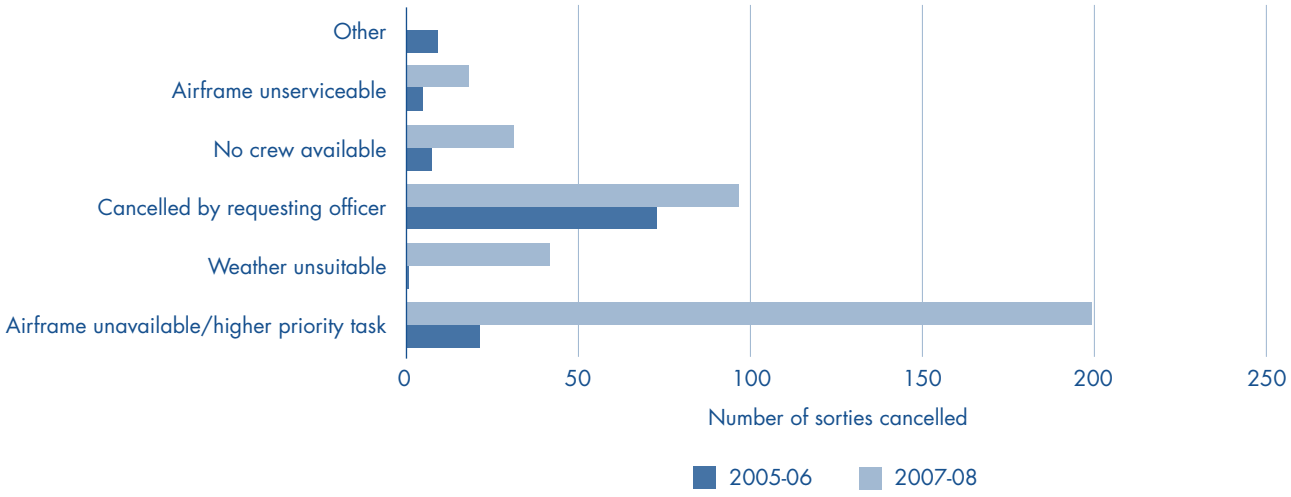
Source: National Audit Office

Crew training and flying intensity

2.31 The predominance of operations in aircrews' flying hours and the lack of training hours flown means that they are less likely to maintain the breadth of capability and experience that would be required to fly on different operations in other environments. On average aircrews are flying fewer than 13 hours per month when posted in the United Kingdom. This has been exacerbated by a tenfold increase in the number of cancellations of planned training sorties tasked by RAF Lyneham because of insufficient aircraft or aircraft being re-assigned to higher priority tasks **(Figure 21 overleaf)**.

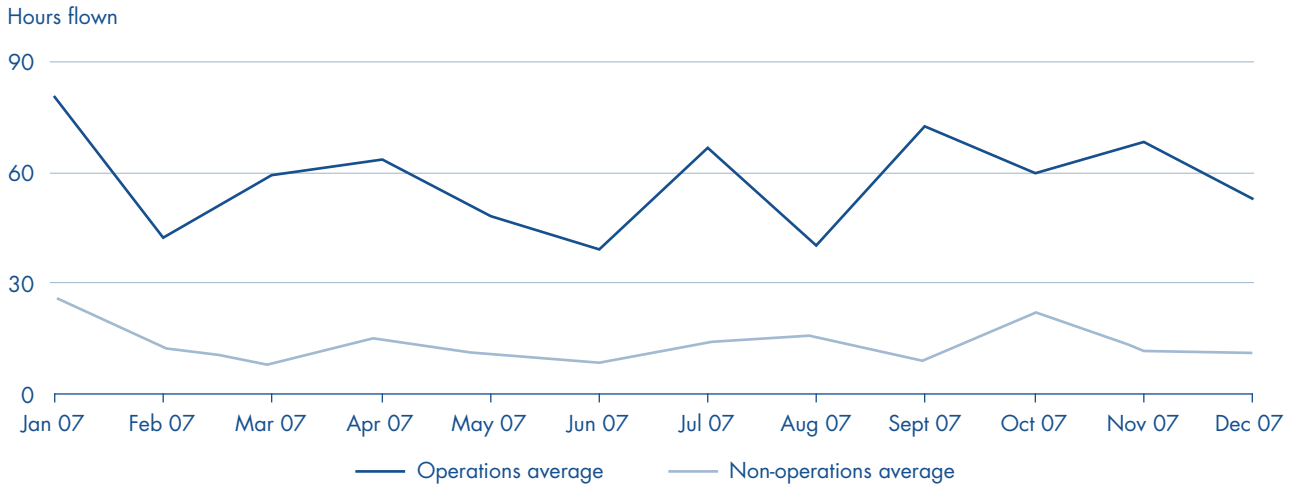
2.32 Aircrews are experiencing different levels of flying intensity. **Figure 22 overleaf** shows that when on operations the hours flown by the crews is highly variable and much greater in number than when in the United Kingdom. As an extreme example, the sample of aircrew hours provided by 24 Squadron for 2007 showed one pilot flying 77 hours on operations in February, one hour 15 minutes while back in the United Kingdom in March and over 66 hours on operations in April.

21 The number of training sorties cancelled



Source: National Audit Office analysis of Departmental data

22 Average hours flown by crews per month



Source: National Audit Office anlaysis of Departmental data

2.33 Concerned that the lack of aircraft available for training is causing crew competency levels to seriously decline, the Department is attempting to provide four aircraft for training purposes on a daily basis. Early indications are positive as since 1 February 2008 there have been two Hercules C-130Js and two Hercules C-130Ks available to RAF Lyneham on 34 and 21 days respectively. These aircraft have enabled crews to practice formation flying as well as general aircraft handling skills and have reduced the impact of unserviceable aircraft on the training programme. If the Department had an all-weather natural runway instead of training for landings on unpaved airstrips on a beach, it could reduce the time aircraft needed washing to remove salt water. The Department has estimated this would save around £230,000 per annum and provide an extra 41 days of Hercules available for Defence wide tasks.

2.34 The lack of aircraft for training is also affecting adversely other areas of Defence. For example, one of the capabilities reduced is the Department's ability to respond immediately to an emergency using airborne troops (Airborne Task Force). In 2001, there were a total of 24,265 parachute descents by service personnel from Hercules aircraft. In 2007, fewer than 10,000 descents were made. These were achieved in part by "piggy backing" on to training flights scheduled for aircrews.

PART THREE

Managing future tactical fixed wing airlift availability and capability

3.1 Over the next decade, the Department's transport aircraft fleet will change significantly with the retirement of older aircraft such as the Hercules C-130K and the introduction of A400M. Delivering tactical fixed wing airlift capability involves more than managing the existing aircraft and acquiring new ones. For example, training, personnel, infrastructure and logistics also need to be put in place and associated risks managed coherently. This is not an easy task and involves many different groups within the Department and several private companies. This Part of the report examines the risks the Department is managing and what prospects exist to improve availability. The Department faces significant challenges in providing sufficient tactical fixed wing airlift in the future, particularly at the point at which the Hercules C-130K is due to be retired. It has identified some mitigating actions within the available resources; but it has only limited ability to influence some risks.

Meeting future demand for tactical fixed wing airlift

3.2 The demand for tactical fixed wing airlift is likely to remain high in the near future. The Department has taken a deliberate decision to increase the United Kingdom's capacity for strategic airlift. As a result it has used recuperation funds from the Treasury for the loss of three out of four Hercules to partly finance the purchase of two additional C-17 aircraft. This is a much larger aircraft than the Hercules, but, in theory, a C-17 could perform tactical tasks and operate directly to southern Afghanistan, landing on the newly completed tarmac runway at Camp Bastion. C-17 flights could therefore reduce the pressure on the in-theatre Hercules aircraft. In practice, these Hercules are likely to be redeployed to land on more austere and less secure strips in theatre.

3.3 The Department faces a number of significant risks to providing tactical airlift. Many of these risks stand to materialise in the critical time period of 2011 to 2013, during which the Hercules C-130K fleet will be retired. Extra airlift can be obtained in three ways:

- Purchasing additional Hercules C-130Js or other forms of airlift such as C-17s. The Department would require £37 million to buy the basic Hercules C-130J model. This aircraft would need to be upgraded, for example with the United Kingdom's defensive aids, so it corresponds with rest of the fleet. Normally there is a long lead time for aircraft, but as the United Kingdom's success with purchasing the C-17 at short notice shows, it is possible to negotiate to take an earlier aircraft off the production line.
- Leasing Hercules or other transport aircraft from other nations. Likely to be high cost and only limited scope to upgrade in line with rest of fleet.
- Increase the use of charter. Very few aircraft can be provided with appropriate defensive aids.

3.4 Given the existing pressure on spending, however, the Department will not be able to maintain current levels of tactical airlift tasking unless it finds additional funding from other budgets or reduces demand for aircraft. Alternatively the Department could choose to change the way it uses the Hercules fleet, for example using alternative aircraft such as C-17s, or leaving aircraft permanently stationed on operations with an appropriate repair facility which would stop the long flights between the United Kingdom and the Middle East.

There are significant risks to future availability and capability

3.5 The Department's primary focus is the risks to delivering output and capability and a number of different groups within the Department maintain risk registers that, either fully or in part, pertain to the Hercules. At present they are not linked in a coherent way to provide comprehensive insight into the key issues which affect both the aircraft and the personnel who fly and support it and a picture of the level and nature of the risk the Department is managing.

3.6 Project INTERWEAVE brings together all the relevant RAF transformation programmes taking place over the next decade and identifies the impact of current operations and subsequent recuperation periods. A total of 24 plans, such as those for the introduction of the new A400M aircraft (paragraph 3.22-3.24) and the move of the Hercules fleet to RAF Brize Norton (paragraph 3.30-3.31), will be combined into the Large Aircraft Transition Plan. This offers senior Departmental personnel visibility of key risks.

The retirement of the Hercules C-130K fleet

3.7 Until 2004 the Department intended that the Hercules C-130K fleet would go out of service in 2008. This date was extended to 2010 and then 2012. However, some of the aircraft are being withdrawn before 2010 due to high levels of fatigue. Four aircraft were taken out of service in 2007, and on current plans five will be retired in 2008; and five will be retired in 2010. The retirement of these Hercules will create a serious but planned gap in capability.

3.8 The loss of the three Hercules C-130Ks in theatre has further exacerbated the problem. Of the remaining nine Hercules C-130K aircraft, five must undergo programmes to replace or refurbish their outer wings to ensure that they have sufficient life to last until the end of 2012. The Department has already found two sets of outer wings which will be fitted to two aircraft at a total cost of £5.1 million. Three sets of outer wings will be sourced and fitted to the other three aircraft as part of the Hercules Outer Wing Refurbishment Programme which aims to replace the old outer wings with either refurbished or second hand wings, at an estimated cost of £10.2 million. Both these programmes will be funded by the Treasury's Conflict Prevention Fund (now known as the Reserve for Operations and Peacekeeping). There is concern that the wings may need to last until 2014 due to delays to the delivery of the A400M aircraft and so the Department has invited industry to provide solutions which give the wings additional life at no extra cost. Any extension will require an early decision to facilitate crew retention and maintenance planning as well.

Fatigue on the Hercules C-130J fleet

3.9 The impact of fatigue on the Hercules is becoming better understood as industry refines structural tests conducted throughout the aircraft's life. Fatigue particularly affects the Hercules C-130K outer wings, which are a bespoke design for RAF aircraft. By interpreting the results from test wings where the stresses of operational flying are simulated, the Department is able to make accurate estimations of the remaining life of the Hercules C-130K relative to their extended out of service date of 2012.

3.10 The newer Hercules C-130J has a much more durable outer wing design and there are various on-board monitoring systems that provide fatigue data which can be used to refine the estimates for the life of the whole fleet. Nevertheless the Department is learning from its experiences with fatigue on the Hercules C-130K. It is now undertaking an analysis to forecast the impact of levels of fatigue on the life of the "J" centre wings, based on recent patterns of intensive usage of the Hercules C-130J. Given the significant stresses to which the aircraft are being subjected on operations, initial indications suggest that the worst affected Hercules C-130Js will need their centre wings replaced or refurbished between 2012 and 2015 in order to reach their planned out of service date of 2030. The Department has identified refinements that will improve the validity and accuracy of the analysis, for example, to include operational scenarios, and it may decide to limit the loads carried by the Hercules C-130J in order to reduce levels of fatigue and prolong life.

3.11 The Department, in conjunction with the Royal Australian Air Force, plans also to simulate the accumulation of fatigue over time on a Hercules C-130J wing. This will improve understanding of the risks of cracking over the course of the wing's life and provide more accurate data on fatigue. The nature of this test means that the results will not be available until 2013 at the earliest, after the worst affected wings of the aircraft may have reached the end of their life. There is a risk that a gap will develop between the end of the current wings' life and the arrival of replacement wings.

The transfer of capability for specialist operations

3.12 Some Hercules C-130Ks currently support specialist operations. These aircraft are being retired in 2012 and the Department intends to transfer this capability to a number of the existing Hercules C-130Js. There are two parts to this transfer which ideally should be conducted in a cohesive manner.

- The international Block Upgrade 7.0 programme provides the systems architecture for the specialist equipment to be installed as well as some of the equipment itself. The programme is a collaboration between several nations to upgrade the Hercules C-130J in capability blocks rather than undertaking piecemeal modifications. Together the nations' Departments of Defence decide which capabilities to install. The Department plans for industry to begin the work in September 2011 and for it to last a year.
- Project HERMES installs the specialist equipment on to the aircraft. The project team has yet to submit a business case for full approval but to date, it is on track to provide an initial operating capability by 2012 and a full operating capability by 2013.

3.13 By choosing to enhance capability through the Block Upgrade programme, the Department does obtain economies of scale by sharing development costs with the other international members of the Hercules C-130J User Group, but loses flexibility to install new capabilities when it best suits the United Kingdom's fleet. Nevertheless, the Department has installed specific modifications such as Explosion Suppressive Foam outside the Block Upgrade programme. The Department also aims to conduct any necessary re-winging work at this time to limit the impact on the availability of aircraft.

3.14 The main risk to specialist operations relates to its dependency on the Block Upgrade programme, the timing of which is uncertain. The Main Gate Business Case was originally due to be submitted by the end of 2007; the current forecast is for August 2008. With so many nations participating, the Department cannot rely on Lockheed Martin prioritising its place in the programme until the work is on contract. Much of this work will need to be undertaken at the same time as the Hercules C-130K fleet is being retired and inevitably the number of available aircraft will be severely reduced. Any delay beyond 2012 may create a serious gap in capability, especially if the wing life of the Hercules C-130Ks has not been extended (paragraph 3.8).

3.15 Some specialist equipment from Project HERMES can be installed on the Hercules C-130J without the Block Upgrade. This is not an optimal solution as it does not provide full capability and requires the aircraft to go to industry for the HERMES work and then for the Block Upgrade rather than doing them both at the same time. Therefore the risk to specialist operations has been assessed as high impact, high likelihood and high severity and is being addressed by the recently formed Programme Board.

The supply chain for the Hercules C-130Js

3.16 An effective supply chain should enable engineers to replace a part that has failed on an aircraft with a spare so that the aircraft can be made ready to fly with the minimum of delay. Problems with the provision for spares for the Hercules C-130J have resulted in aircraft being grounded while waiting for spare parts so they can be repaired, with an average Hercules C-130J which is heavily deployed on operations being unavailable to fly for 29 days a year, while for an average Hercules C-130J predominantly based in the United Kingdom the time is 13 days.

3.17 Most of the current problems with availability of parts can be traced back to the initial procurement of the Hercules C-130J. As the United Kingdom was the first customer for this aircraft, there was no historical data on the failure rate and consumption of spares from which to calculate the required stock holding. At the time of purchase the Department was involved in fewer operations conducted at a lower tempo and so the supply chain model was based on these assumptions. Furthermore, the Department had only planned to have the aircraft based at RAF Lyneham, but current deployments have resulted in multiple and widely dispersed geographical locations requiring spares holdings. The level of spares is therefore insufficient to support the current operational situation. The Hercules Integrated Operational Support Contract signed in May 2006, included an agreement to recover the spares shortfalls and at the end of April 2008, 98 per cent of the items have been delivered.

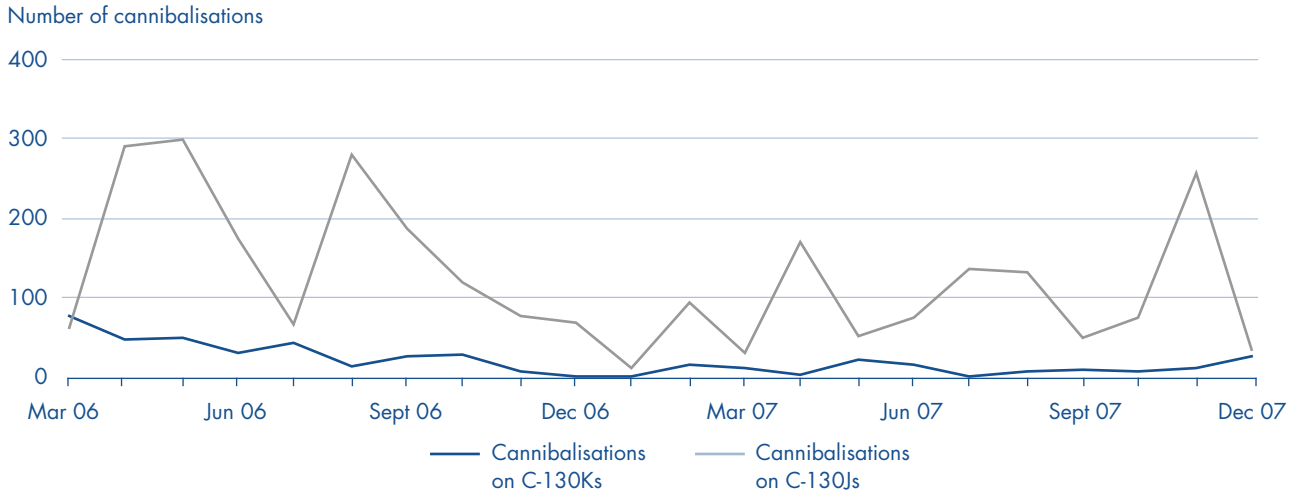
3.18 The Department's efforts are geared to minimising supply chain problems for aircraft deployed in Afghanistan and Iraq:

- All aircraft are deployed with Priming Equipment Packs that are intended to contain the parts that require repair/replacement most frequently in the initial 30 days of operations. However the content of the pack was based on relatively limited operational data that does not reflect fully the needs of the current deployed environment.
- Spares that are in stock at RAF Lyneham are relocated to the Middle East according to need. While this ensures the availability of aircraft in theatre, it adversely affects the availability of spares for United Kingdom based aircraft, particularly those undergoing scheduled maintenance or long term repair. For repairable parts, the reverse supply chain, which delivers them back to industry for overhaul, has been problematical. Parts have not been given the highest priority on air transport and so returning them to RAF Lyneham once repaired and fitting them to United Kingdom based aircraft has not always been as quick as required.
- Where no spare part is available for operations it is taken ('cannibalised') from another aircraft, either in theatre, in the United Kingdom or already in depth repair or maintenance. While cannibalisation is a pragmatic way to ensure operational needs are met, it significantly increases the workload of engineers and maintainers because it requires double the effort to return both aircraft to working order. It also reduces further the availability of aircraft, particularly for training and exercises.

3.19 **Figure 23** shows the level of cannibalisations on the Hercules fleet. While the extent of cannibalisations has reduced since a peak in March 2006, there are still times when there are very high levels of cannibalisation on the Hercules C-130J fleet. By resorting to cannibalisation the underlying causes of supply chain problems are not addressed and inefficiency is built into the repair and maintenance regime. With the commencement of arrangements for the Hercules Integrated Operational Support in April 2006, the Department placed a limit on each fleet of 100 man hours per month to be spent on cannibalisations at RAF Lyneham and this contributes to the measurement of the performance of the industrial partners in managing the supply chain. Thus there is an incentive for industry to collect data to calculate the correct level of stock required and then configure the supply chain to meet the operational needs of the fleet.

3.20 The interface between the Department's and Lockheed Martin's spares software systems is poor. There is a lack of visibility of spares held and stocks are sometimes reported inaccurately as being unavailable. This delays the process of getting the right stock to the right place. As a temporary solution, the information transfer is replicated manually which is time consuming and inefficient. The proposed software for automatic transfer is yet to be fully developed and implemented.

23 Cannibalisations on Hercules C-130J and Hercules C-130K fleets



Source: National Audit Office analysis of Departmental data

3.21 The Department is undertaking a number of initiatives to address the continuing problems with the availability of spares:

- The inventory for spares held by the Department when the Hercules Integrated Operating Support contract was let was inaccurate[2], so the plans for the future supply chain were predicated on a higher level of starting stock than existed. The spares shortfall has been agreed with industry. The Department's initial estimate is that it will require around £3.9 million to settle this liability.
- Recognising that it now has multiple locations that require spares (RAF Lyneham, Marshall Aerospace, Afghanistan, Iraq and the Falkland Islands), the Department is making an additional purchase of parts specifically for Kandahar, rather than persisting with re-allocating its existing holdings. A spare engine has already been purchased to support Kandahar. As well as providing better support to operations at Kandahar, the increased number of spares will benefit the United Kingdom and other Middle East bases. The Department has been authorised by the Treasury to spend up to £3.7 million from the Conflict Prevention Fund (now known as the Treasury's Reserve for Operations and Peacekeeping).
- Reviewed the available data on the usage of spares from the Priming Equipment Packs to ensure that packs in future contain a more relevant mix of parts. Changing the pack through the Hercules Integrated Operational Support contract requires discussion between the Department and industry.
- The Department has recently increased the forecast numbers of hours that the Hercules C-130 J fleet will fly. This will mean an increase in the amount of spares held.

3.22 We have estimated that if the supply chain worked more effectively and the initiatives outlined above were undertaken, this would reduce the number of days per year that an average Hercules C-130J spent waiting for those spares. If the Department could reduce levels on the Hercules C-130J fleet to those experienced on the Hercules C-130K fleet, then unavailability of "J"s could be reduced by a third in theatre and a fifth at RAF Lyneham. Across the Hercules C-130J fleet this would equate to an extra 168 days of aircraft availability.[3] So a relatively minor cost outlay of under £8 million could make a significant improvement to the number of days an aircraft could be flying.

The late delivery of the A400M aircraft

3.23 The A400M aircraft will provide tactical and strategic airlift to all three Services. The required capabilities include: operating from airfields and semi-prepared rough landing areas in extreme climates and all weather conditions by day and night; carrying a variety of equipment including vehicles and troops over extended ranges; air dropping paratroopers and equipment; and being unloaded with the minimum of ground handling equipment.

3.24 A400M is a collaborative programme involving Germany, France, Turkey, Spain, Belgium, Luxembourg and the United Kingdom. A total of 180 aircraft are planned to be procured through a contract with Airbus Military and the United Kingdom's potential share is 25 aircraft. When the project began, the Department expected the first seven A400M aircraft to be delivered in December 2009. The project has been delayed subsequently by a variety of contractual and budgetary difficulties affecting all partner nations and the Department does not now expect the first seven aircraft to be in use until December 2011, with the final aircraft delivered four years later. The Department plans that the A400M fleet will deliver the full range of operational benefits by 2018.

3.25 The delays present a risk that is difficult for the Department to mitigate. The procurement is managed by the Organisation for Joint Cooperation in Armaments, a multi-national administrative body for the management of collaborative programmes based in France. The Department does not have a direct contractual relationship with, or access to, Airbus Military which means that visibility of progress is limited, and makes it very challenging for the Department to plan effectively. It is unlikely that the Department will obtain payments for the late delivery of A400M aircraft at a sufficiently early time in order to purchase additional airlift capability. In the short-term delays to the introduction of the A400M have cost £41 million with the extension of the life of some of the Hercules C-130Ks. Airlift capacity will be compromised after the Hercules C-130Ks retire in 2012 and a decision must be taken soon to reduce the impact of long lead times required for some solutions (paragraphs 3.3 and 3.8).

2 These problems cover all military equipment, not just the Hercules, and are long standing. The C&AG's qualified opinion on the Defence Resource Account Audit Certificate in 2001-02 was due to the Department's inability to capture data accurately on the usage of stock and fixed assets held on its behalf by industrial contractors. Although the Department's performance improved in subsequent years the C&AG has specifically referred to issues with measuring stock consumption in Iraq (2003-04 and 2006-07 Reports on the Financial Statements)

3 These figures are based on aircraft status data for April 2007 – January 2008 inclusive.

Maintaining the overall capability of aircrews

3.26 Crew training on Hercules C-130s has declined due to a lack of available aircraft. Understandably, training has focused on preparing for current operations. Flight simulators are used extensively by the aviation industry for the training of pilots and other cockpit crew to supplement hours in the aircraft itself. For the RAF however, the simulators for both aircraft variants have limitations, particularly because their software has not kept pace with aircraft modifications, especially defensive aids, and they are therefore not able to replicate flying the Hercules accurately. From a sample provided by 30 Squadron for 2007, pilots used the simulators for the Hercules C-130J for fewer than nine hours per month while based in the United Kingdom. These limitations necessitate training on actual aircraft.

3.27 The Department estimates that it would cost £0.5 million to install software to reproduce the current operational environment on the Hercules C-130J simulator and to upgrade it more fully would cost at least £3.75 million. The Department estimates that updating the simulator and using it round the clock could provide an additional 300 days of aircraft availability – the equivalent of one aircraft per year for other tactical airlift tasks.

3.28 There was a common concern among those we interviewed about the impact the increasing number of training sorties which were cancelled was having on the expertise of crews more generally and their ability to respond to a different operational environment and new tactics in the future. The Department is producing a Capability and Training Paper to quantify existing and potential future skills gaps and what will be required to recuperate these skills in the future. The paper will confirm the training required, the number of aircraft needed to fulfil this and the benchmarks against which the success of the training plan can be measured.

3.29 The Hercules fleet is currently operating to a higher tempo than that envisaged by the Department. The operation of the fleet is almost as tightly managed as is possible and so there is little spare capacity to airlift the Armed Forces should they be required to mobilise elsewhere. The Department has accepted that elements of deployment, such as the ability to parachute a 600-strong battalion en-masse with equipment and supplies into a country, are at risk while current operations continue.

The move to RAF Brize Norton

3.30 As part of an estate rationalisation programme called CATARA (Centralisation of Air Transport and Air-to-air Refuelling Assets), RAF Lyneham will close as the Hercules operating base by 2012. The Hercules fleet and all related forward maintenance and support activity will be relocated to RAF Brize Norton, which will become the single airport for arrival and departure to and from the United Kingdom for equipment and service personnel, during 2011.

3.31 Initially the Department's plan was for the Hercules C-130K to continue to operate from RAF Lyneham until the aircraft retired in 2012. Given the possibility of extending the life of the remaining Hercules C-130Ks beyond 2012, splitting the fleet between the two main operating bases could have created significant logistical difficulties. The entire Hercules fleet will now be moved to RAF Brize Norton at the same time. As yet the Department has not quantified the effect on the Hercules Integrated Operational Support contract. There may be a lack of repair bays, insufficient parking space for aircraft and the layout of RAF Brize Norton may require aircraft to be towed some distance to the repair hangars. To ensure that issues specifically related to the Hercules are fully considered, two members of staff from RAF Lyneham have begun working with the CATARA project team.

Maximising opportunities to increase tactical airlift capability

3.32 The condition of the Hercules fleet is changing very rapidly and some solutions, particularly around the extension of the service life of the Hercules C-130K, have long lead times. Consequently it is vital that the Department has a system for decision making and financing that can respond quickly to ensure capability is maintained.

3.33 In addition key personnel must be in place. The restructuring of the Hercules Integrated Project Team has enabled the Block Upgrade 7.0 and HERMES projects to be managed within one branch and consequently the Department now has sufficient full-time experienced procurement and finance staff to progress the Block Upgrade programme. There is also a shortage of 107 engineering personnel at RAF Lyneham to successfully support current levels of flying. The 54 posts recommended in the recent manpower review of engineering trades at RAF Lyneham are being filled. In the meantime, additional personnel are being provided to RAF Lyneham as part of a targeted Headquarters Air Manpower Placement Plan; with individuals drawn from less operationally-loaded units. Repair and maintenance is taking up to 25 per cent longer on some parts of the Hercules fleet. Aircraft will always need some additional maintenance beyond that routinely scheduled, but the RAF estimates that the activity undertaken by these additional engineering personnel could release an additional 300 days of aircraft availability.

APPENDIX ONE

Methodology

1 The aim of our study was to assess whether the Department has successfully managed its tactical fixed wing airlift capability given the pressures caused by the current operational tempo and how it is managing for the future when it faces a number of key challenges to providing airlift, including the introduction of the A400M aircraft. Within this scope we considered:

- the Department's current performance in providing sufficient Hercules to support the full range of airlift tasks;
- the future risk to Hercules availability and capability; and
- ways in which the Department can become more efficient in its use of existing aircraft to increase its airlift capacity.

Interviews and visits

2 In order to carry out the detailed study on the performance of the Hercules fleet we interviewed representatives of the stakeholders listed in **Figure 24**. We also sought input from the Department's industrial partners – Marshall Aerospace, Lockheed Martin and Rolls-Royce.

3 During our visits in summer 2007, we held semi-structured interviews with senior management, aircrew and financial, commercial, administrative, engineering and supply staff. We examined documents which included policy and planning papers related to the Hercules fleet, regular reports for and by the Integrated Project Teams, and the results of studies by the Department into various aspects of training and tasking.

Analysis of the Department's use of the Hercules fleet

4 A number of different organisations within the Department supplied quantitative and qualitative data. We used this in a range of financial and non-financial measures to assess performance and cost, based on the overall operational availability of the aircraft, the ability to meet tasking requests and the performance of the repair organisations.

Qualitative and quantitative modelling of the factors affecting Hercules fleet availability

5 Following a competitive bidding process, we commissioned PA Consulting Group to ascertain the factors that influence the availability of the Hercules fleet, and to identify the current pinch points in the use of the fleet and recommend how these might be alleviated. The work comprised two stages: the development of a model and more in-depth analyses in areas warranting investigation.

6 On the basis of the documentary review and interviews, PA used systems thinking to identify the factors that influence the availability of Hercules aircraft. They concentrated on identifying causal factors, their influence on the system's performance and the nature of the relationships between them. The factors and relationships are illustrated in a causal map of the entire system so that the impact of changes can be understood in context of the overall system. The causal map is shown in Appendix 2 of this report.

7 Departmental statistics were compiled into a database and cleansed to remove inconsistencies. The work was subject to review by Departmental stakeholders at key points to ensure it accurately reflected their collective understanding of the system. The team's initial analysis used combinations of this data to provide an evidence base to determine the dominant drivers of availability. Key measures included:

- Number of flying hours
- Number of sorties (by type and categorisation)
- Number of landings (by type)
- Aircraft availability
- Crewing
- Cannibalisations
- Maintenance

Working closely with the study team, PA Consulting Group then prioritised further specific areas for detailed investigation for the second phase of data collection and analysis.

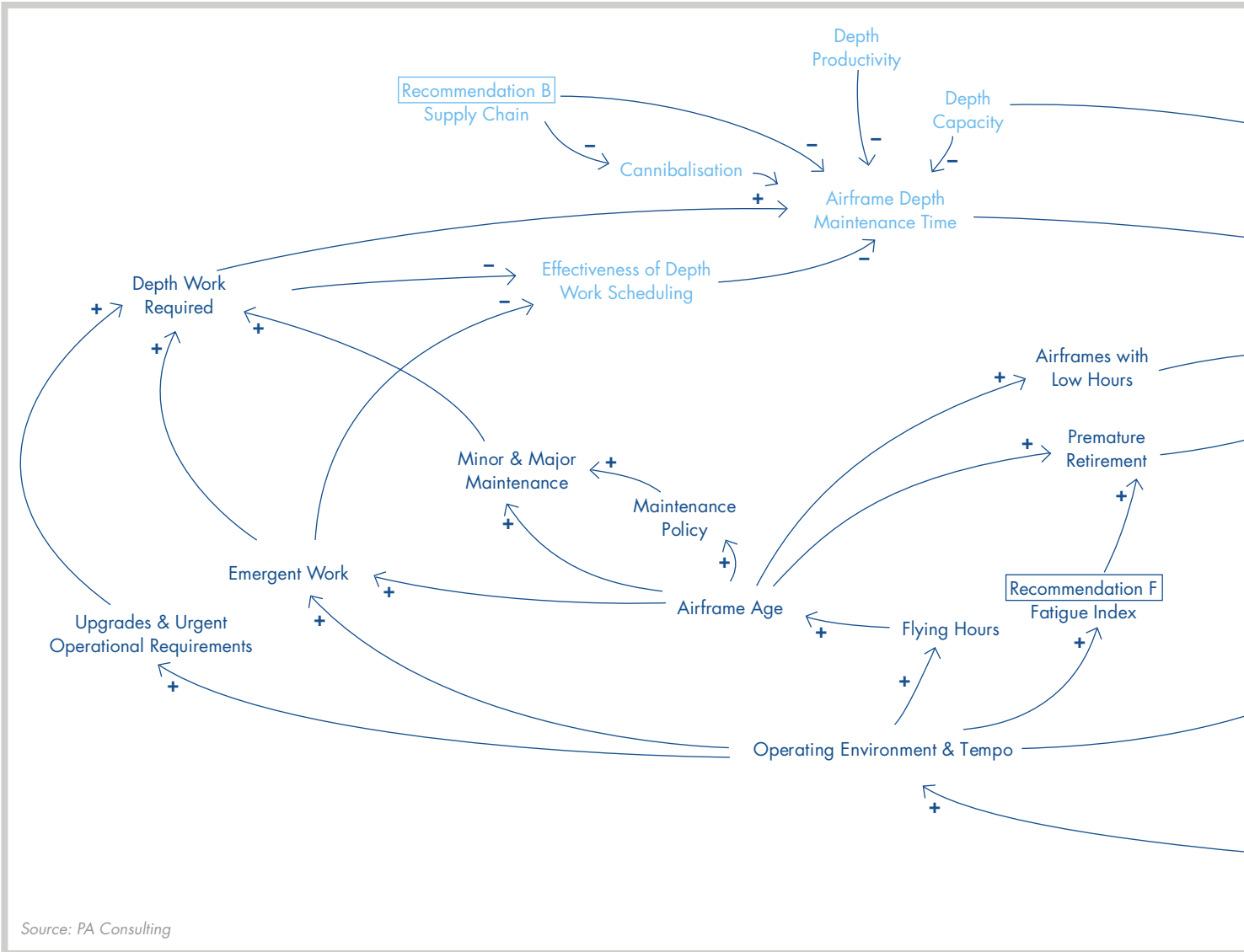
24 Hercules Stakeholders

Organisation	Role	Reason
Defence Equipment Capability – Expeditionary Logistics and Support	Responsible for analysing the specific military needs within their area, including shaping and managing research, and to determine when and where gaps in capability will occur and formulate plans to close those gaps.	To understand how they plan to keep the fleet up-to-date in the longer term and work with other stakeholders. To gain an understanding of what the key issues and risks for the future are.
Directorate of Joint Capability	Shape, evaluate, arbitrate and advise upon the delivery of current and future integrated capability in order to enable the United Kingdom to plan, prepare for and execute joint and combined operations.	To discuss the prioritisation of the use of the Hercules fleet, and specifically the work of the Commitments Area Requirements and Availability of Air Transport Team.
RAF Air Command No 2 Group	Also known as the Combat Support Group, controls the Strategic and Tactical air transport aircraft which provide airlift for operations.	To obtain a strategic overview of the RAF's management of the Hercules fleet, its risk management processes and the use of the Hercules in Afghanistan and Iraq.
RAF Lyneham	Home base for the RAF's tactical fixed wing air transport force – the Hercules aircraft.	To gain an understanding of the day to day operation of the Hercules fleet. To discuss maintenance, crewing and availability issues.
Joint Helicopter Command	Comprising units of the Royal Navy, Army and Royal Air Force. The principle Army formation in the command is 16 Air Assault Brigade, which is designated for rapid deployment to operations potentially by parachuting into theatre.	To discuss how 16 Air Assault's parachute training is affected by the stretch on the Hercules fleet.
Permanent Joint Headquarters	Primary role is to be responsible for the planning and execution of multi-national operations in which the United Kingdom participates.	To understand what the future requirements for the Hercules fleet might be and how it is being used in Afghanistan and Iraq.
Defence Supply Chain Operations and Movements	Provides Defence and other authorised users with agreed transport and movements services world-wide in peace, crisis and war in order to support current and future United Kingdom military capability.	To learn how the aircraft are tasked on a day to day basis and how tasking is prioritised.
Defence Equipment and Support	Acquires and supports through-life, including disposal, military equipment.	To gain an understanding of the logistical support requirements of Air Transport as a whole, and for information regarding budget and finances.
Hercules Integrated Project Team	Engineering, supply, financial, administration and commercial specialists who provide logistic support to the Hercules aircraft.	To discuss the issues relating to the management of the fleet, including capbility upgrade programmes, finances and the retirement of the C130K.

APPENDIX TWO

The Causal Map

1 The main influences and factors that will affect the Hercules fleet's availability are represented on this causal map. The relationships between factors can be complex and also have time delays, which are not represented on the map. The group of factors that are driven by 'Operating Environment and Tempo' are also influenced by non-operational tasks but have not been explicitly shown here to simplify the presentation. However, an arrow from factor A to factor B with a positive (+) sign indicates "as A increases then B will increase", and similarly if the sign is negative (-) then "as A increases then B will decrease".

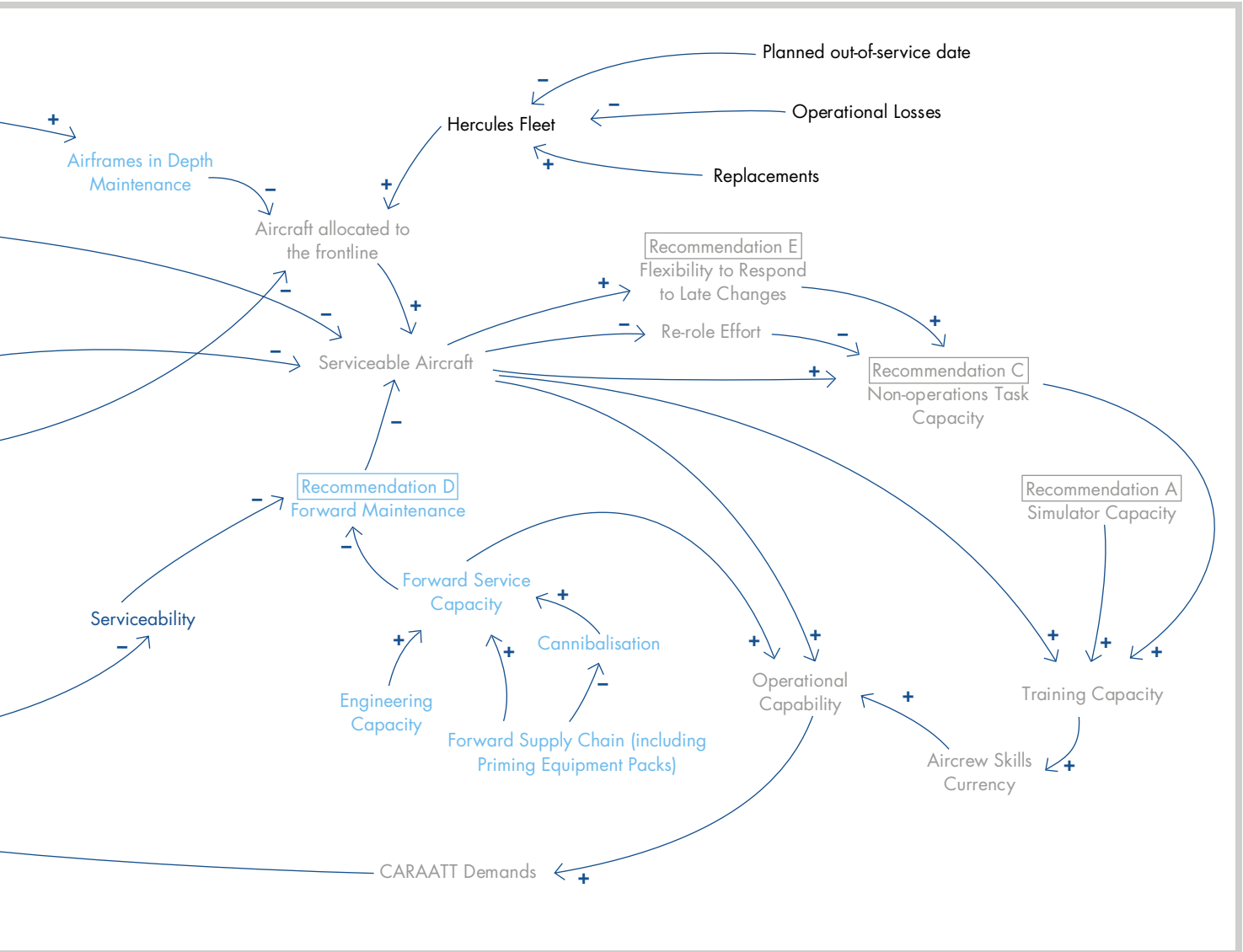


Source: PA Consulting

2 In this diagram the availability of the Hercules fleet is represented by Serviceable Aircraft. This is influenced by four main factors: the overall size of the fleet, the aircraft in planned maintenance, the aircraft in forward scheduled maintenance and those aircraft that are unable to fly because they have reached their inter-maintenance flying hours limit.

3 Each of these four factors is itself influenced by a range of other factors and so on, creating influence chains and feedback loops that can then be explored to appreciate the full range of influences one factor may have. For example, the short and the longer term effects of the current 'Operating Environment and Tempo' on the forward fleet size, the maintenance programme, aircraft availability and the non-operation tasking, such as training.

4 We used the causal map and the qualitative views gained through the interviews to identify pinch points and bottle necks in the system which warranted further, more in depth investigation. For example, the fatigue and re-winging (paragraphs 3.9–3.11). Using additional data we then analysed the effects on the relationships in the map. We did not fully measure every factor on the map but we were able to conduct quantitative analysis of the forward supply chain (paragraphs 3.16–3.22); training, simulator capacity and aircrew skills currency (paragraphs 2.31–2.34; 3.26–3.20); and the targets for the number of serviceable aircraft (paragraphs 2.26–2.29). This analysis enabled us to make a number of specific recommendations in the areas which are highlighted on the causal map.



APPENDIX THREE

Loss of Four Hercules

January 2005, Iraq

The aircraft was on a routine task from Baghdad International Airport to Balad. It crashed en route. The Department's Board of Inquiry concludeed that the aircraft crashed because it became uncontrollable after hostile ground-to-air-fire and the subsequent explosion was caused by the ignition of the fuel/air mix in the fuel tank. Ten servicemen died in the crash. The Coroner's Inquest has been adjourned until 30 September 2008.

May 2006, Afghanistan

The aircraft was on a routine task to deliver vehicles and personnel from Kabul International Airport to Lashkar Gah. Shortly after landing on a dirt airstrip, there was an explosion. The aircraft suffered damage to the main landing gear and the surrounding area. Debris punctured the fuel tanks causing a major fuel leak which then ignited. All passengers and crew were safely evacuated but the aircraft was destroyed in the fire. The Board of Inquiry concluded that the aircraft hit an anti-tank mine on landing.

February 2007, Iraq

The aircraft was on a routine task to transport personnel in the Maysan Province. It was damaged while landing on a makeshift landing zone at night, causing significant damage. The aircraft was destroyed by United Kingdom Forces to prevent sensitive equipment falling in to enemy hands. Two people suffered minor injuries. The Board of Inquiry reported in May 2008 and concluded that the damage was caused by explosive devices buried along the edge of the landing strip.

August 2007, Afghanistan

The aircraft, a specially modified Hercules, crash landed at night on an ad hoc airstrip in southern Afghanistan. As it was not possible to repair or recover the plane, all sensitive equipment was removed before the Royal Engineers blew it up. The Board of Inquiry has yet to report.

APPENDIX FOUR

Maintenance Case Studies

1 Figure 13 gives details of how long an aircraft in the fleet spend, in one year, on average, in the various states, for example, in maintenance, on operations and waiting spares. This appendix provides case study examples of what happens in one year, when a "J" and a "K" aircraft go into depth maintenance.

2 When a Hercules aircraft has an upgrade to its capability or undergoes deep maintenance, the work is contracted out to Marshall Aerospace in Cambridge under the Hercules Integrated Operational Support agreement. The aircraft is thus classified as being 'in depth' repair and not available. During such upgrades or maintenance there is a contracted number of days for the work plus an allowance for routine rectification, but additional work packages may have to be performed on the aircraft with approval from the Hercules Integrated Project Team. These are paid for in addition to standard maintenance packages stipulated under the Hercules Integrated Operational Support contract.

3 The additional work will fall into one of the following categories:

- Fatigue related work – this mostly relates to the Hercules C-130K fleet and results from hours flown and severity of flying.
- Minor Modification work – these are small changes or upgrades that are being funded as additional work rather than as upgrades in their own right.
- Emergent Rectification works – usually discovered during the repair or upgrade. If they have risen as a result of operations in Iraq or Afghanistan then the Department seeks additional funds from the Treasury.
- Additional discrete Maintenance packages – these are additional to minor or major maintenance and are often synchronised with a Hercules going into 'In Depth' to maximise availability.

To illustrate the types of additional work performed, an aircraft has been chosen from both the Hercules C-130K and J fleets for a more detailed examination of what occurred when they went in for repair.

Aircraft X

4 X is a Hercules C-130K aircraft which was deployed in Afghanistan and Iraq between April 2006 and January 2007. It had several short periods of repair at RAF Lyneham and a lengthy 'major' maintenance at Marshall Aerospace:

- June 2006 – unavailable for two weeks due to a lack of spare parts required for repairs;
- September 2006 – Base 1 service at RAF Lyneham for one week;
- January 2007 – post Afghanistan recovery and repair at RAF Lyneham;
- February 2007 – 'major' depth maintenance. To minimise the impact on availability the Department planned for Explosion Suppressant Foam to be installed by Marshall Aerospace at the same time.

Duration of work

5 According to the RAF Fleet Plan, a 'major' service is expected to last between 152 and 206 working days. This aircraft was released 13 days earlier than originally scheduled, despite the need for an additional 34 days of work to undertake substantial fatigue damage repair on the centre wing.

Additional work included with routine maintenance

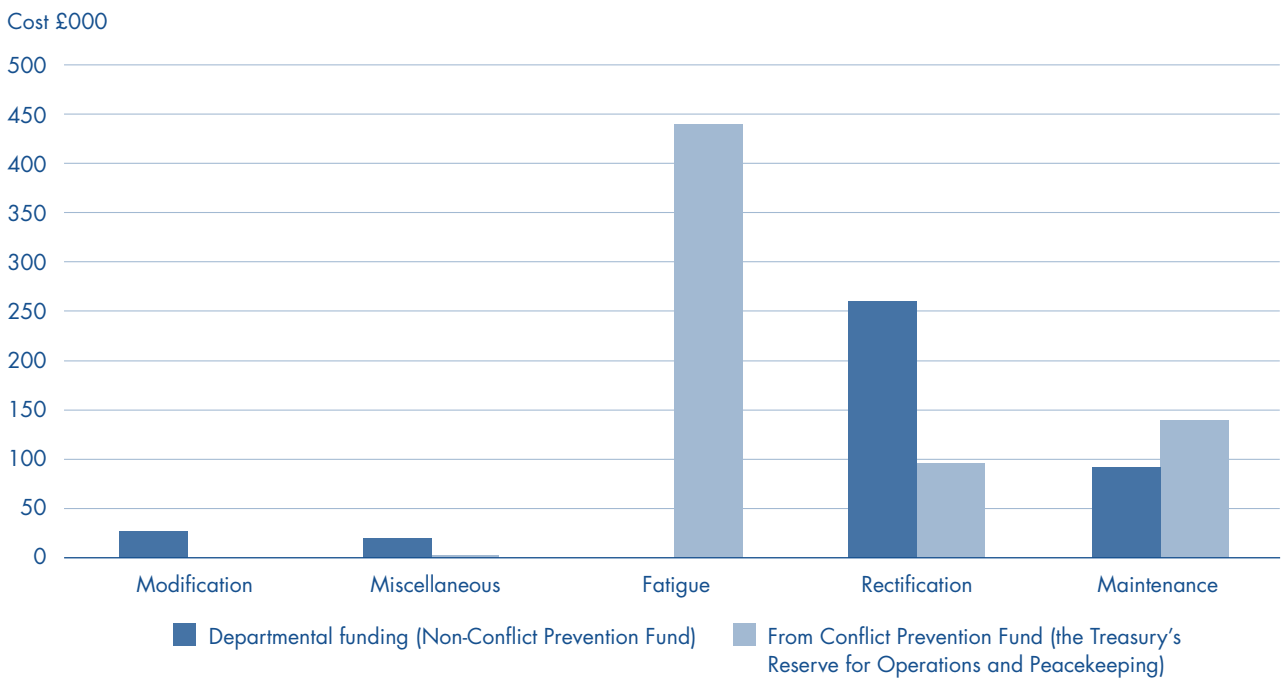
6 On Aircraft X in addition to the standard package of maintenance Marshall Aerospace undertook 89 other pieces of work, costing an extra £1.21 million. Labour costs were the largest factor, since the cost of additional materials was only £163,303. The work related to fatigue on the wings was the most costly repair overall; almost half of the additional total labour was required to conduct it and 20 per cent of the extra materials.

7 Rectification work required 30 per cent of labour, with the remaining hours spent on other maintenance and modification tasks. With regards to the cost of materials, rectification work accounted for 66 per cent of the total extra cost.

Impact of the hostile environment of operations in Iraq and Afghanistan

8 It is difficult to assess the impact of operations in Iraq and Afghanistan as data on this is not collected on a regular basis. We have used the funding sourced from the Treasury's Conflict Prevention Fund as an indicator of the work required as a result of operating in a hostile environment. **Figure 25** demonstrates the split between maintenance paid for by the Conflict Prevention Fund (now known as the Treasury's Reserve for Operations and Peacekeeping) and the Defence budget. It indicates 62 per cent (£0.7 million) of the work on this aircraft beyond that conducted on a standard scheduled maintenance was due to damage that occurred during operations in Afghanistan and Iraq.

25 Funding sources for types of repair undertaken on Hercules aircraft X



Source: National Audit Office analysis of Departmental data

Aircraft Y

9 Y is a Hercules C-130J aircraft and its flying tasks have included a mix of operational and non-operational flying with periods of maintenance at RAF Lyneham and Marshall Aerospace:

- April 2006 – Primary service at RAF Lyneham lasting 4 days;
- July 2006 – Upgrade;
- August 2006 – depth repair at Marshall Aerospace;
- December 2006 – return to the United Kingdom for post operations recovery at RAF Lyneham and another Primary service at the end of the month;
- February 2007 – return to RAF Lyneham for recovery work from operational service before re-deployment;
- April 2007 – return to RAF Lyneham for recovery work from operational service before re-deployment to operational tasks;
- May 2007 – 18 day Explosion Suppressant Foam Upgrade at Marshall Aerospace;
- September 2007 – 51 days 'minor' service and extended range voice communication systems upgrade at Marshall Aerospace.

Additional work included with routine maintenance and upgrade

10 The RAF estimates that a 'minor' repair package will take approximately 30 working days; however, this aircraft was scheduled to be in depth repair for 51 working days because of the additional work required for the extended range voice communication systems upgrade. There were also 35 additional pieces of work conducted during the maintenance period and 46 per cent of the cost was as a result of emergent rectification work. The total cost of the additional work was £309,293 and as the aircraft had undertaken non-operational tasks for the majority of the nine months before it went into depth repair, only 11 per cent of the expenditure was drawn down from the Conflict Prevention Fund.

11 While the aircraft was being fitted with Explosion Suppressant Foam, the Department took the opportunity to commission additional maintenance packages and underbelly protection work, which makes the airframe more capable of coping with the environment in theatre. Total costs, including royalties, for this additional work were £73,000 – 55 per cent of which were met through the Conflict Prevention Fund.

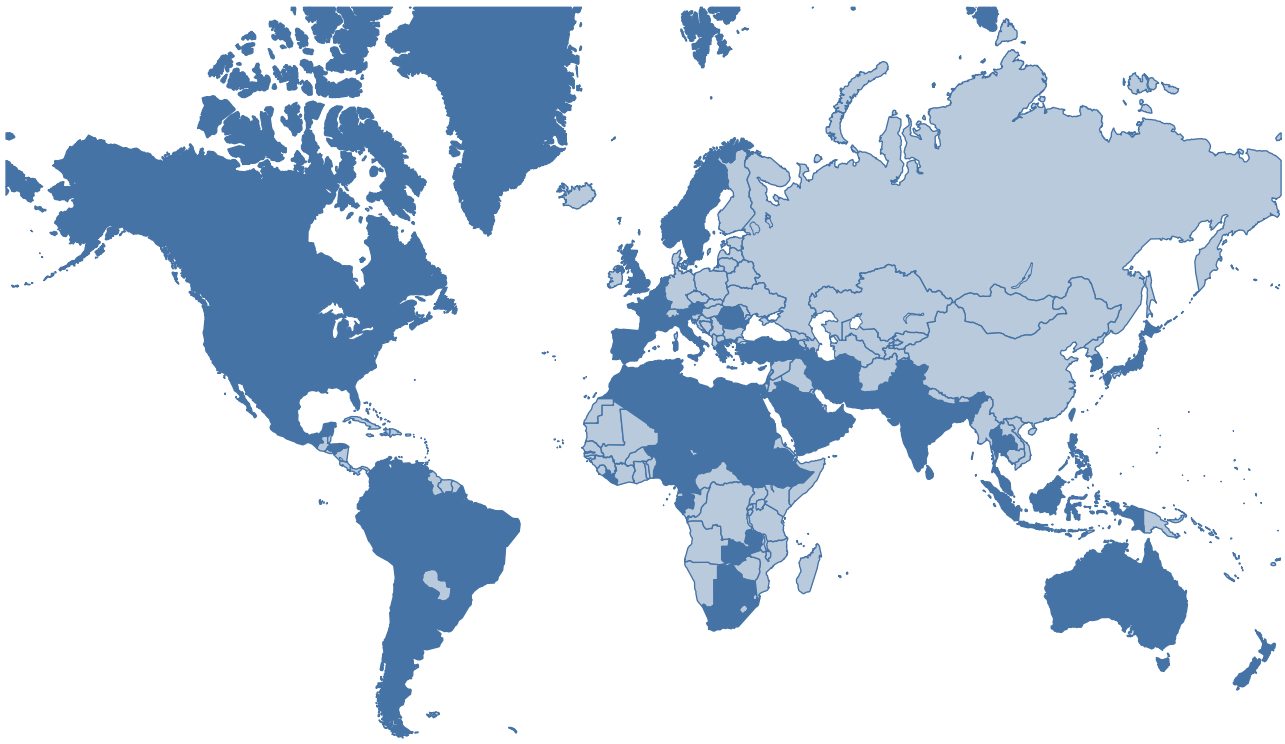
APPENDIX FIVE

International uses of Hercules

1 **Figure 26** shows the countries that operate variants of the Hercules C-130. Half of them face similar challenges to the United Kingdom in that their fleets are ageing and require upgrading and extensions to their service life. Some, like France and the United States of America are looking to acquire and bring other aircraft into service to provide tactical air transport.

2 The Hercules of the United States of America, Australia and France are involved in the North Atlantic Treaty Organisation mission in Afghanistan and the Americans and Australians are part of the Multi-National Force in Iraq. Similar to the United Kingdom they have more than one Hercules variant on operations and have problems with spare parts and fatigue. **Figure 27** summarises the findings of our research into the use of Hercules aircraft by these countries. It looks at the size of their fleets and the other transport aircraft they operate, and describes the key issues and future plans they have.

26 Worldwide operators of Hercules military aircraft



Source: National Audit Office

27 Hercules aircraft in the American, Australian and French Armed Forces

Country	Number and type of C-130	Other airlift assets	Uses of C-130	Issues and future plans
United States of America 	Approximately 700 C-130s including: 100 C-130 E 287 C-130 H 70 C-130J Tanker/Transit: 14 C-130H 6 C-130J 15 C-130N 23 C-130P 98 US Marine Corp 94 Specialist operations 10 Weather Reconnaissance	150 C-17 Globemasters 111 C-5 Galaxy	Primarily performs tactical tasks, such as transporting or air dropping troops and equipment into hostile areas. Variants have diverse roles, including Antarctic ice re-supply, medical missions, weather reconnaissance, fire fighting duties and natural disaster relief missions.	The Hercules C-130Es have been in service since the 1960s and the Department of Defense has been progressively modernising them. For example since 1994 there have been programmes to update avionics, self-protection and auxiliary fuel systems. The contract for the C-130 Avionics Modernisation Programme was signed in 2001 and will consolidate 13 systems into one core avionics suite. 222 aircraft will be modified and upgraded and crew training simplified. A second phase will address structural and engine upgrades, potentially involving more than 500 aircraft. Maintenance is undertaken by both service personnel and industry. Warner Robins Air Logistics Center is responsible for the repair, modification and overhaul of Hercules and it is currently reforming its repair practices to reduce the maintenance time and improve availability rates on the ageing fleets. The United States Air Force is currently seeking to enhance its heavy lift capability. It is aiming for a more robust and stealthy Hercules C-130 type aircraft with the ability to land on shorter strips, and perhaps have a vertical take off and landing capability. Construction of early prototypes could begin by 2012.
Australia 	Total: 20 C-130s 8 C-130Hs (4 were retired in November 2007) 12 C-130Js	4 C-17 Globemasters (fourth delivered in January 2008) 1 Boeing 707	Tactical and multi-role aircraft for operations but also provides long range support, search and rescue, medical evacuation.	Hercules C-130Hs have been in service for 30 years and were due to go out of service in 2008. Aircraft availability could be improved and now a major refurbishment of these aircraft to extend their life until at least 2020 is planned. This programme is likely to include structural upgrade and new avionics and electronic systems. Upgrades to self-protection systems to meet current operational requirements are underway. Maintenance is conducted on two levels – operational and deeper repair. Currently seven contractors, including Marshall Aerospace, work on the C-130J but the Department of Defence is negotiating a long-term contract (until their retirement in 2030) for a support package based on aircraft availability.
France 	Total: 14 C-130s 5 C-130Hs 9 C-130H30s	3 A310s and 2 A319s for heavy lift 53 C-160Rs 19 CN 235s	Air transport support for missions, i.e. strategic air transport to theatres, participation in manoeuvres within theatres.	Aircraft have been in service for an average of 26 years and there are upgrade programmes for avionics and self-protection systems. Maintenance is currently being rationalised – operational and industrial – similar to the United Kingdom's forward and depth repair construct. Deep maintenance is undertaken by a Portuguese company. Aircraft availability was as low as 48 per cent in 2002, but has improved to 68 per cent in 2006. The French have limited ability to lift large volumes or massive loads and so they have made extensive use of the other nations' spare airlift and charter. France plans to procure 50 A400M aircraft, bringing them into service in 2009.

Source: National Audit Office

GLOSSARY

Air Command	The RAF's single Command formed in 2007, with the merger of RAF's Personnel and Training Command and Strike Command.
Airlift Allocation Committee	A Tri-Service committee, chaired by Defence Supply Chain Operations and Movements, which determines which bids for airlift made by Departmental organisations can be satisfied by offers of aircraft from the RAF.
Air Logistics Programme Group	Covers all aircraft operated by the United Kingdom Armed Forces and takes a strategic overview of logistics and support. It considers a wide range of equipment, transformation programmes, personnel and infrastructure issues. A broad range of stakeholders from both the Department and defence contractors attend.
Annual flying hours	Currently 30,160 hours for the Hercules fleet which is divided between the C-130K and C-130J fleets on a 40:60 split respectively.
Available aircraft	Aircraft that are available to fly. It excludes all aircraft in depth repair.
Block Upgrade	Lockheed Martin's programme to upgrade the Hercules C-130J in capability blocks rather than undertaking piecemeal modifications. Block Upgrade 7.0 is critical in providing a baseline configuration for the conversion of a number of Hercules C-130Js to the specialist operations role.
Cannibalisation	Removal of a part from one aircraft, if there is no spare part ready to fit, to install it on another aircraft.
Capability upgrade/enhancement/ modification	The addition of equipment or software to enable the aircraft to perform new tasks or to perform existing tasks better, or to provide it with additional protection.
CATARA	Centralisation of Air Transport and Air to Air Refuelling Assets – an estate rationalisation programme which will relocate the Hercules C-130 fleet to RAF Brize Norton during 2011 and close RAF Lyneham by 2012.
Commitments Area Requirements and Availability of Air Transport Team	This forum manages the medium to long term prioritisation and use of the Hercules C-130 fleet and is chaired by Directorate of Joint Capability.
Conflict Prevention Fund (now known as Operations and Peace Keeping)	The Department, the Department for International Development and the Foreign and Commonwealth Office have objectives to reduce conflict around the world. The costs of overseas operations are not included in the forward estimates of the Defence Budget and the Defence Secretary has the right to a make claim on the Treasury Reserve for the net additional costs of deployment in an international crisis.

Defence Equipment and Support	This organisation equips the United Kingdom's Armed Forces for current and future operations. It acquires and supports through-life, including disposal, equipment and services ranging from ships, aircraft, vehicles and weapons, to electronic systems and information systems. It was formed in April 2007 with the merger of the Defence Procurement Agency and the Defence Logistics Organisation.
Defence Supply Chain Operations and Movements	This organisation tasks the movement of people and equipment worldwide for Defence.
Defensive Aids	A range of measures installed into the aircraft designed to defend from enemy fire, for example chaff and flares.
Design authority	The organisation which holds the intellectual property rights for the equipment.
Depth Repair	Maintenance that consists of the scheduled repair, partial or full reconditioning and modification of aircraft, requiring specialist skills and equipment.
Emergent work/rectification	Additional repair work found when the aircraft is stripped for depth repair.
Explosion Suppressant Foam	A foam which prevents over-pressure in fuel tanks which can be caused by sparks or shock resulting from ground or air fire.
Fatigue	Every time an aircraft is flown, the airframe is subject to stresses which cause localised structural damage known as fatigue. The greater the stresses applied to the airframe, the shorter the life of the aircraft. When an aircraft is introduced into service, a date for the end of its safe and useful life is set which reflects the predicted effect of fatigue.
Fit for Purpose	A percentage of the Forward Available Fleet – 80 percent of the Hercules C-130K, and 75 percent of Hercules C-130J. This percentage reflects a proportion of the fleet that is likely to need unscheduled maintenance at any one time.
Full Operating Capacity	A key milestone that refers to the successful delivery of what is considered to be the entire agreed capability.
Forward Available Fleet	Includes aircraft that are not in depth maintenance, preparation and recovery from operations and modifications or Urgent Operational Requirements and includes all aircraft available to fly, as well as those that are undergoing unscheduled maintenance (or rectification) and those awaiting spares or simply not worked.
Forward maintenance	Maintenance conducted out of depth in the forward environment at RAF Lyneham or on operations.
Frontline Command	Fleet (Royal Navy), Land (Army) and Air (RAF) Command.
Hercules Integrated Operational Support contract	A partnership between the Department and industry to provide depth maintenance. Marshall Aerospace, Lockheed Martin and Rolls-Royce are the industrial partners.
Hercules User Working Group	Considers risks to current and future availability of the Hercules fleet ranging from personnel to capability enhancements and the retirement of the Hercules C-130K.
HERMES	A project to convert a number of Hercules C-130J aircraft for specialist operations.
Initial Operating Capacity	A milestone in the delivery of a capability before it becomes fully into service and usually refers to the successful delivery of a specified capability or numbers of equipment.

Integrated Project Team	A team of civilian and military personnel responsible for maintaining an aircraft from concept to disposal. The Hercules Integrated Project Team is part of the Defence Equipment and Support.
Joint User Group	An international forum including the United Kingdom, Australia, Italy, Denmark and the United States. The Group acts as a collective customer for Lockheed Martin's programme to upgrade the Hercules C-130J in capability blocks rather than undertaking piecemeal modifications. The cost of core design and development work is shared in a ratio reflecting the number aircraft operated by all participants. The Group also helps with the exchange of good practice.
Movements Control Centre Europe	This organisation coordinates the use of any spare air and sea lift assets of 15 member nations using a system of credits and debits.
Preparation/Recovery	Maintenance required to prepare an aircraft to be deployed to theatre and repair damage caused while in theatre on its return to the United Kingdom.
Primary, Primary Star and Base 1	Basic scheduled maintenance that is conducted at RAF Lyneham.
Priming Equipment Packs	A selection of Hercules C-130 parts that require repair/replacement most frequently in the initial 30 days of operation.
Prime contractor	The contractor who has overall responsibility for coordinating and integrating the activities of a number of subcontractors; in the case of Hercules C-130, it is Marshall Aerospace.
Strategic airlift	Airlift that transports people and equipment long distances from the UK worldwide.
Strategic Mobility – Capability Planning Group	Manages capability across all environments, not just air. It draws together the stakeholders from the frontline, acquisition and research communities to support the Director of Equipment Capability for Expeditionary Logistics Support in planning the Equipment and Equipment Support elements of the Defence Programme.
Supply chain	The policies, processes and activities associated with the receipt of stock from industry to their delivery to the unit from where demand came from (for example RAF Lyneham) and the return loop.
Tactical airlift	Airlift that transports people and equipment short distances usually intra-theatre.
Underbelly Protection	Work that strengthens the under carriage of the Hercules C-130 providing additional protection when landing on unpaved strips.
Urgent Operational Requirement	A requirement for the rapid procurement of capability to support military operations.

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Hercules C-130 Tactical Fixed Wing Airlift Capability

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