



National Audit Office

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## **Report**

by the Comptroller  
and Auditor General

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## **Ministry of Defence**

# Investigation into equipment cannibalisation in the Royal Navy

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Ministry of Defence

# Investigation into equipment cannibalisation in the Royal Navy

Report by the Comptroller and Auditor General

Ordered by the House of Commons  
to be printed on 30 October 2017

This report has been prepared under Section 6 of the  
National Audit Act 1983 for presentation to the House of  
Commons in accordance with Section 9 of the Act

Sir Amyas Morse KCB  
Comptroller and Auditor General  
National Audit Office

26 October 2017

Cannibalisation involves removing a working part from one piece of equipment, such as a ship or submarine, to put it into another that is in greater operational need. The Ministry of Defence recognises the adverse impact of cannibalisation and we have previously recommended that it is monitored and controlled. Tight budgetary constraints increase the risk of parts not being available, and therefore of cannibalisation. This investigation outlines when, why and how cannibalisation occurs across the Royal Navy and its impact.

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## **Investigations**

We conduct investigations to establish the underlying facts in circumstances where concerns have been raised with us, or in response to intelligence that we have gathered through our wider work.

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## Key facts

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**3,230**

instances of ship and submarine cannibalisation, April 2012 to March 2017

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**49%**

increase in cannibalisation, April 2012 to March 2017

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**0.3%–1.4%**

percentage of all parts provided by DE&S that were cannibalised across the main ship and submarine types, April 2012 to March 2017

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**26%** instances where the same part was cannibalised three or more times

**71%** percentage of cannibalised parts valued at less than £5,000, April 2012 to March 2017

**59** average number of cannibalisations per Astute-class submarine in 2016-17

**£92 million** estimated maritime support funding removed in-year from 2015-16 and 2016-17 budgets that could increase the need to cannibalise parts

**34%** part demands past their required delivery date with no forecast due date for their receipt

**21%** shortfall in trained and qualified staff within Defence Equipment & Support (DE&S) navy supply teams

**5%** percentage of part demands where parts identified as obsolete

# Summary

## What this investigation is about

**1** The Royal Navy (the Navy) operates ships, submarines and helicopters to meet the United Kingdom's defence requirements. These typically comprise complex mechanical and electrical engineering systems made up of thousands of parts. The Navy needs additional parts to maintain and repair its equipment. This could be for scheduled maintenance or where it needs to unexpectedly fix equipment if it breaks, or following an accident, which cannot always be planned for.

**2** How ships and submarines source parts will depend on whether they are operating at sea, or undergoing maintenance in the dockyard, and on the type of support solution put in place by Defence Equipment & Support (DE&S), a bespoke trading entity and arm's-length body of the Ministry of Defence (the Department). The support solution will be influenced by the Department's decision on how to balance investing in spares upfront against not doing so and managing the resultant risks.

**3** When vessels require parts that are unavailable, the Department can authorise that they are taken from other equipment – a process known as cannibalisation. In some circumstances, cannibalisation can be the most effective way to keep vessels' operational or maintenance schedules on track. It can, for example, be a necessity during periods of high-intensity operations.<sup>1</sup> However, it can also lead to increased costs and disruption, divert resources from other activities and create additional technical and financial risks. In the past, we have recommended that the Department should carefully monitor and control the use of cannibalisation.<sup>2</sup>

**4** Evidence gathered during past National Audit Office (NAO) work suggests that cannibalisation has become more common. This increase comes at a time when funding for spares has reduced across all the Armed Forces. The risk of cannibalisation has increased further with reductions in fleet sizes meaning the Armed Forces have limited alternative equipment to deploy. Introducing new ships and submarines also creates greater uncertainty over how equipment will operate and means less information is available to help make decisions on the appropriate support solution and investment. The Department has also increasingly relied on contracted rather than in-house support.

<sup>1</sup> Comptroller and Auditor General reports: *Operation TELIC – UK Military Operations in Iraq*, Session 2003-04, HC 60, National Audit Office, December 2003; *Support to high-intensity operations*, Session 2009-10, HC 508, National Audit Office, May 2009.

<sup>2</sup> Comptroller and Auditor General reports: *Transforming logistics support for fast jets*, Session 2006-07, HC 825, National Audit Office, July 2007; *Operation TELIC – UK Military Operations in Iraq*, Session 2003-04, HC 60, National Audit Office, December 2003.

5 Cannibalisation occurs across all the Armed Forces but our recent work has identified specific examples within the Navy, which explains the focus of this investigation. As cannibalisation becomes more frequent, its causes and consequences need to be fully understood. This investigation describes:

- cannibalisation across the Navy;
- the use and impact of cannibalisation; and
- how the Department manages cannibalisation and its causes.

6 This investigation was prepared against a background of wider concerns about the affordability of the Department's equipment and support plans, and consideration of the forthcoming changes to how the Navy will operate as vessels such as the new aircraft carriers are brought into service.<sup>3</sup> The investigation does not focus on inventory or supply chain management. We conducted fieldwork between April and June 2017. We carried out more detailed work on those ships and submarines experiencing the most cannibalisation – Astute-class submarines, Type 45 Destroyers and Type 23 Frigates. These complex vessels represent a core element of the Navy's operational capability. Unless otherwise stated, data analysis covers the period April 2012 to March 2017.

## Key findings

### Use of cannibalisation

7 **Cannibalisation can be necessary but should only happen when no other solution is available.** Cannibalisation involves removing a working part from a vessel or aircraft to install it on other equipment in greater need. The Department's guidance states "cannibalisation will only be conducted where no other solution is available". Decision-makers consider operational priorities and the estimated time to obtain new parts. In the past five years, between 0.3% and 1.4% of parts provided to the main classes of ships and submarines have been cannibalised parts. However, each instance has a wider impact beyond the part being replaced and can signify broader issues with the process for obtaining spare parts (paragraphs 1.2 to 1.6).

8 **Across ships and submarines, cannibalisation has increased 49% in the past five years, with a total of 3,230 instances involving 6,378 parts.** During 2016-17, there were 795 instances of cannibalisation. This equates to 66 instances a month, compared with 30 a month in 2005. Since 2004, the Navy has reduced its fleet of ships and submarines 31% from 127 to 87, meaning that a higher proportion needs to be deployed, or ready to deploy, at any one time in order to meet defence requirements. In 2016-17, ship and submarine cannibalisation accounted for 60% of instances across the Navy. Navy Merlin helicopters make up the remaining 40% (paragraphs 2.1 to 2.4).

3 Comptroller and Auditor General reports: *The Equipment Plan 2016–2026*, Session 2016-17, HC 914, National Audit Office, January 2017; *Delivering Carrier Strike*, Session 2016-17, HC 1057, National Audit Office, March 2017.



**9 Some 40% of ships and submarines receiving cannibalised parts**

**needed them so they could be ready for operations or training.** In these cases, cannibalisation rectified issues that would have reduced the operational capability of ships and submarines. The remaining 60% of ships and submarines did not need the parts for operations or training. Instead, in some cases the parts were required to complete planned maintenance work to a specified schedule so as to avoid potential delays and additional costs (paragraphs 2.7 and 2.8).

**10 Both older and newer classes of ships and submarines have required cannibalised parts.** In particular:

- **new Astute-class submarines** experienced the highest average number of cannibalisations across ships and submarines, with 59 instances per submarine. They also experienced more defects than older equipment, with a third of these defects resolved through cannibalised parts (paragraph 2.5).
- **older Type 23 Frigates** experienced an average of 17 cannibalisations per ship in 2016-17. As technology progresses and equipment gets older, parts can be more difficult to obtain. During 2016-17, 5% of parts requested through DE&S, part of the Department, have consistently been identified as obsolete (paragraphs 2.5 and 3.7).

**11 Our analysis shows 71% of parts cannibalised on the basis of operational need were low-value, but the cost of moving the parts could be much greater.**

Our analysis shows that the majority of cannibalised parts cost less than £5,000, with less than 1% valued at more than £500,000. The Department does not know how often the cost of replacing cannibalised parts exceeds the value of the part being replaced. Departmental analysis, covering 146 Type 23 Frigate cannibalisations in 2012, showed that in 50% of these cases, the cost of cannibalisation was equal to, or greater than, the value of the part. In 25% of cases it was four times greater. Even though cannibalisation has increased, the Department has not updated or broadened its analysis (paragraph 2.16).

## Managing cannibalisation and its impact

**12 The need for cannibalisation is exacerbated by both a lack of information about when parts will be delivered, and delays in receiving parts on time.**

In March 2017, the DE&S Ships Operating Centre met 55% of part demands from ship and submarine crews by the required date (target 75%). The Submarine Operating Centre met 63% of demands (target 80%). At the same point, of 17,038 ship part demands already past their required delivery date, 34% had no recorded forecast delivery date. Identifying a forecast delivery date can be more difficult where the Department has contracted-out support arrangements. The Department has undertaken a number of initiatives to improve ship and submarine supply chain management (paragraphs 3.9 and 3.10).

**13 The Department does not routinely monitor the use, causes and impact of cannibalisation across the Navy.** The Department considers and assesses cannibalisation and trends over time for individual vessel types. There is no overall accountability for managing cannibalisation across the Navy or routine data collection or analysis assessing why cannibalisation occurs or its impact. This information gap makes it difficult to determine when cannibalisation is becoming more routine, its underlying causes, and the trade-offs between cost savings and cannibalisation (paragraphs 3.1 to 3.4).

**14 The Department has taken decisions to reduce support without complete information to fully assess and manage the impacts and costs.** In the past two years, the Navy has removed an estimated £92 million from its maritime support in-year budgets, 34% of the total £271 million maritime support budget cuts, which could then increase the need to cannibalise parts. In particular, the Department decided not to invest in complete technical documentation or in fully cataloguing parts when vessels are brought into service. Of Type 45 Destroyer parts cannibalised, 42% were not catalogued, making it difficult to identify and obtain the required parts and increasing the likelihood of further cannibalisation. As of March 2017, the Astute-class submarine production programme had not committed £137 million of approved support funding (paragraphs 3.12 to 3.14).

**15 Each instance of cannibalisation can delay programmes, create additional engineering risks and add to the work of staff, affecting morale.** Cannibalisation has a number of impacts the Department needs to manage including:

- **programme delays:** In the past five years, the number of cannibalisations from the Astute-class submarine production line increased 43%, from 77 instances in 2012-13 to 110 in 2016-17. Cannibalisation caused a 42-day delay and led to the Department having to pay an additional £4.9 million in relation to HMS Artful (Boat 3), and has also affected other boats (paragraph 2.17);
- **engineering risk:** Cannibalised parts, along with additional parts that must be removed to gain access to them, may be damaged while being removed, transported or reinstalled. An estimated 11% of the parts recorded by ships as having shortcomings in their material, design or documentation were cannibalised (paragraph 2.12);
- **testing:** As well as additional work to remove cannibalised parts, engineers need to test systems on both the donor and recipient equipment, reducing the time available for routine maintenance (paragraph 2.12); and
- **people:** The 2017 Navy risk register identified a lack of spare parts as a risk to operational capability given its demoralising effect on personnel (paragraph 2.13).

# Part One

## What is cannibalisation?

### Definition

**1.1** The Royal Navy (the Navy) manages complex equipment such as ships, submarines and helicopters. It needs to ensure certain equipment is operational, available for training or ready to be deployed at any time. Defence Equipment & Support (DE&S) manages projects to buy and support all the equipment and services of the Armed Forces. In doing so, it held parts valued at £2.7 billion for ships and submarines in March 2017 and manages contracts to obtain required parts.

**1.2** Sometimes equipment engineers may require a part that is not in stock or cannot be provided quickly enough through the established supply process. In such cases, the Ministry of Defence (the Department) may choose to remove the part from other equipment. This is known across the Armed Forces as cannibalisation, or also as 'store robbing' within the Navy.<sup>4</sup>

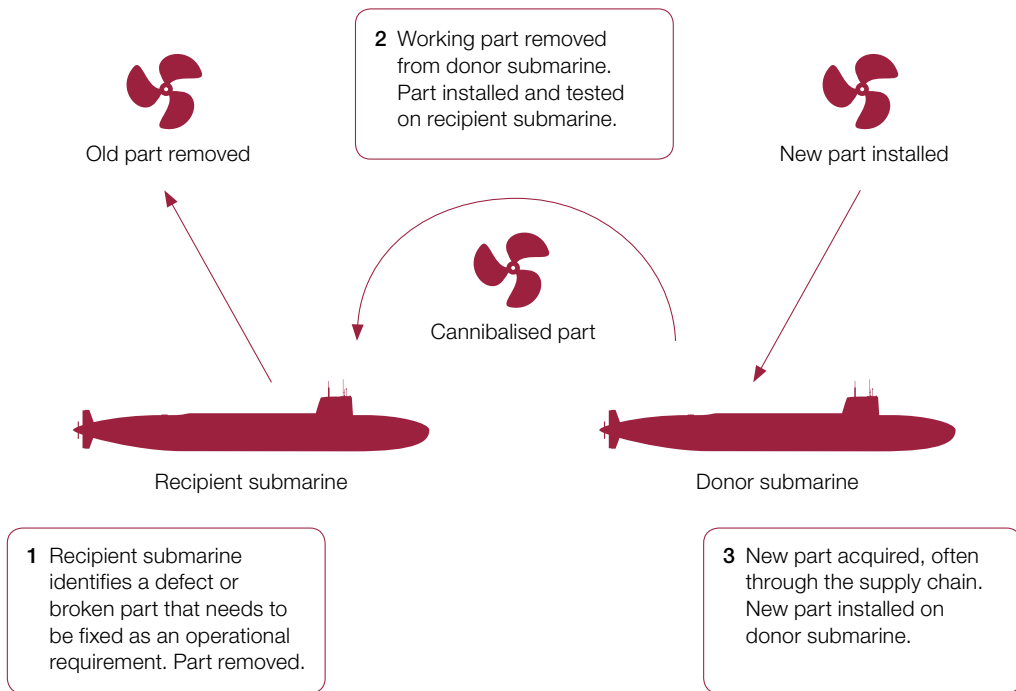
**1.3** Cannibalisation involves removing parts from a vessel or aircraft (the donor) that is operational, in maintenance or in production, and transferring them to another vessel or aircraft (the recipient) (**Figure 1** overleaf). It could involve moving an interchangeable part or more complex components through:

- isolating the part from the donor's systems to ensure safety;
- ensuring back-up systems function fully to ensure vessel or aircraft integrity;
- removing other parts, such as valves and casing, to access the part;
- removing other systems and equipment to clear a route to move the cannibalised part;
- physically moving the part to, for example, the dockside (which may require a crane) and packaging it to prevent damage during transit; and
- dispatching the part to the recipient, which may be in the same location or elsewhere.

<sup>4</sup> The *Defence Logistics Framework* describes store robbing as happening "on Royal Navy units when all normal sources of supply have failed and it becomes necessary to remove materiel from one unit to satisfy the priority needs of another unit".

**Figure 1**  
Cannibalisation process

Cannibalisation involves removing parts from donor equipment and transferring them to a recipient



**Note**

1 Similar processes are undertaken for all Navy equipment in operational use, maintenance or production.

Source: National Audit Office

**1.4** The recipient’s engineering team will then repeat this process, while the donor will be left with a defect. If the part remains unavailable when the donor requires it, for example to become operational or undergo specific maintenance, the cannibalisation process may have to be repeated. We found eight instances of the same type of part being transferred between the same type of ship or submarine at least five times (see paragraph 2.9).

## Deciding when to cannibalise

**1.5** Previous National Audit Office reports have recognised that some cannibalisation is to be expected, for example, during intense periods of operations (Appendix Two). However, the Department's guidance, as set out in its *Defence Logistics Framework*, is that cannibalisation should only be "used if no other solution is available due to the risk of damage to equipment components".

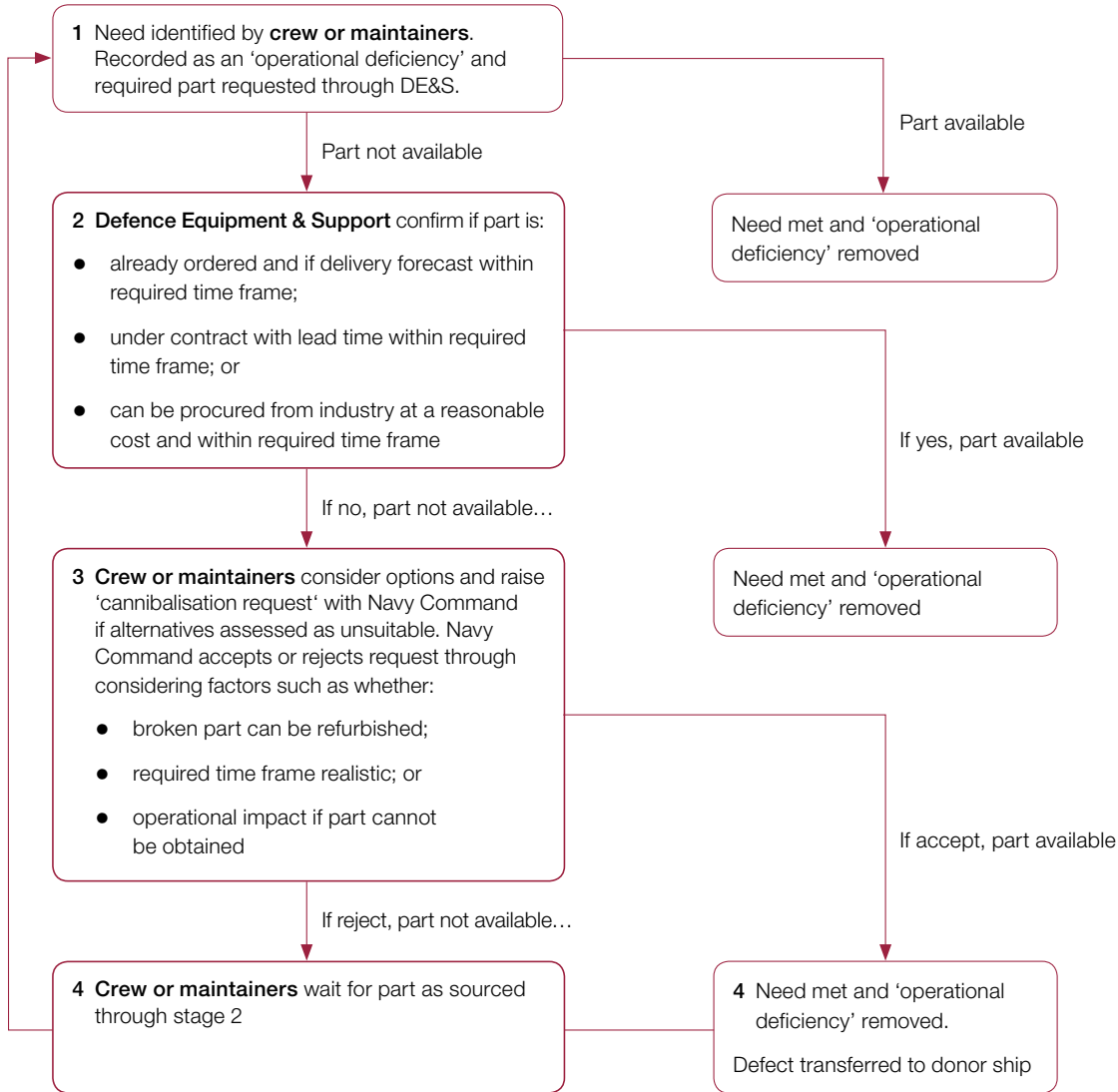
**1.6** The Department has a formal decision-making process relating to cannibalisation across the Armed Forces as set out in the Framework (**Figure 2** overleaf). Decision-makers make judgements by balancing:

- the priority and nature of requests;
- the appropriateness of alternatives such as reduced capability, fixing or manufacturing the part; and
- the estimated time to obtain parts and the impact on the fleet's operational requirements.

Based on our review of 10 cannibalisation decisions made in the past five years, it took four days on average to approve the cannibalisation following a request.

**Figure 2**  
Cannibalisation decision-making process

The Department’s guidance is for cannibalisation to “only be used if no other solution is available”



**Note**

1 Similar processes are undertaken for all ships and submarines whether they are in operational use, maintenance or production.

# Part Two

## Use and impact of cannibalisation

### Instances of cannibalisation

**2.1** In the past five years, the Royal Navy (the Navy) cannibalised its ships, submarines and helicopters 6,122 times, with 1,329 instances in 2016-17 (**Figure 3** overleaf).<sup>5</sup> In 2016-17, some 60% of the cannibalisations were of ships and submarines, the main focus of this report. The remaining 40% were of Merlin helicopters used by the Navy. The Ministry of Defence (the Department) told us it expected to cannibalise aircraft more often than ships and submarines as there are more aircraft, often co-located together, to cannibalise and their parts are more easily exchanged due to greater equipment standardisation.

### Ships and submarines

**2.2** Cannibalised parts constituted less than 1% of all parts issued by the Ships Operating Centre in Defence Equipment & Support (DE&S) in 2016-17, ranging from 0.3% to 1.4% across the main ship and submarine types (Figure 3). However, each instance has a wider impact beyond the part being replaced and can signify broader issues with the process for getting spare parts.

**2.3** Cannibalisation has become a more routine part of equipment support. In five years, ship and submarine cannibalisation increased by 49% to 795 instances in 2016-17, with 3,230 instances involving 6,378 parts over the period (**Figure 4** on pages 16 and 17). This equates to 66 instances per month, compared with 30 a month in 2005.<sup>6</sup> Over this period, the Navy has reduced its fleet of ships and submarines by 31%, from 127 in 2004 to 87 in 2016.<sup>7</sup> This means that it now needs to have a higher proportion of each vessel type ready to operate at any given time and reduces the likelihood of alternative vessels being available when equipment breaks.

<sup>5</sup> Does not include Wildcat helicopters.

<sup>6</sup> Comptroller and Auditor General, *Assessing and Reporting Military Readiness*, Session 2005-06, HC 72, National Audit Office, June 2005.

<sup>7</sup> Covers submarines, Royal Fleet Auxiliary and ships including mine-sweeping vessels, in-shore patrol craft, Type 23 Frigates and Type 42 Destroyers.

**Figure 3**  
Breakdown of Navy cannibalisations, April 2012 to March 2017

In the past five years there has been a 49% increase in cannibalisation among ships and submarines

	April 2012 to March 2017				2016-17			
	Number in fleet	Instances of cannibalisation	Change 2012-13 to 2016-17 (%)	Number of parts cannibalised	Instances of cannibalisation	Average per vessel/aircraft in-year	Average days between instances	Cannibalisations as percentage of parts issued (%)
Type 23 Frigates	13	1,005	7	1,413	224	17	1.6	0.7
Astute-class submarines	3	551	107	2,120	178	59	2.1	1.9
Type 45 Destroyers	6	532	217	701	133	22	2.7	1.1
Mine-sweeping vessels	15	378	10	488	90	6	4.1	0.5
Vanguard-class submarine	4	279	234	694	97	24	3.8	0.4
Trafalgar-class submarines	4	206	-31	425	27	7	13.5	0.2
Other	42	279	5	537	46	1	7.9	0.1
<b>All vessels</b>	<b>87</b>	<b>3,230</b>	<b>49</b>	<b>6,378</b>	<b>795</b>	<b>9</b>	<b>0.5</b>	<b>0.6</b>
<b>Merlin helicopters</b>	<b>55</b>	<b>2,892</b>	<b>-27</b>	<b>n/a</b>	<b>534</b>	<b>10</b>	<b>0.7</b>	<b>n/a</b>

**Notes**

- 1 'Mine-sweeping vessels' include single-role minehunters and mine counter-measures vessels. 'Other' includes landing platform docks, Royal Fleet Auxiliaries and those not labelled. Merlin includes Mk2 and Mk3 helicopters. Data do not include any cannibalisations to or from the Queen Elizabeth carrier or Wildcat helicopters.
- 2 Astute-class submarines increased from two in 2012-13 to three in March 2015-16. In July 2016, one submarine was damaged in a collision. Type 45 Destroyers increased from three in 2011-12 to five in 2012-13 and six in 2013-14. Trafalgar-class submarines decreased from five to four in 2014-15. The number of Type 23 Frigates and Vanguard submarines remained constant over the period.

Source: National Audit Office analysis of Ministry of Defence data



**2.4** Around half of cannibalisation instances where data are available (49% of 2,472), have been one-offs. More than a quarter (26%) involved parts cannibalised at least three times. The Department did not have data for 758 of the total 3,230 cannibalisation instances.

**2.5** Cannibalisation affects both new equipment, such as Type 45 Destroyers, and older equipment such as Type 23 Frigates. The Department told us it is not always possible to fully understand a vessel's support requirements when it is brought into service and requirements can be harder to predict. During 2016-17, Type 45 Destroyers experienced an average of 22 instances per ship, compared with 17 for the older Type 23 Frigates. Astute-class submarines experienced the highest number of cannibalisations; an average of 59 instances per submarine, equating to a part being removed or installed once every two days. In the past five years, the three in-service Astute-class submarines had 506 defects, with 28% of the 313 resolved defects in 2016-17 fixed through cannibalisation, and the remainder by sourcing parts from the supply chain. An average 1.4% of parts issued to Astute-class submarines involved cannibalised parts compared with 0.4% across all ships and submarines.

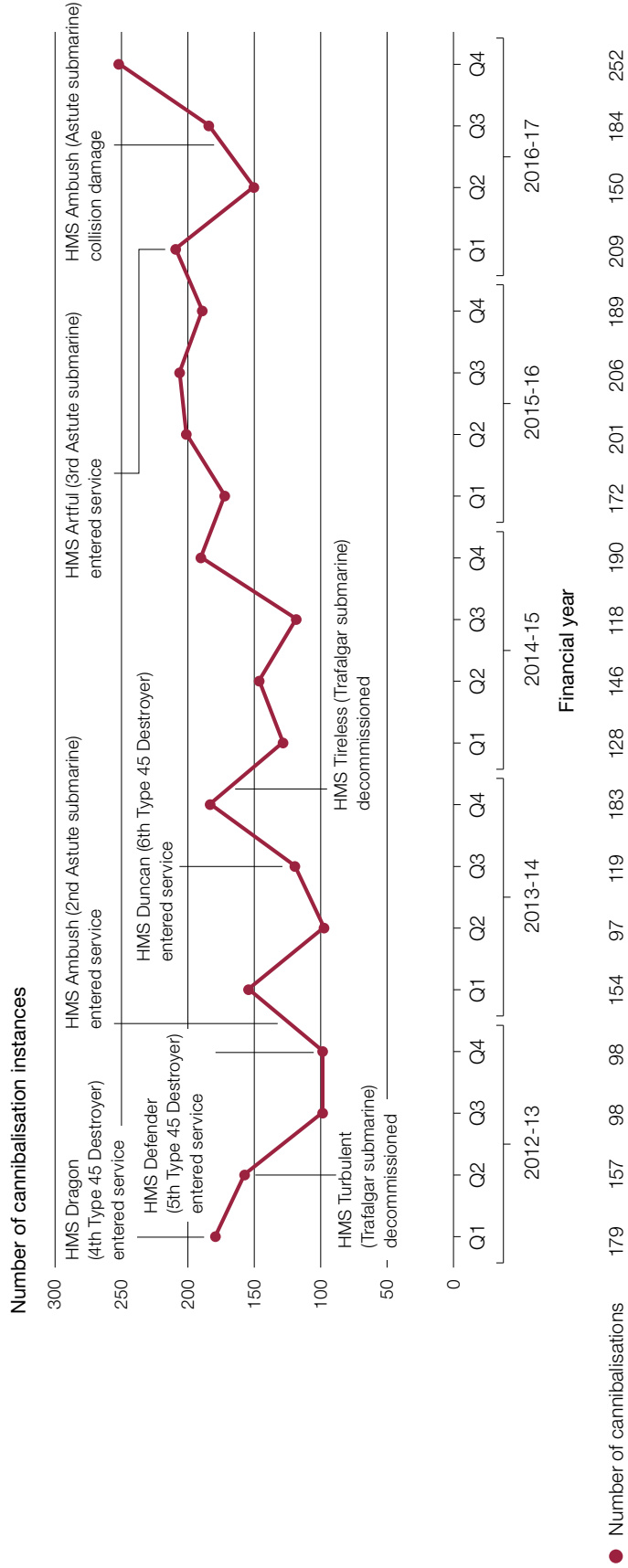
### Merlin helicopters

**2.6** The Navy uses Merlin helicopters for several tasks, including anti-submarine warfare and transporting marines. Over five years, Merlin cannibalisation fell 27% to 534 instances in 2016-17. However, as fewer aircraft and trained aircrew led to a 33% reduction in Merlin fleet flying hours over this period, the number of cannibalisations per 100 flying hours increased 14% from an average of 5.4 in 2012-13 to 6.2 in 2016-17 (Figure 4 overleaf). The Department uses this latter metric to assess cannibalisations across the Merlin fleet. The rest of this report focuses on ship and submarine cannibalisation.

**Figure 4**  
Cannibalisation trend across Navy equipment, April 2012 to March 2017

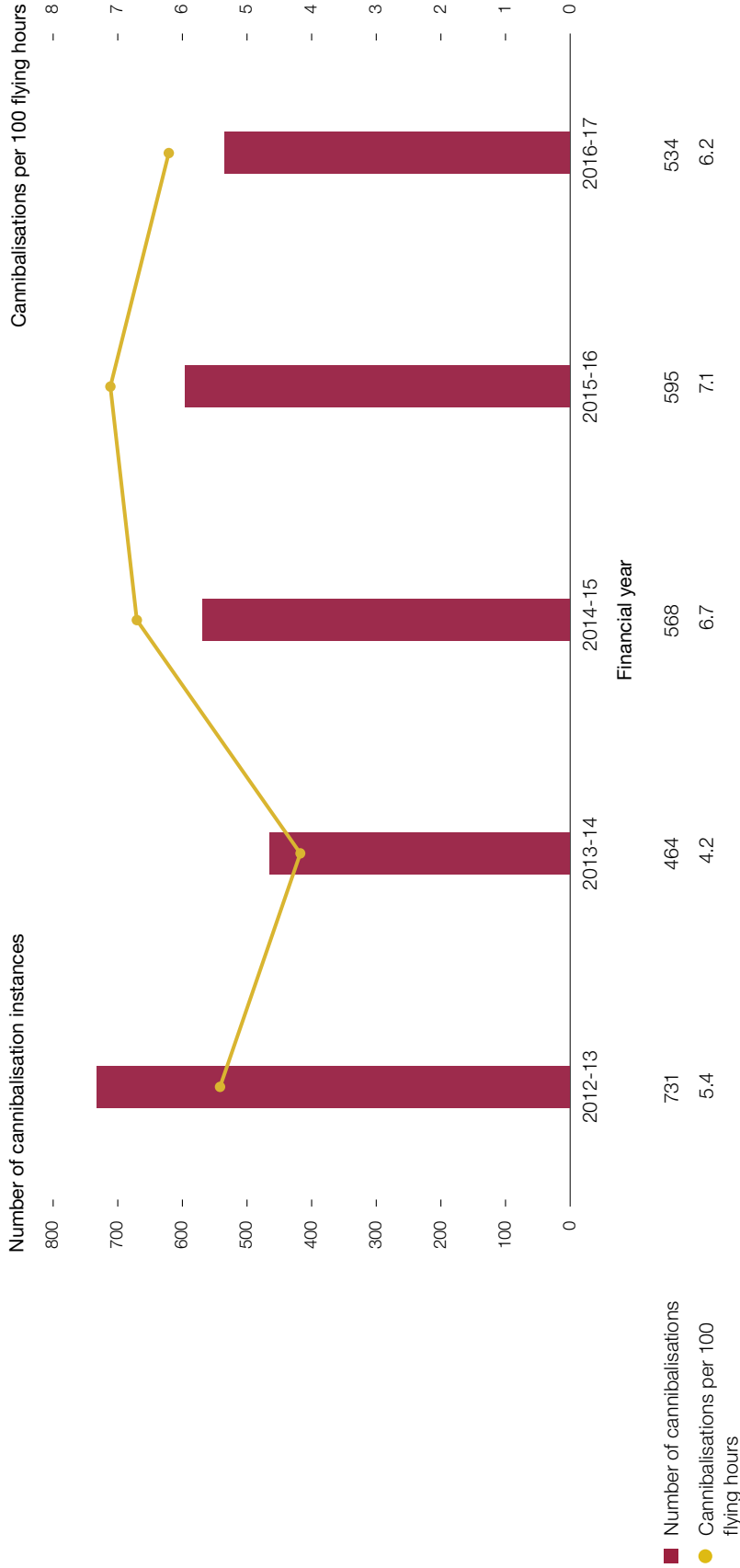
**Ships and submarines**

Ship and submarine cannibalisations increased over the period



**Merlin Helicopters**

Over the past five years, the overall number of cannibalisations per year has fallen but the rate of cannibalisations per 100 flying hours has increased



**Note**

1 This does not include Merlin aircraft stripped of parts prior to entering maintenance or unauthorised ship and submarine cannibalisations.

Source: National Audit Office analysis of Ministry of Defence data

## Impacts of cannibalisation

### Capability

**2.7** When deciding whether to cannibalise parts, the Department considers factors such as operational requirements and the time taken to obtain parts. Over the five-year period, some 40% of recipient ships and submarines were classed as immediately needing parts so as to be ready for operations or training for operations (**Figure 5**).

**2.8** The remaining 60% of recipient ships and submarines did not need parts for operations or training as they were, for example, in maintenance. In these cases, cannibalisation can help the Navy meet planned maintenance schedules or ensure that ships and submarines re-join the fleet on time. The proportion of recipients requiring parts to complete planned maintenance work has increased consistently from 27% in 2013-14 to 89% in 2016-17.

**2.9** Cannibalisation also affects the donor equipment. In line with the Department's guidance, almost all donor vessels (99%) were classed as at a lower or the same state of readiness as the recipient. The donor must replace the cannibalised part, along with other parts removed during the process, in one of two ways:

- **Through the supply chain**

Departmental guidance requires the donor to request the cannibalised part given the recipient's request will cease once they receive the cannibalised part. Guidance does not require those making the cannibalisation decision to consider the subsequent support solution.

- **By cannibalising other equipment**

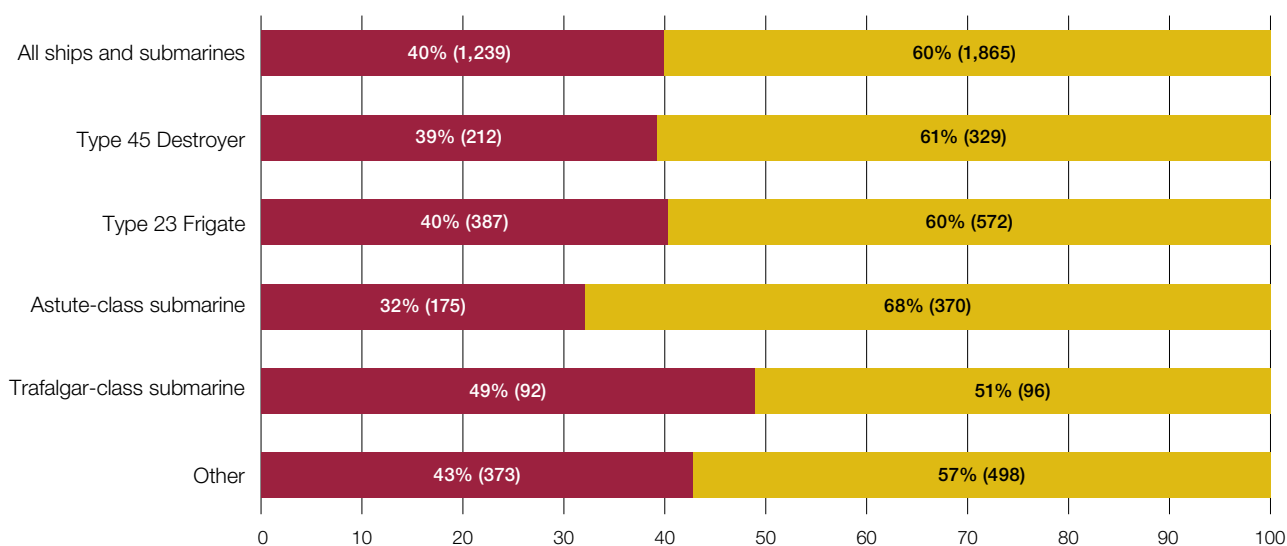
We identified eight instances of the same type of part being transferred between the same type of vessel at least five times (**Figure 6** on page 20). For example, the circuit card assembly for the torpedo launch system, which costs £6,750, has been cannibalised 26 times across 12 Type 23 ships. Reductions in the number of Type 23 ships mean defects need to be fixed rather than using a different ship.

**Figure 5**

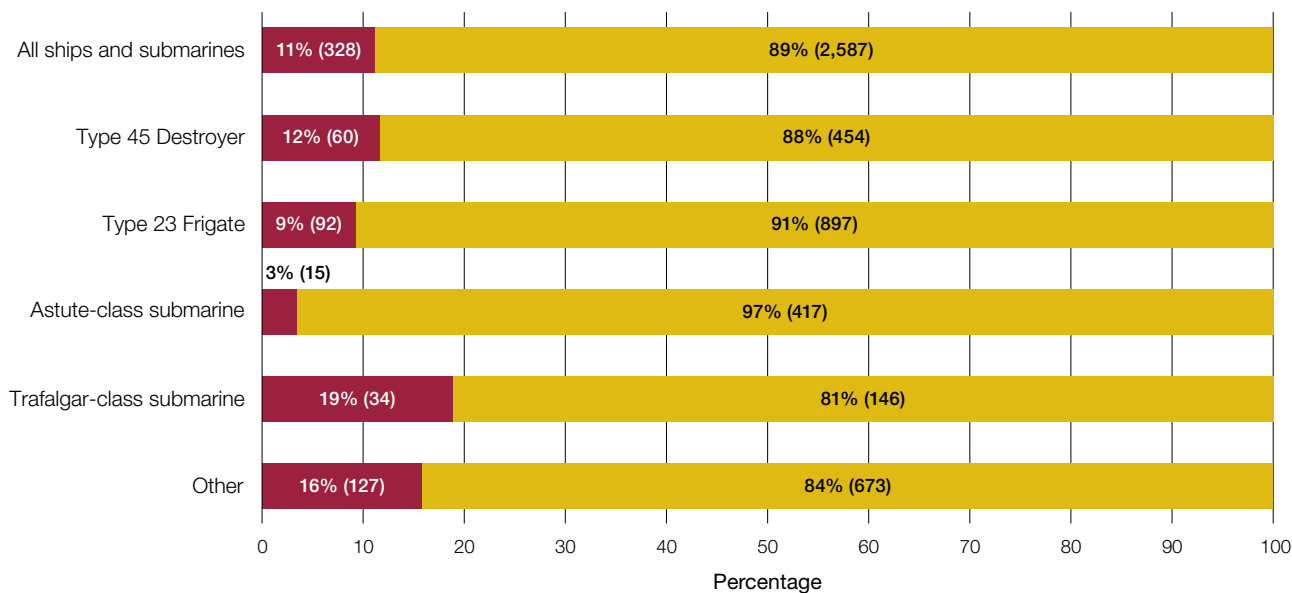
Readiness of donor and recipient ships and submarines by class, April 2012 to March 2017

**Most recipient and donor ships and submarines have been classified as 'low readiness'**

## Status of recipient



## Status of donor



- High readiness
- Low readiness

**Notes**

- 1 'High readiness' refers to ships and submarines that are either on, or due to embark shortly on, operations or required for training. 'Low readiness' refers to ships and submarines requiring parts, which are often in maintenance.
- 2 Readiness data on recipients were available in 3,105 from 3,230 instances. Data on donors were available in 2,915 from 3,230 instances.
- 3 'Others' include Vanguard-class submarines, single-role minehunters, mine counter-measures vessels and Royal Fleet Auxiliaries.
- 4 The data refer to the number of instances of cannibalisation occurring on classes of ships and submarines.

Source: National Audit Office analysis of Ministry of Defence data

**Figure 6**

Parts most often repeatedly transferred across ships and submarines of the same class, April 2012 to March 2017

**Some parts have been repeatedly cannibalised**

Part	Occurrences	Value (£)
Magazine torpedo launch system circuit card assembly	26	6,750
Chemical agent monitor	8	n/a
Perkins marine engine generator	8	219,956
Machine control and surveillance system display screen	6	16,793
Command support system interface	5	n/a
Low voltage electrical generator	5	286,129
Alternating current motor	5	n/a
Multi-functioning radar circuit card assembly	5	n/a

**Notes**

- Shows where a ship or submarine has both received and donated an item with the same stock number and where the number of transfers between vessels exceeds five. The Department does not have data to show whether the exact same part has transferred.
- The Navy needs the magazine torpedo launch system, procured in the 1980s, until the Type 23 Frigate leaves service in 2036. It is currently considering funding a system upgrade given significant obsolescence issues.

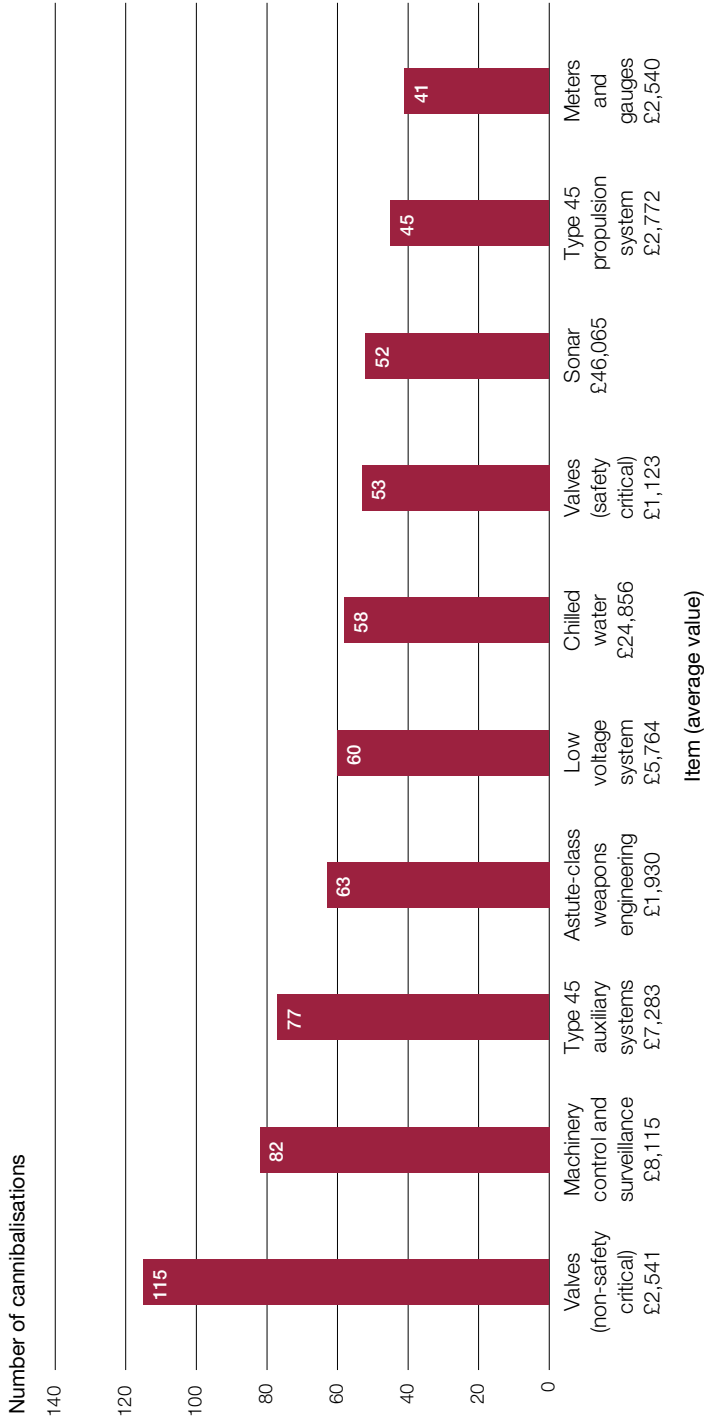
Source: National Audit Office analysis of Ministry of Defence data

**2.10** Cannibalisation can also affect scheduled maintenance by displacing other work or extending the time taken to return vessels into service. For submarines, the Department requires contractors to set out maintenance work at least six months in advance. Unexpected changes, such as those resulting from a part being cannibalised, will affect the timing, sequence and extent of maintenance. A quarter of the defects arising during HMS Ambush's recent maintenance resulted from parts having been cannibalised. As the Department originally expected to complete its routine maintenance by March 2018, later than other submarines, HMS Ambush was cannibalised 43 times to support those submarines with a higher operational need. Following a change in the maintenance programme, which meant it had to complete its maintenance earlier, HMS Ambush had to request the cannibalised parts back, leading to additional work to both refit the part and test the submarine.

## Technical

**2.11** As at March 2017, all 22 in-service Astute-class submarines, Type 45 Destroyers and Type 23 Frigates had both received and donated cannibalised parts. These represent the most complex vessels operated by the Navy. The most cannibalised parts included valves (non-safety critical), costing on average £2,541, and chilled water systems, costing an average of £24,856 (**Figure 7**).

**Figure 7**  
 Most frequently cannibalised ship and submarine parts, April 2012 to March 2017  
 Valve parts have been most frequently cannibalised



**Note**

1 Data cover 646 instances of cannibalisation involving 1,188 parts, as each instance may involve multiple parts.

Source: National Audit Office analysis of Ministry of Defence data

**2.12** Cannibalisation creates additional engineering risks for both the cannibalised parts and those parts removed to get access to them within the donor and recipient ship or submarine. The engineering teams may need to conduct additional systems testing to ensure vessel integrity. Resultant risks include:

- **Defects**

Some cannibalised parts have been damaged while being removed, transported or reinstalled. Between April 2012 and March 2017 an estimated 11% of the 193 parts recorded by ships and submarines as having shortcomings in their material, design and documentation related to cannibalised parts.<sup>8</sup>

- **Reduced service life**

Repeatedly transferring the same part between vessels may reduce its service life. The Department cannot always identify whether the same physical part has been transferred and does not monitor the expected life of all parts.<sup>9</sup>

- **Loss of warranties**

The Department does not enforce standard warranty terms and the impact of cannibalisation on part warranties is unclear. Cannibalisation may invalidate warranties where parts are used for a purpose beyond that intended. However, this may depend on whether the Navy or a contractor removed and reinstalled the cannibalised part.

## People

**2.13** In 2005, we reported that cannibalisation “may result in retention difficulties and shortages of key skills within the Armed Forces”.<sup>10</sup> The 2017 Navy risk register identifies a lack of spares as a risk to operational capability, given its demoralising effect on personnel. The Department told us that a lack of spares and cannibalisation continues to affect staff morale, although it cannot quantify the impact. In interviews, we were told that the need to take parts from other vessels on a regular basis was demotivating and seen by personnel as indicative of an under-resourced organisation.

<sup>8</sup> Does not include an additional 93 parts recorded as having shortcomings as complete part information not available.

<sup>9</sup> The Department does monitor the service life of safety critical components such as those relating to aircraft safety and airworthiness.

<sup>10</sup> See footnote 6.



## Financial

**2.14** Cannibalisation increases the work of staff who need to access, remove, transport, install and test the cannibalised part. This can be particularly challenging within submarines given the confined space and the need to maintain safety and operational standards. The extent of additional work varies but can be time-consuming, diverting resources from other work such as scheduled or preventative maintenance and increasing costs.

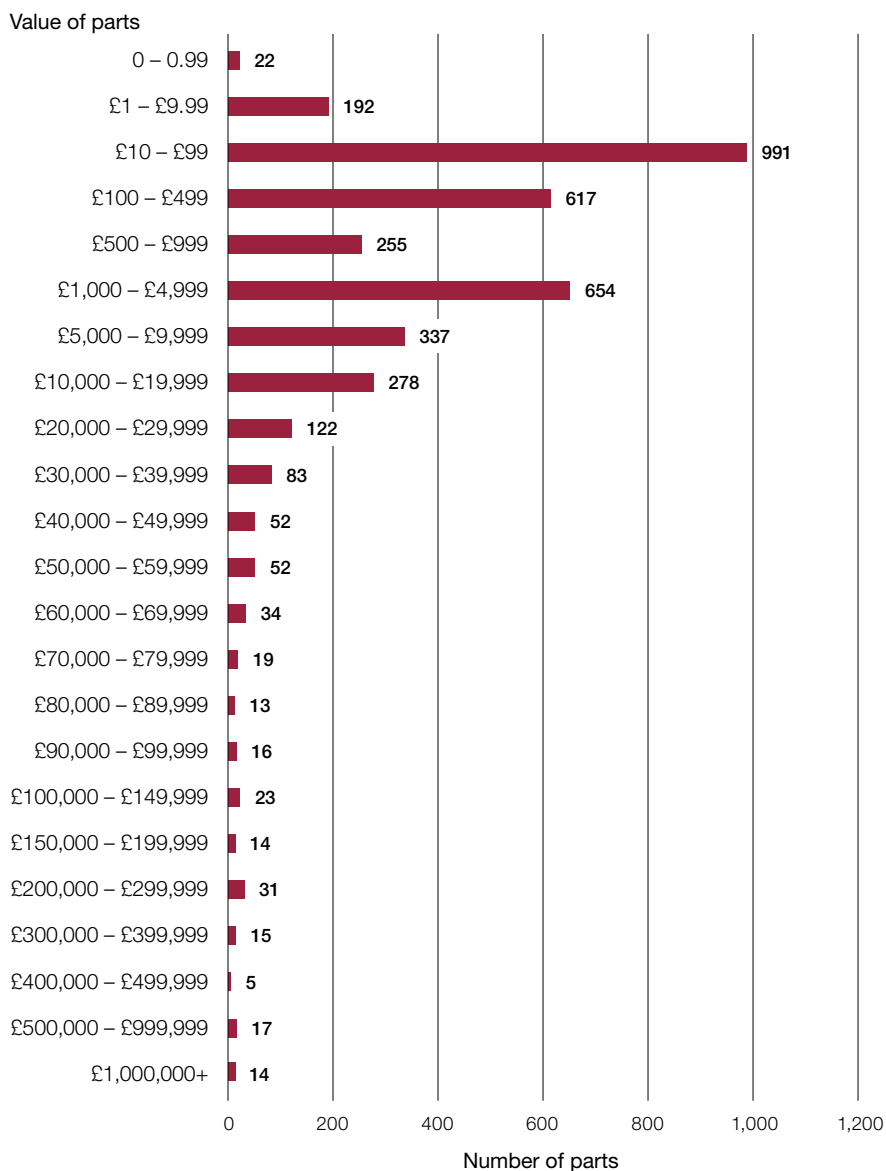
**2.15** Cannibalisation also involves additional administrative work such as producing temporary operating instructions. In addition, the Department pays extra to BAE Systems, which produces the new Astute-class submarines, to assess the impact of cannibalisation on submarines in production.<sup>11</sup> In the past five years, the number of cannibalisations from submarines in production increased by 43% to 110 instances in 2016-17.

**2.16** The Department does not routinely assess the engineering and administrative costs of cannibalisation. Our analysis showed almost three-quarters of cannibalised parts cost less than £5,000, with less than 1% valued at more than £500,000, correlating with the value of total parts held by the Department (**Figure 8** overleaf). The Department's only analysis of 146 Type 23 Frigate cannibalisations in 2012 identified the work cost an average of £4,000 (£4,480 in today's prices). In 50% of these cases, work to remove and reinstall cannibalised parts was equal to, or greater than, the value of the part itself. In 25% of cases it was four times greater.

<sup>11</sup> The Department does not conduct impact assessments for equipment not in production.

**Figure 8**  
Value of cannibalised ship and submarine parts, April 2012 to March 2017

A total 2,731 (71%) of items cannibalised cost less than £5,000



**Notes**

- 1 Data were available for 3,856 out of 6,378 cannibalised parts. The trend in value of cannibalised parts reflects the trend in value of ship and submarine parts held by DE&S as at March 2017.
- 2 The Department told us that in some cases, cannibalisation will be the recognised supply solution for certain high-value items that cannot be held in stock and can be easily transferred.

Source: National Audit Office analysis of Ministry of Defence data

**2.17** Cannibalisations also have longer-term cost implications that need to be understood. These include:

- **Maintenance costs**

During 2016-17, HMS Dauntless, the designated Type 45-class 'harbour training ship', donated 148 parts.<sup>12</sup> As a training ship, HMS Dauntless would not have the same equipment requirements as operational ships. The Department has had to replace these parts before HMS Dauntless enters maintenance. It could not provide a cost for this work. Generally, supply contracts cover the cost of cannibalised parts but not the cost of the work undertaken. This will be covered by the Navy or existing contractor budgets depending on where these costs fall.

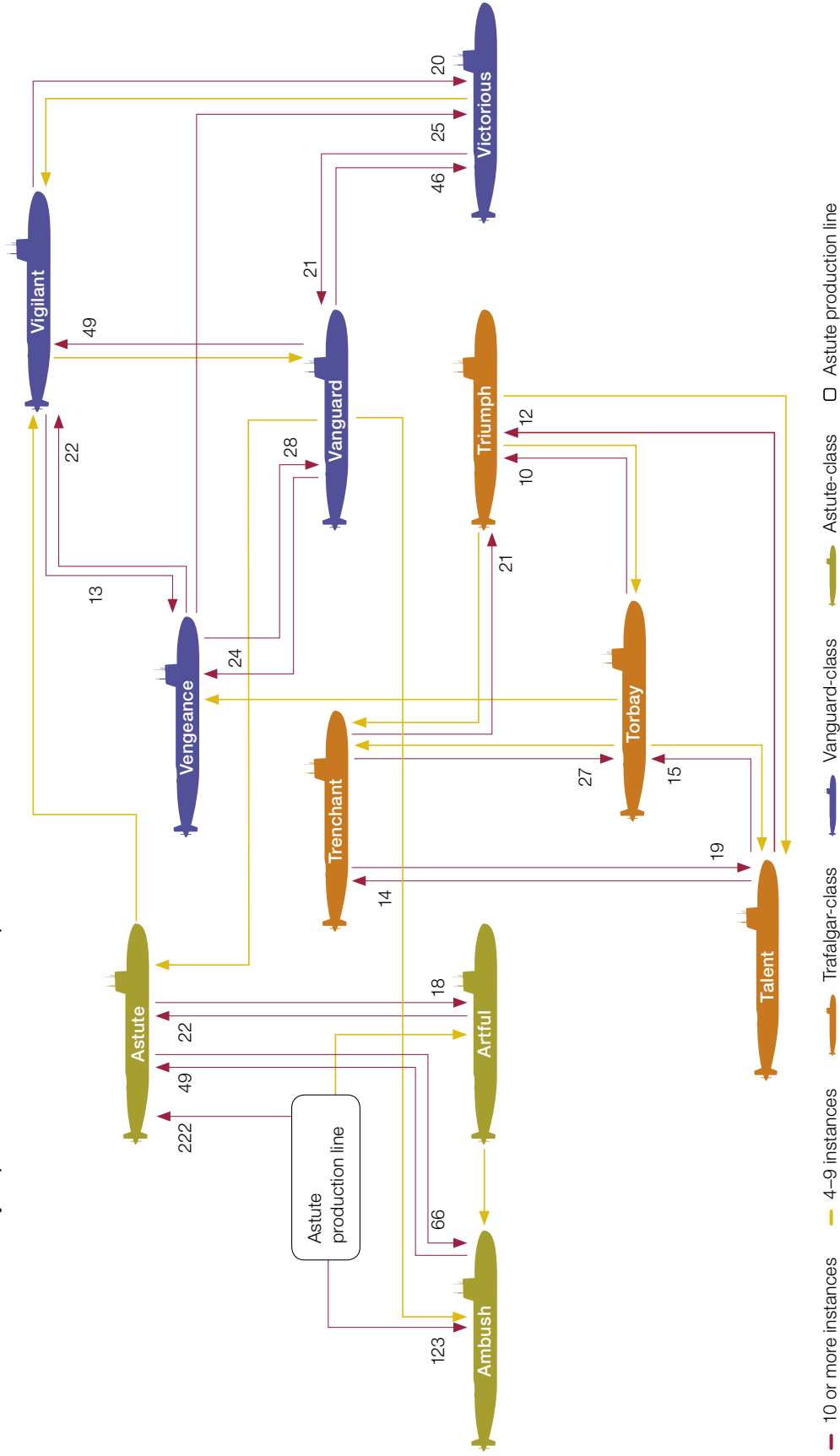
- **Production costs**

The Department relies on cannibalising parts from Astute-class submarines in production (**Figure 9** overleaf). It estimates that parts worth £22 million have been supplied to in-service submarines. Cannibalisations created a 132 day delay to HMS Artful (Boat 3) although action by the contractor meant this only affected the production schedule by 42 days. This led the Department to pay an extra £4.9 million of indirect costs. The Department has also identified that cannibalisation has affected submarines currently in production, leading to an estimated £40 million cost increase. This results from a potential five-month delay to HMS Anson (Boat 5) and a 10-month delay to Boat 7, reduced to three months given existing contractor poor performance.

<sup>12</sup> Ship accommodated trainees and reduced ship's company over this time.

**Figure 9** Instances of cannibalisation across submarines, April 2012 to March 2017

Astute-class submarines rely on parts cannibalised from the production line



# Part Three

## Managing Cannibalisation

### Monitoring cannibalisation

**3.1** Defence Equipment & Support (DE&S) and the Royal Navy (the Navy) do not have complete information to understand cannibalisation. In particular, we found some inconsistencies between central and ship crew data on cannibalisations for Astute-class submarines and Type 45 Destroyers, with not all occurrences recorded centrally. This makes it difficult for the Ministry of Defence (the Department) to have full visibility of cannibalisations.

**3.2** The Department records cannibalisation decisions but does not routinely capture the reasons behind them, such as why parts were unavailable, or the cost and broader impacts. Without this information, the Department will be unable to fully evaluate or manage the effect of wider decisions on cannibalisations. Except when parts are taken from submarines in production, decision-makers do not consider cannibalisation costs or conduct formal impact assessments.

**3.3** In the past three years, decision-makers within the Navy have not approved 274 cannibalisation requests (an estimated 11% of all submitted). Of the 134 cases where information is available, 37% were refused because the relevant parts were subsequently obtained, 20% as the case was being investigated further, and 11% as there was no suitable donor.

**3.4** The Navy has established equipment-specific boards, also involving representatives from DE&S, to monitor and respond to spares availability and cannibalisation issues (Appendix Three). However, the Department does not have a single board, or point of accountability, with overall strategic oversight of cannibalisation across the Navy, to identify and address systemic issues. Consequently, it has not determined a threshold beyond which cannibalisation is unacceptable and the resultant risks the Department may carry. However, the Department has set a cannibalisation threshold for Merlin helicopters based on flying hours.

## Understanding the causes of cannibalisation

**3.5** Cannibalisation can result from a wide range of factors, which we discuss below.

### Technical performance and obsolescence

**3.6** In designing and constructing equipment, the Department makes assumptions about its level of performance, useful life and the number and type of spares required. Getting these assumptions wrong can lead to higher than expected defects and the need to procure more, or different, spares than expected. New vessels may also experience defects resulting from the build quality or developing technology. During 2016-17, the new Astute-class submarines experienced more defects than older vessels (**Figure 10**), with a third of them resolved using cannibalised parts.

**3.7** Given the bespoke nature of ships and submarines, parts can be difficult to obtain, for example if they are no longer manufactured. This can be particularly challenging as technology progresses and equipment gets older. During 2016-17, an average of 5% of parts requested through DE&S were identified as obsolete. Both older ships, such as the Type 23 Frigate, and newer ships such as the Type 45 Destroyer, have identified obsolete parts.

### Figure 10

Defects resolved by cannibalisation by ship and submarine class, 2016-17

**Cannibalised parts contributed to resolving 28% of defects across Astute-class submarines during 2016-17**

Type (number in class)	Defects recorded	Average defects per ship or submarine	Defects resolved	Defects resolved by cannibalisation	
				(number)	(%)
Astute-class submarine (3)	506	169	313	89	28%
Trafalgar-class submarine (4)	328	82	253	26	10%
Type 45 Destroyer (6)	1,118	186	898	99	11%
Type 23 Frigate (13)	1,511	116	1,184	66	6%

#### Notes

1 In July 2016 an Astute-class submarine was damaged in a collision, leading to unforeseen part requirements.

2 Data available in 2,532 from 3,230 instances. Shows operational defects that could be satisfied through supplying parts or other reasons such as people and part availability.

Source: National Audit Office analysis of Ministry of Defence data

## Spares and supply chain management

**3.8** Within DE&S, the Ships Operating Centre provides an estimated 80% of spares provision for ships and submarines, with the Submarine Operating Centre supplying the remainder. In 2014, DE&S and the Navy introduced an improvement programme to reduce the number of part demands that exceeded their required delivery date. This involved: enhancing inventory manager skills, with the Navy seconding 33 staff to DE&S; improving technical data and the labelling of parts; and using available information systems better. Since 2014, there has been a 53% reduction in parts past their required delivery date with no supply contract in place. This has contributed to an overall 28% reduction in parts not being supplied by the required date.

**3.9** Despite these initiatives, spare parts have not always been available when required (**Figure 11**). In March 2017, DE&S Ship and Submarine Operating Centres met part demands from ships and submarines by the required date in 55% (75% target) and 63% (80% target) of instances respectively. In three of 15 cannibalisation decisions we reviewed in detail, the decision-maker noted the time taken to get new parts as “unacceptable”. Suppliers have not always delivered parts by the required date. Compared to an 80% target, 64% of suppliers delivered parts on time within the Ships Operating Centre and 57% within the Submarine Operating Centre.

### Figure 11

Parts not received by the required due date against target, March 2016

In March 2016, Defence Equipment & Support did not meet its targets for providing parts by the required delivery date

	Ships Operating Centre		Submarine Operating Centre	
	All	Urgent operational demands only	All	Urgent operational demands only
Percentage of part demands met by the required date				
	Type of demand			
Actual	55%	61%	63%	55%
Target	75%	70%	80%	70%
Number of part demands exceeding required delivery date				
Actual	17,038	664	833	139
Target	16,313	585	676	32

#### Note

1 The Ships Operating Centre is responsible for most ships' parts and approximately 80% of submarine parts.

Source: Defence Equipment & Support

**3.10** Decisions to cannibalise need to be made on an informed basis, including understanding if and when parts will be available. The Type 45 Destroyer and in-service submarine teams both identified the lack of parts availability information as a cause of cannibalisation. For example, as at March 2017, at least 34% of 17,038 demands for parts that were past their delivery date had no recorded forecast delivery date. In six of 15 cannibalisation decisions we reviewed, the decision-maker did not have data showing the estimated time to obtain parts. In particular, under the Type 45 support contract, the Department does not have sight of part availability that can be accessed outside of normal working hours. This can lead to unnecessary activity, such as removing parts that are subsequently found to be available from the contractor.

**3.11** DE&S has staff shortages in specialist logistics and commercial roles, including 42% fewer qualified inventory management staff in post in the Submarine Delivery Agency than planned. This affects DE&S's ability to respond to demands for parts quickly, or understand and plan requirements (**Figure 12**). DE&S recognises the need to invest in skills. Within the Ships Operating Centre, staff numbers have increased 26% in the three years since March 2014, with an 18% increase in logistics staff.

### Figure 12

#### Numbers and skills of Defence Equipment & Support staff, March 2017

There are shortfalls in trained and qualified DE&S staff across naval supply roles

Centre	Specialisation	Staff numbers			Correctly trained and qualified staff		
		Target	In post	Difference	Target	In post	Difference
Ships Operating Centre	Inventory management	156	148	-5%	121	105	-13%
	Commercial	174	146	-16%	101	67	-34%
Submarine Delivery Agency	Inventory management	34	35	3%	31	18	-42%
	Commercial	103	87	-16%	68	63	-7%
<b>Total</b>		<b>467</b>	<b>416</b>	<b>-10%</b>	<b>321</b>	<b>253</b>	<b>-21%</b>

**Note**

1 The Ships Operating Centre is responsible for the supply of ships' parts and an estimated 80% of submarine parts.

Source: Defence Equipment & Support



## Impact of savings funding decisions

**3.12** We have previously set out the Department's challenge in being able to afford all the equipment and support that the Armed Forces require.<sup>13</sup> In 2017, we commented that the affordability of the Department's Equipment Plan is now at greater risk than at any time since reporting was introduced in 2012, and that the Department is having to identify areas for savings.

**3.13** Funding constraints have also reduced spares availability. In 2016-17, DE&S spent £303 million on additional capital spares across the Department, compared with £319 million in 2015-16. To remain within its budget, the Navy has reduced its maritime support budget by 6% (£271 million) in-year in the past two years. Of these reductions, an estimated £92 million could increase the need to cannibalise parts.

**3.14** The Department has made savings decisions during the procurement of new vessels that have affected the support arrangements in place and increased the likelihood of cannibalisation. In particular:

- **Type 45 Destroyers**

An internal review identified that the Department prioritised bringing ships into service to time and cost, with less emphasis on in-service support. Given the complexity of savings across both Type 45 Destroyers and broader support programmes, it is not possible to identify the savings made during procurement. The Navy told us that in 2016-17, Type 45 Destroyers had £30 million of savings imposed, with reductions in obsolescence management and the purchase of spares. This would lead to increased costs and decreased equipment reliability, availability and sustainability. To make savings, the Department has not:

- **catalogued vessel parts**

The Department decided not to catalogue, or label, parts not seen as necessary for ships' planned maintenance. This makes it harder to identify the parts needed, or to identify where else they may be available. Of the 532 instances of Type 45 ships' cannibalisation, parts were not catalogued in 42% of cases (**Figure 13** overleaf). The Navy has made available £1.5 million to catalogue up to 2,400 parts, when these are identified; and

- **purchased technical documentation**

Technical drawings and instructions allow engineers to understand how systems work, and how to remove and replace parts safely. Without them, it is hard to identify the required parts, and plan or conduct maintenance. In acquiring the Type 45 Destroyer, the Department decided not to purchase complete technical documentation to save money. The Department could not provide evidence of the expected savings to be made or how they considered the potential resultant risk of increased cannibalisation.

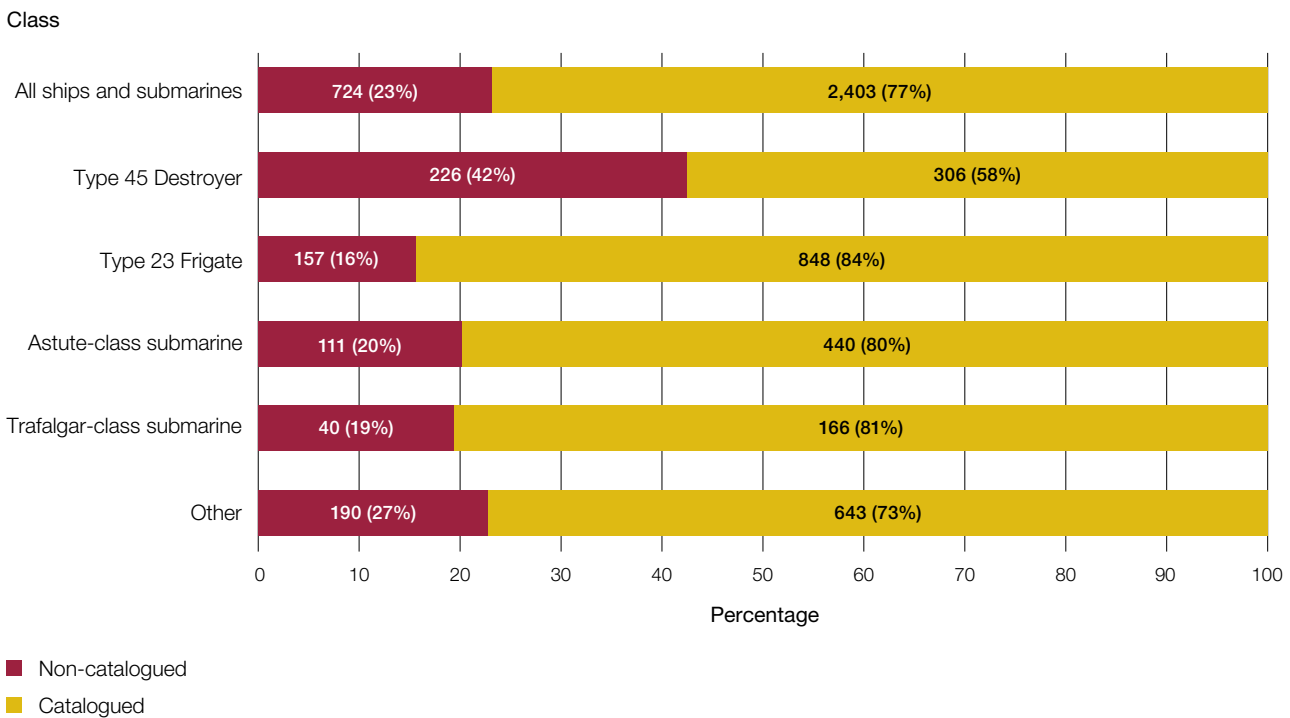
<sup>13</sup> Comptroller and Auditor General, *Equipment Plan 2016–2026*, Session 2016-17, HC 914, National Audit Office, January 2017.

- **Astute-class submarines**

The Navy has identified a critical shortage of spare parts for Astute-class submarines. This resulted from poor inventory management and an incorrectly defined, managed and resourced support solution. As of March 2017, the Astute-class submarine production programme had not committed £137 million of approved support funding over the life of the programme. Technical documentation was also found to be incomplete for Astute-class submarines. The Department has now put in place measures to review and improve the accuracy of technical documentation for Astute-class submarines.

**Figure 13**  
Proportion of cannibalised parts catalogued, April 2012 to March 2017

The proportion of cannibalised parts not catalogued ranged from 16% for Type 23 Frigates to 42% for Type 45 Destroyers



- Notes**
- 1 Non-catalogued refers to parts that have not been assigned a unique stock number.
  - 2 Data were available in 3,127 out of 3,230 instances.
  - 3 The data refer to the number of parts cannibalised from classes of ships and submarines.

Source: National Audit Office analysis of Ministry of Defence data

## **Planning for cannibalisation**

**3.15** As we showed in Part One, although cannibalised parts constitute a small proportion of parts issued, cannibalisation has become more routine with an upward trend up to March 2017. However, Navy structures and processes were planned and resourced to manage cannibalisation as an exceptional process. There is no evidence the Department has considered and planned for the long-term impacts of cannibalisation when making its strategic decisions on the level of spares investment. This work would include:

- fully assessing the trade-offs between savings measures, such as reducing investment in spares upfront, and the longer-term value-for-money implications relating to cannibalisation;
- accurately forecasting the cost implications, such as for the maintenance of heavily cannibalised equipment, to allocate appropriate funding;
- considering any underlying increase in technical risks and subsequent impact on operational testing; and
- clarifying commercial arrangements, given a lack of clarity on the impact of cannibalisation on part warranties.

# Appendix One

## Our investigative approach

### Scope

**1** We conducted an investigation into equipment cannibalisation across the Royal Navy (the Navy) that:

- describes cannibalisation across the Navy and its impact;
- explains the causes of cannibalisation; and
- explains how the Ministry of Defence (the Department) seeks to manage cannibalisation.

**2** Cannibalisation occurs across all the Armed Forces, but our recent work identified specific examples within the Navy. We do not consider the other services as part of this work, but may do so in future. Our review focuses primarily on ships and submarines, although we include data on instances of cannibalisation across Navy Merlin helicopters. This investigation looks specifically at cannibalisation and does not focus on wider inventory management or the supply chain.

## Methods

**3** As well as examining cannibalisation across the Department, our more detailed analysis covered the ships and submarines where most cannibalisation occurred. These were Astute-class submarines, Type 45 Destroyers and Type 23 Frigates. In examining these issues, we drew on a variety of evidence sources including:

- interviews with Defence, Equipment & Support (DE&S) and Navy staff to understand the causes and impact of cannibalisation, including with logistics support teams and equipment teams;
- interviews with two Navy Fleet Operations Maintenance Officers and a review of documentation for a sample of 15 cannibalisation decisions (from Astute-class submarines, Type 23 and Type 45 ships) to understand the information used and how long decisions took;
- analysis of DE&S's cannibalisation data for April 2012 to March 2017 to understand the characteristics of cannibalisation – our reconciliation with Navy data identified understatements within DE&S data (see paragraph 3.1);
- analysis of broader DE&S and Navy data to understand the context of cannibalisations, including operational defects and data on inventory; and
- relevant documentation, such as guidance on cannibalisation, project reports, board papers and DE&S performance monitoring to understand how the process works, how cannibalisation is monitored and its impact.

## Appendix Two

### Previous National Audit Office and Committee of Public Accounts reporting on cannibalisation

#### Figure 14

Summary of relevant National Audit Office and Committee of Public Accounts findings relating to cannibalisation

**We have previously recommended that the Ministry of Defence (the Department) should conduct more robust analysis on the cost-effectiveness of cannibalisation compared with other support arrangements**

NAO/Committee report (year)	Cause	Impact	Recommendation
Management of the Typhoon Project (Committee of Public Accounts, 2011)	Contractor delays in supplying parts (18% late, 12% outstanding).	Three Typhoon planes (£378 million) grounded so RAF unable to train pilots which meant that only eight of 48 pilots were able to conduct ground attack missions.  13% shortfall in the Department's target for annual flying hours.	Need for more robust analysis of cost-effective balance between cannibalisation, buying spares and accepting operational risks.
Support to High-Intensity Operations (NAO, 2009)	Lack of codification of spares for Mastiff armoured vehicles.  Difficulties with spares suppliers.  Reliability issues with Vector vehicles.	Ordering of spares slow and convoluted.  Short-term cannibalisation of vehicles to meet operational needs.  Lower than required vehicle availability.	Need for analysis to consider possible scenarios of spares shortages and or operational changes.  Catalogue spares in a timely way, wherever possible before equipment is fielded.
Support to High-Intensity Operations (Committee of Public Accounts, 2009)	Contractor delays supplying parts.  Department prioritised spares for operations, affecting availability for UK-based fleets.	11% shortfall in Merlin and Apache helicopters available for training and contingency.	Address deficiencies in logistics information systems to improve inventory management.  Agreeing spares contracts that cover actual activity levels rather than forecasts.
Hercules C-130 Tactical Fixed Wing Airlift Capability (NAO, 2008)	Inventory inaccurate when contract let.  Insufficient support at the multiple locations worldwide.	Department's initial estimate of £3.9 million to settle the liability.  Cannibalisations increase the workload of engineers as the process is more complex and longer than a repair. By resorting to cannibalisation the underlying causes of supply chain problems are not addressed and inefficiency is built into the repair and maintenance regime.	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.

NAO/Committee report (year)	Cause	Impact	Recommendation
Assessing and Reporting Military Readiness (NAO, 2005)	Cannibalisation within Armed Forces becoming more prevalent due to reduced support.	Increased levels of cannibalisation within the Navy. Department unable to sustain majority of helicopter fleets beyond peacetime rates without heavy cannibalisation.	Take into account the potential longer-term risks of relying on redistribution of people and equipment (in particular, cannibalisation). While cannibalisation may be a useful measure of last resort it could have consequences for value-for-money and there may be longer-term problems.
Operation TELIC – United Kingdom Military Operations in Iraq (NAO, 2003)	One of the key lessons identified by the Department was that operational stock levels were, in many instances, not sufficient for readiness and sustainability requirements of Operation TELIC.	Equipment was removed from a number of vehicles held at home bases to provide additional spares for those vehicles deployed to the Gulf.	While cannibalisation may have some advantages, particularly for older equipment and those approaching their out-of-service date, it must not replace prudent and sensible plans to provide operational sustainability.  Reissue guidance that sets out that cannibalisation should be used only as a fall-back option.

**Note**

1 NAO = National Audit Office, Committee = Committee of Public Accounts.

Sources: HC Committee of Public Accounts reports: *Ministry of Defence: Building an Air manoeuvre Capability – The Introduction of the Apache*, Forty-sixth Report of Session 2002-03, HC 1246, January 2004; *Ministry of Defence: Support to High-Intensity Operations*, Fifty-fourth Report of Session 2008-09, HC 508, July 2009; *Ministry of Defence: Management of the Typhoon Project*, Thirtieth Report of Session 2011-12, HC 755, April 2011. Comptroller and Auditor General reports: *Ministry of Defence: Hercules C-130 Tactical Fixed Wing Airlift Capability*, HC 627, National Audit Office, June 2008; *Ministry of Defence: Support to High-Intensity Operations*, HC 508, National Audit Office, May 2009; *Ministry of Defence: Management of the Typhoon Project*, HC 755, National Audit Office, March 2011; *Ministry of Defence: Providing Anti-Air Warfare Capability: the Type 45 Destroyer*, HC 295, National Audit Office, April 2011.



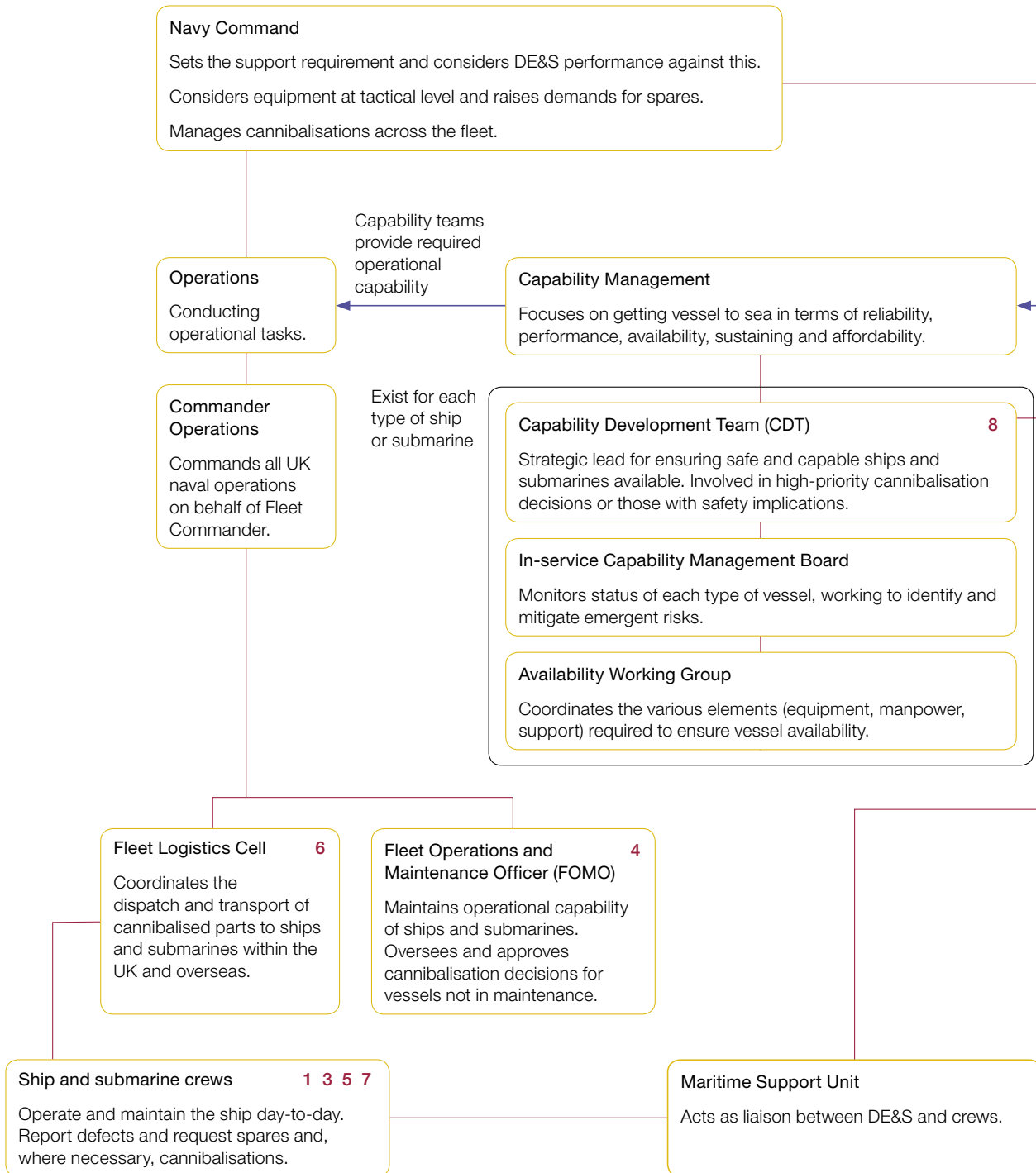


## **Appendix Three**

Organisations and teams involved  
with cannibalisation of Naval equipment

**Figure 15**  
Cannibalisation governance structures

There is no central oversight of the cannibalisation process



DE&S provides in-service support to Navy Command through the **Command Acquisition and Support Plan** and agreed service levels

**Defence Equipment & Support (DE&S)**  
 Provides support services to Navy Command.  
 Manages supply chain.  
 Oversees cannibalisation for equipment in maintenance.

DE&S provides support to capability required for operations

**DE&S Strategic Class Authority (SCA)** 4  
 Programme teams for specific classes provide and coordinate logistic and spares support for equipment and systems. Negotiates, lets and manages contracts for support. Approves cannibalisations that impact on maintenance.

**Ships Operating Centre, Submarine Operating Centre, DE&S Equipment Programme Teams** 2 8  
 Manage support of equipment and systems aboard ships and submarines. Oversee contracts with suppliers, including for provision of spare parts.

Coordinates vessel through-life approach

**Main contractor** 1 5 7  
 Tier 1 contractors lead on ship and submarine support. Can request cannibalisation decision. Staff may undertake cannibalisations on behalf of DE&S/Navy.

**Output Management teams** 5 7  
 Contractor-led with mixed MoD civilian, military and contractor personnel to support ships and submarines in dock. Exist for each class of ship and submarine.

**Supply contractor**  
 Provides equipment and relevant spares.

- Defence Equipment & Support
- Navy Command
- Commercial supplier
- Joint organisation

**Roles in cannibalisation process**

- 1 Ship's crew or contractors request delivery forecast for required part.
- 2 DE&S confirm if part available within required timescale.
- 3 If available, ship's crew fit part. If not available within required timescale, crew request part from alternative source, such as cannibalisation.
- 4 SCA and FOMO identify alternatives and FOMO approves cannibalisation as last resort, consulting with SCA if ship in maintenance.
- 5 Donating ship's crew/contractors remove cannibalised part and prepare it for transport/transfer. Donating ship raises resulting defect report.
- 6 Fleet Logistics Cell coordinates transport of part to recipient vessel.
- 7 Receiving ship's crew/contractors install new part and test system. If successful, report defect as resolved and continue operations/programme.
- 8 Navy Command and DE&S programme/vessel teams monitor and respond to spares availability and cannibalisation issues.

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