National Audit Office

**Report**
by the Comptroller
and Auditor General

**Ministry of Defence**

# Investigation into submarine defueling and dismantling

**HC 2102 SESSION 2017–2019 3 APRIL 2019**

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Ministry of Defence

# Investigation into submarine defueling and dismantling

Report by the Comptroller and Auditor General

Ordered by the House of Commons
to be printed on 1 April 2019

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

29 March 2019

HC 2102 | £10.00

The Ministry of Defence has committed to act responsibly and dispose of its nuclear submarines “as soon as reasonably practicable”. To date, it has not disposed of any of the 20 submarines retired from service since 1980. We investigated the Department’s progress with submarine disposal and in implementing the projects needed to make this work.

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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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The National Audit Office study team consisted of:
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This report can be found on the National Audit Office website at www.nao.org.uk

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# Key facts

**20**
out-of-service submarines stored by the Ministry of Defence (the Department)

**19**
average number of years submarines out-of-service, against 26 years in-service

**£0.5bn**
estimated total cost to the Department of maintaining retired submarines since 1980 (to 2017)[1]

**£96 million** estimated cost to the Department of fully disposing of a submarine[1]

**£7.5 billion** Department's future liability for maintaining and disposing of its 20 stored and 10 in-service submarines, as at March 2018

## Defueling submarines

**11** number of years' delay in re-establishing an ability to defuel submarines, moving from 2012 to a current planning estimate of 2023[2]

**57% (£100 million)** budget increase for re-establishing a defueling capability from £175 million (2007) to £275 million (2018)

**9** average number of years fuelled submarines have been stored

## Dismantling submarines (removing radioactive parts)

**15** number of years delay rolling out a tested submarine dismantling approach, moving from 2011 to a current planning estimate of 2026[2]

**50% (£0.8 billion)** increase in the cost of the project from £1.6 billion (2002) to £2.4 billion (2016)

**£0.9 billion** estimated increase in the Department's longer-term financial liabilities related to submarine dismantling should it take:

- six months longer to remove intermediate-level waste from boats dismantled in two stages than the expected 18 months; and
- a similar delay dismantling the remaining submarines

**Notes**

1 Figures estimated based on the average annual cost over the last four years at 2017-18 prices.

2 'Current planning estimate' reflects the Department's current working level assumption, which has not yet been approved by the Departmental Investment Board as it is subject to ongoing scrutiny.

# What this investigation is about

**1** The Ministry of Defence (the Department) uses nuclear-powered submarines, including those with and without nuclear weapons, to meet its operational requirements. Since 1980, it has removed 20 submarines from service and replaced them with newer ones. It has committed to handling the resultant nuclear liabilities responsibly and disposing of submarines "as soon as reasonably practicable". Disposal includes removing the irradiated nuclear fuel (defueling), safely storing submarines, taking out the radioactive parts (dismantling), and then recycling the boat (**Figure 1** on pages 6 and 7).

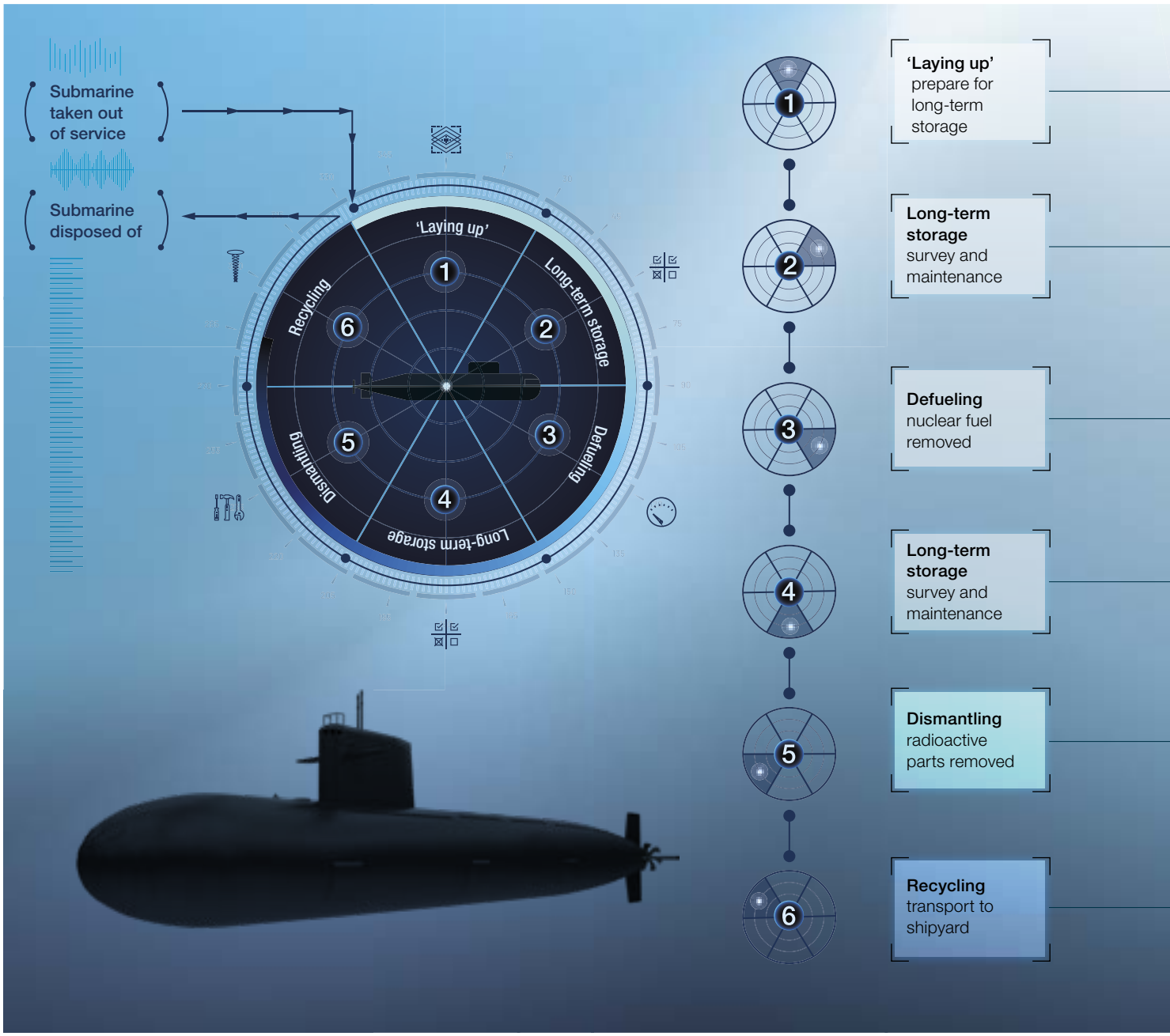
**2** To date, the Department has not yet disposed of any of its 20 retired submarines, with nine of them still containing irradiated fuel. The Department plans to take a further three submarines out of service over the next decade. The Department stores out-of-service submarines at dockyards in Devonport (Devon) and Rosyth (Fife), which the nuclear regulators have assessed as safe.

**3** After examining our May 2018 landscape review of the Defence Nuclear Enterprise, the Committee of Public Accounts commented on the lack of berthing space within the Devonport dockyard. It recommended that the Department end the delays to submarine disposals.[1] The Department told the Committee that although it had deferred dismantling submarines on affordability grounds in the past, this was no longer acceptable on safety and reputational grounds. It committed to fully dismantling its first submarine, Swiftsure, by 2023.

1 Comptroller and Auditor General, *The Defence Nuclear Enterprise: a landscape review*, Session 2017–2019, HC 1003, National Audit Office, May 2018; HC Committee of Public Accounts, *Ministry of Defence nuclear projects*, Sixty-first Report of Session 2017–2019, HC 1028, September 2018.

## Figure 1
Submarine disposal process

**To dispose of a submarine, the Ministry of Defence needs to defuel, dismantle and then recycle the boat**




**Notes**

1 The submarine disposal time varies depending on the available funding, staff and facilities.

2 Government catergorises its nuclear waste according to radioactivity and heat generation levels.

3 On behalf of UK government, the Nuclear Decommissioning Authority (NDA) will provide the Geological Disposal Facility, which will provide a safe and secure long-term solution for the disposal of higher activity radioactive waste. The NDA manages the fuel storage site at Sellafield.

Source: National Audit Office

1 **Submarine prepared for long-term storage** by placing the nuclear reactor plant in an appropriate state and making the boat watertight and disabling systems. It can take between two and three years depending on nuclear-licensed dock and staff availability. The Ministry of Defence is considering how to conduct this process in the water rather than a dry dock.

2 **Submarine stored** with both annual and more in-depth (at least every 15 years) surveys and maintenance, in nuclear-licensed docks for fuelled submarines, to preserve and test the systems and hull integrity. The Ministry of Defence is considering moving to more regularly assessing submarine condition to conduct maintenance based on need.

3 **Irradiated fuel removed** from the Reactor Pressure Vessel, within the nuclear reactor compartment, using nuclear-licensed dock space, and skilled staff and infrastructure, such as cranes and storage facilities. Defueling must be undertaken before dismantling.

**Irradiated fuel** Transported to Sellafield for storage

4 **Submarine returned to storage**. Surveys and maintenance conducted annually and then in a dock at least every 15 years.

Low-level waste

Transported to Low-Level Waste Repository in West Cumbria for disposal

5 The Department adopts a two-stage approach to dismantling by removing:

**a** Low-level waste (ie less radioactive reactor compartment parts).

**b** Intermediate-level waste such as the Reactor Pressure Vessel.

a

b

6 Submarines sent to UK-based commercial shipyard to be broken down.

Intermediate-level waste

Moved to Geological Disposal Facility (around 2050s)

Transported to interim store in Capenhurst

**4** This report builds on our 2018 work by detailing the disposal process and the Department's progress at different stages. It sets out:

- the disposal process, roles and responsibilities and the Department's progress in disposing of out-of-service submarines (Part One);
- the Department's progress in re-establishing its ability to defuel submarines (Part Two); and
- the Department's progress in removing radioactive parts from submarines (Part Three).

We conducted our fieldwork between December 2018 and January 2019 (Appendix One). We interviewed staff in the Defence Nuclear Organisation and the Submarine Delivery Agency, and reviewed project data and documents. This report does not consider the value for money of the Department's approach to disposing of submarines.

# Summary

## Key findings

1 **Despite a government commitment over 20 years ago, the Ministry of Defence (the Department) has not yet disposed of any of the 20 submarines it has decommissioned since 1980.** Because of this, the Department now stores twice as many submarines as it operates, with seven of them having been in storage for longer than they were in service. Following a government commitment in 1995, the Department has committed to disposing of its submarines "as soon as reasonably practicable". It started considering submarine disposal in 2000 and first aimed to have an operational process agreed by 2011. Having started dismantling its first submarine in 2016, the Department now estimates to roll out its approach across other submarines by 2026. The Department has spent an estimated £0.5 billion on maintaining and storing its retired submarines since 1980 (paragraphs 1.2, 1.8, 3.7 and Figure 4).

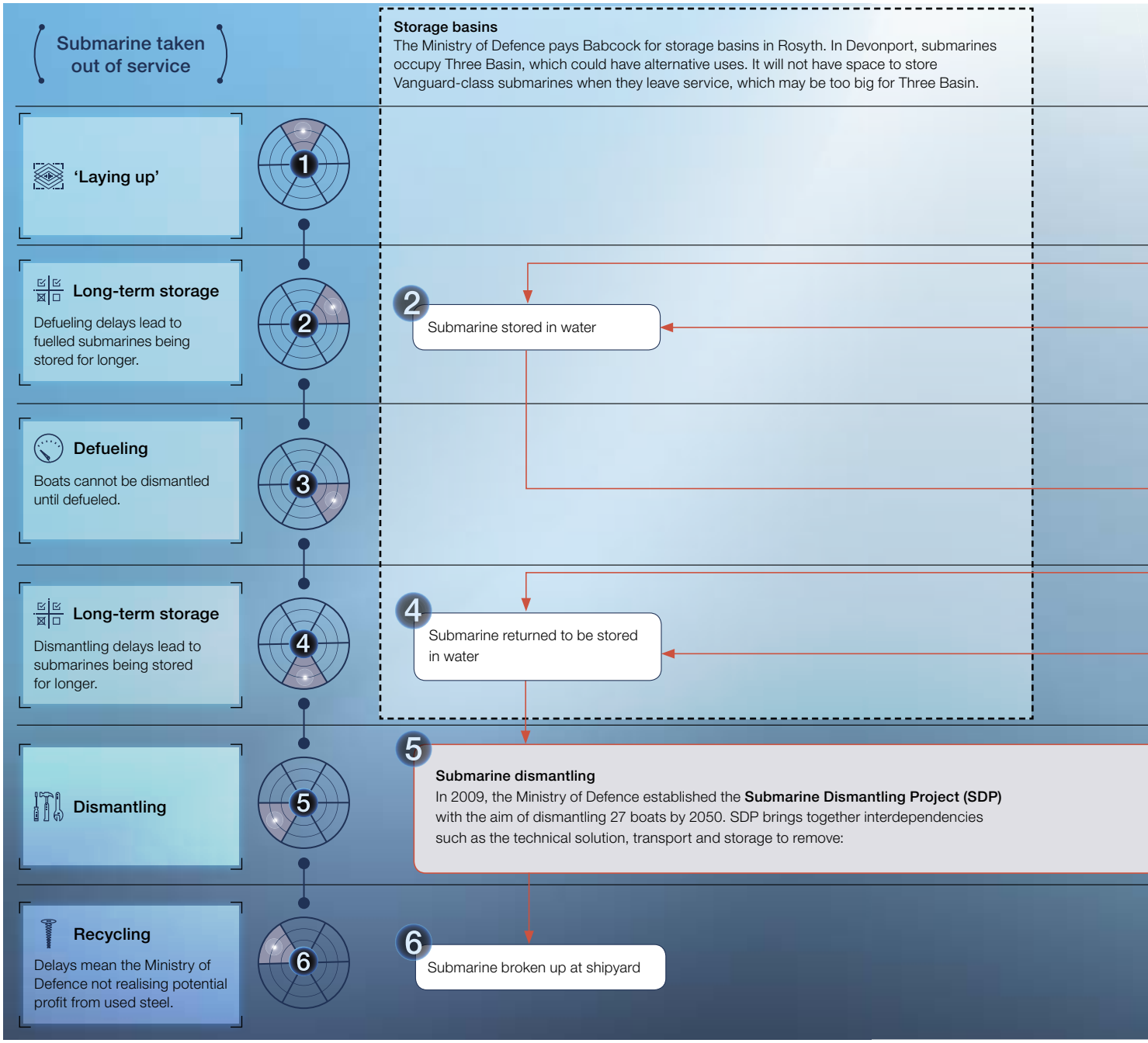
2 **The Department includes a £7.5 billion liability in its 2017-18 accounts for maintaining and then disposing of its out-of-service submarines.** Of this figure, £2.2 billion relates to maintaining the 20 submarines currently out-of-service and the costs of using the Devonport site. The Department also provided £1.5 billion to dispose of these boats and the remaining three Trafalgar-class and four Vanguard-class submarines currently in service. The Department does not need to provide for the liabilities associated with storing and disposing of submarines that are not yet operational. It increased its liability by an average £100 million for each of the Astute-class submarines recently brought into service. Potential changes to HM Treasury's discount rates, which contributed significantly to the 50% (£2.5 billion) increase in the provision from 2016-17 to 2017-18, affect the size of the Department's liability (paragraphs 1.10 to 1.12 and Figure 6).

3 **To dispose of submarines, the Department must undertake a complex series of inter-related tasks.** At each stage of the disposal process (**Figure 2** on pages 10 and 11), the Department needs the necessary space, infrastructure, skills and regulatory approvals. It manages several interdependent projects to ensure these are in place. They include:

- **defueling-related projects at Devonport,** including the upgrade to defueling facilities (the defuel facility project) such as the crane to remove the fuel, and a wider project upgrading nuclear-licensed docks and infrastructure (Part Two); and
- **the Submarine Dismantling Project** (the dismantling project), covering Rosyth and Devonport, to remove the radioactive parts from the submarine (Part Three).

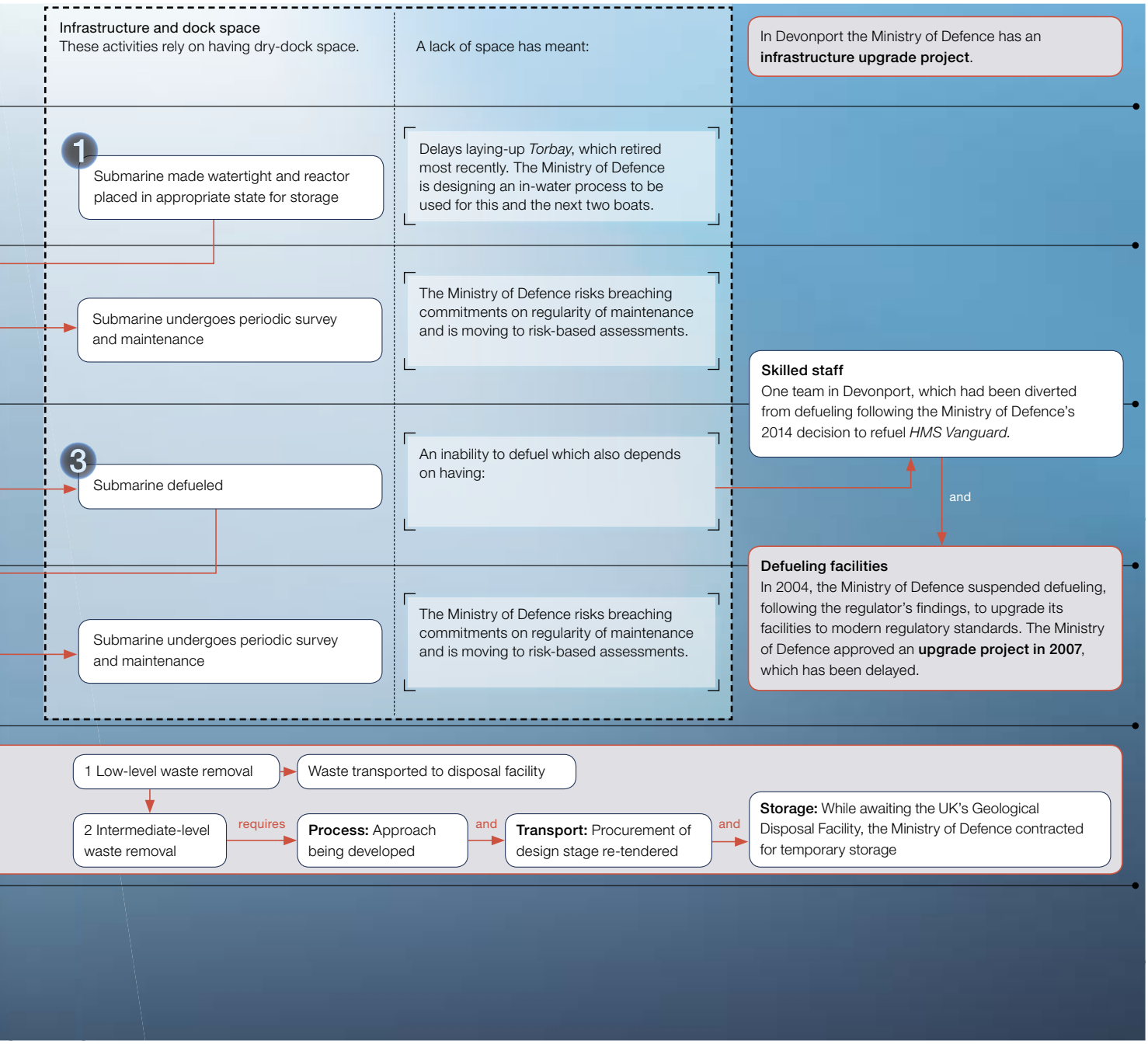
## Figure 2
Interdependencies across the submarine disposal process

**The Ministry of Defence needs to manage interdependencies across the processes and projects it has in place to dispose of a submarine**




**Notes**
1 The Ministry of Defence's projects include upgrading defueling facilities, upgrading Devonport infrastructure and dismantling submarines.
2 Fuelled submarines are stored in Devonport, where defueling will be conducted.
3 The Nuclear Decommissioning Authority has responsibility for providing the Geological Disposal Facility, with the Department contributing 6% of total annual costs (equivalent to £2 million in 2017-18) based on the estimated storage space it requires.

Source: National Audit Office analysis of Ministry of Defence data




Key

Dockyard requirements

Disposal-related projects

**4 The Department's ability to dispose of its submarines depends largely on one contractor and also on government more widely.** Babcock International Group plc (Babcock) is currently the Department's sole supplier capable of undertaking most of the Department's defueling and dismantling requirements. It owns the nuclear-licensed dockyards and facilities in both Devonport and Rosyth, and also provides aspects of the related projects. The Department also relies on Radioactive Waste Management, a wholly owned subsidiary of the Nuclear Decommissioning Authority, to provide the Geological Disposal Facility. This is expected to be available to receive submarine-related intermediate-level waste from the 2050s. The Department currently contributes 6% of the total annual cost, equivalent to £2 million in 2017-18 (paragraphs 1.14 and 1.15, and Figure 7).

## The defueling facility project

**5 The Department has not defueled any submarines since 2004 and does not have a fully funded plan to re-start defueling.** Nine of the Department's 20 out-of-service submarines contain irradiated fuel, which needs to be removed using dock facilities that have been approved by the nuclear regulator. In 2004, the Office for Nuclear Regulation found that facilities did not meet the latest required standards and the Department stopped defueling submarines. The Department estimates that defueling may take two years per boat. It has not yet allocated a defueling budget as part of its long-term financial planning and will have to consider this alongside other priorities (paragraphs 2.2, 2.3 and 2.11).

**6 The defueling facility project has been delayed 11 years, with a £100 million (57%) increase in costs.** In 2007, the Department approved the facilities project aiming to re-start defueling in 2012. Then, in 2013, it delayed the start date to 2017 as, although this project remained the best option, it did not represent value for money given commercial and technical issues. This represents the latest departmental approved start date. There have been further delays meaning the Department's latest planning estimate, subject to ongoing scrutiny and departmental approval, is to start defueling in 2023. Delays arose from the Department deciding in 2014 on an unplanned refuel of *HMS Vanguard*, and then in 2016 deciding to pause for two years its Devonport infrastructure upgrades. This meant defueling could not re-start and the facilities project, which was an estimated 90% complete, was suspended. To control costs and delays, in 2018 the Department contracted with Babcock to sustain necessary skills during the suspension. The Department now expects to pay more to complete this project than in 2016. There remain uncertainties over the project timeframes and costs given the need for commercial negotiations, regulatory permissions and financial approval (paragraphs 2.5 to 2.7 and Figure 9).

**7 Delays to the defueling facility project have wider cost, risk and dock space implications.** The Department pays an estimated £12 million a year to maintain and store the nine fuelled submarines currently stored in Devonport. Maintaining fuelled, rather than unfuelled, submarines also presents additional technical uncertainties and affects dock availability. This has contributed to space pressures in Devonport, with the Department at risk of not meeting its commitment to inspect, clean and repaint stored submarines at least every 15 years, and not having space to prepare *Torbay*, which left service in 2017, for long-term storage. Until submarines are prepared, the Department must keep them partially crewed, potentially affecting the Department's ability to redeploy its personnel. In 2017, the Department started a £1.5 million project to design a storage preparation process that could be conducted in the water, rather than a dock (paragraph 2.8).

## The Submarine Dismantling Project

**8 The Department has started to dismantle two submarines and is now developing its designs into approved processes to complete the work.** In December 2016, the Department started dismantling *Swiftsure* (which left service and was defueled in 1992) by removing its low-level waste, the less radioactive parts of the reactor compartment. It completed this in August 2018, on time and within the £13 million budget, and in December 2018 started a similar process for *Resolution*. Following its 2011 and 2014 public consultations on the dismantling approach, the Department committed to removing the intermediate-level waste, such as the Reactor Pressure Vessel (RPV), from the submarine intact and then transporting it to an interim store in Cheshire. To date, it has not yet approved the technical processes for removing and transporting this waste. It is paying an estimated £1.5 million a year to reserve storage at the Cheshire site which it currently expects to use from the mid-2020s (paragraphs 3.13, 3.16 to 3.17 and Figure 11).

**9 The dismantling project has been delayed by 15 years, with the whole-life cost increasing by £0.8 billion (50%).** The delay follows changes to the requirements and temporary suspension of the project. In May 2000, the Department started to consider a submarine dismantling subsequently aiming to have an operational process by 2011. Given the lack of progress, which included a four-year deferral to make savings and the need to consider evolving government nuclear waste policy, it re-scoped the project in 2009 and 2013, resulting in an aim to have a tried and tested approach by 2024. The Department had to re-start its waste transportation procurement after it did not receive any viable bids, which caused a further two-year delay. The Department now estimates that it will roll out its approach by 2026 (paragraphs 3.6 to 3.8, 3.10 and 3.17).

**10 Delays create cost, capacity and reputational risks beyond the project, but have given the Department an opportunity to re-assess its submarine dismantling approach.** Alongside annual maintenance, the Department has committed to removing submarines from the water at least every 15 years for more detailed maintenance in dock. It recognises a £2.2 billion liability for this within the overall £7.5 billion liability included in its 2017-18 accounts. If this work took 24 months, rather than the assumed 18, and there was a two-year delay in dismantling the submarines, this could increase liabilities by an estimated £0.9 billion. Delays also put pressure on dock space, with Devonport expected to run out of space for retired submarines in the mid-2020s, while making it harder for the Department to demonstrate it has disposed of submarines as soon as practicable. Given developments in the civil nuclear sector and, having gained a better understanding of how to remove and transport waste, the Department is now reconsidering its approach to intermediate-level waste (paragraphs 1.10, 2.12 and 3.19).

## Looking ahead

**11 In the past two years, the Department has revised its governance arrangements which it is continuing to develop.** In 2018, the Defence Nuclear Organisation (DNO) established a dedicated nuclear liabilities project board and set project-wide objectives. It is also developing its first strategic overview of projects and their interdependencies, alongside encouraging more routine senior-level engagement. From April 2019, DNO is responsible for all disposal-related projects, including those previously within the Royal Navy's remit. It continues to recognise as a high risk the failure to manage its nuclear liabilities coherently and has assessed itself as not yet having fully developed plans in place to meet 67% of its submarine defueling and dismantling objectives (paragraph 1.16).

**12 To meet its commitments to Parliament, the Department has set itself a series of milestones.** In particular, in order to dismantle its first submarine by 2023, the Department assesses that by December 2019 it needs to have decided its approach to removing and transporting intermediate-level waste. It will then design the process, and demonstrate it can do this work, alongside contracting for the transport and ensuring it has the budget in place. Beyond this, the Department's current estimates include:

- completing the defueling-related projects in 2023 to start defueling submarines at that date, although there remain uncertainties around this timeframe (paragraph 2.5 and Figure 9);
- removing the intermediate-level waste from *Swiftsure* between 2023 and 2024 to test its chosen approach to dismantling (Figure 10); and
- rolling out a dismantling approach in 2026, after having tested this on one submarine. It expects to formalise this date by summer 2020 (paragraph 3.18 and Figure 10).

13 **The Department has not fully considered its approach to disposing of all its operational and future submarines.** At present, the Department does not have a fully developed plan to dispose of Vanguard, Astute and Dreadnought-class submarines, which have different types of nuclear reactor. For the Vanguard and Astute-class it has identified suitable dock space which, if used, will need to be maintained. Within the civil nuclear sector, organisations must consider nuclear waste disposal during the design stage of power stations and nuclear infrastructure. The Department does not have a similar obligation (paragraphs 1.11, 2.12 and 3.22).

# Part One

## Background

**1.1** The Ministry of Defence (the Department) has committed to disposing of its nuclear submarines "as soon as reasonably practicable". The Department has not yet fully disposed of any of the 20 submarines it has taken out of service. This part describes the submarine dismantling process, roles and responsibilities, and the Department's progress to date.

### The submarine disposal process

**1.2** The UK has committed to acting as a responsible nuclear owner and operator, which includes ensuring the safe storage of nuclear materials before disposal. In line with this, in 1995 the UK government published its policy to decommission and manage its radioactive waste "as soon as reasonably practicable". The Department reinforced this in 2011 and 2016 when stating that it would dispose of submarines "as soon as reasonably practicable". This commitment aligns with international standards and agreements, as well as regulatory requirements on managing nuclear liabilities.

**1.3** To dispose of a retired submarine, the Department needs to undertake a series of tasks (Figure 1, pages 6 and 7). These include preparing the boat for long-term storage; routinely maintaining retired boats; removing irradiated nuclear fuel (defueling); taking out the radioactive parts (dismantling); and then breaking up the boat and recycling its parts. At each stage, the Department needs to consider how it will transport and store parts with different radioactivity levels. The Department stores submarines at both Devonport dockyard in Devon and in Rosyth, Fife (**Figure 3**). Aside from its storage basin in Devonport, it contracts with Babcock International Group plc (Babcock) to use these dockyards. It currently only defuels and prepares submarines for storage in Devonport, and has started dismantling in Rosyth, where all the submarines have already been defueled.

## Figure 3

UK locations related to submarine disposal, January 2019

**The disposal process uses various locations across the United Kingdom**


1. **Devonport Royal Dockyard:** operated by Babcock International Group plc, which undertakes submarine maintenance, refuelling and defueling. Thirteen retired nuclear submarines are based here.
2. **Rosyth Dockyard:** owned by Babcock International Group plc and base for seven retired nuclear submarines.
3. **Low-Level Waste Repository, West Cumbria:** The UK's national low-level waste disposal facility.
4. **URENCO Nuclear Stewardship:** intermediate-level waste interim storage site.
5. **Sellafield Ltd:** storage for irradiated nuclear fuel and nuclear decommissioning site.

**Note**

1 The location of the UK's Geological Disposal Facility for intermediate-level waste has not yet been determined. In December 2018, UK government launched a public consultation to help determine a suitable site.

Source: National Audit Office

**1.4** Retired submarines generate three levels of radioactive material, which influences how parts can be handled, transported and stored. Appendix Two summarises the submarine parts. Levels of radioactive material include:

- **irradiated fuel** from within the submarine's reactor core. As it continues to generate heat, fuel will be stored under water at the Nuclear Decommissioning Authority's (NDA's) Sellafield site, after which it will be sent to a disposal facility;
- **intermediate-level waste**, primarily the Reactor Pressure Vessel (RPV) and other parts from within the reactor compartment, which had been close to the nuclear fuel. This waste comprises about 1% (50 tonnes) of the boat and is stored and then disposed of in designated facilities; and
- **low-level waste** that needs to be handled and disposed of within the regulatory framework but does not meet the criteria for intermediate-level waste. This covers the remainder of a submarine's reactor compartment such as pipework and comprises around 4% (176 tonnes) of the boat, which will be disposed of in a low-level waste repository.

**1.5** It will cost an estimated £96 million to fully dispose of a submarine.[2] There remains uncertainty about these costs given that the Department still needs to approve how it will remove and transport intermediate-level waste. This figure does not include costs associated with the Department establishing the required facilities and infrastructure, and disposing of nuclear waste at the end of its storage period.

**1.6** To dispose of a submarine, the Department needs to design the process and ensure it has the infrastructure, dock space and skills required. Given broader nuclear safety policy expectations, the Department needs to meet regulations governing the whole process. Regulatory responsibilities are principally divided between two organisations:

- The Office for Nuclear Regulation regulates the contractor-owned and operated sites. It ensures that the nuclear industry controls its hazards effectively, continually improves its practices and maintains high standards. It oversees the transportation of certain nuclear materials and the design, build, operation and decommissioning of nuclear facilities.
- The Defence Nuclear Safety Regulator regulates nuclear activities and facilities at Department-owned and operated sites. It reports independently to the Defence Secretary and regulates the transport of defence nuclear materials.

2 These figures are based on assumptions including the Department continuing its existing practices for long-term berthing and the number of maintenance periods.

**1.7** The Department has several interdependent projects, described in Parts Two and Three of this report, to develop the processes and infrastructure required. These cover:

- **defueling projects** to establish the nuclear-licensed facilities and infrastructure, such as dock space, for defueling; and
- **a submarine dismantling project** to design and test how to remove, transport and store the radioactive parts.

## The Department's progress

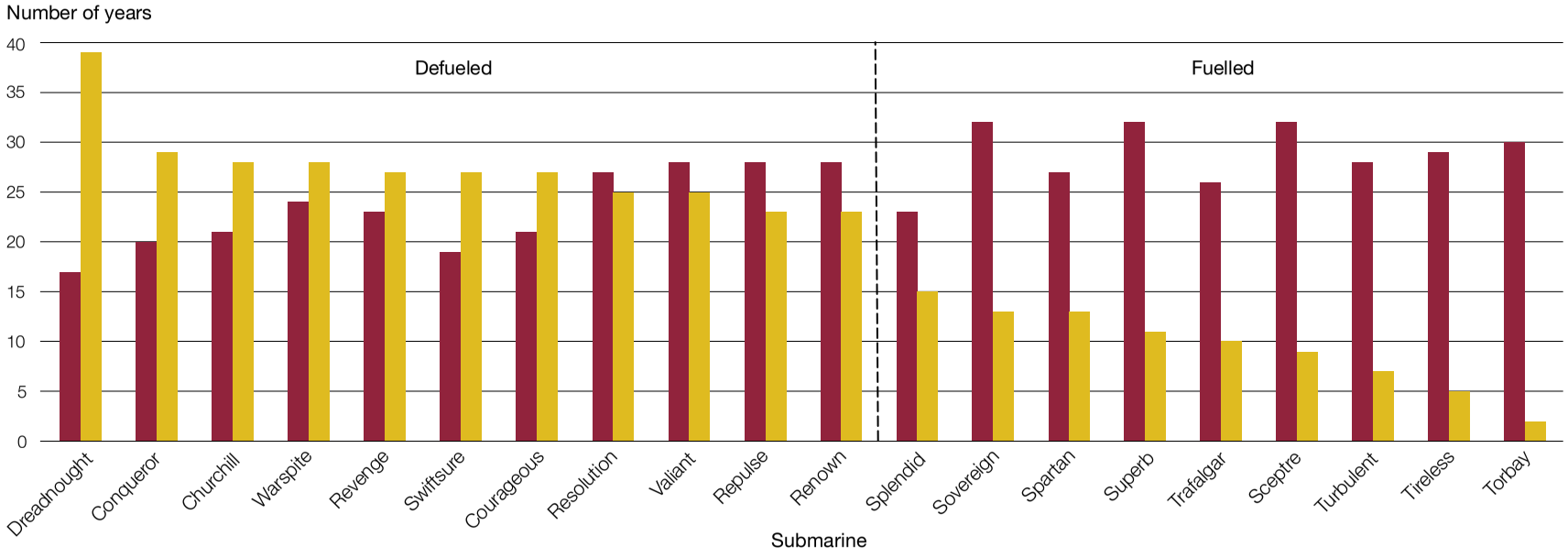
**1.8** The Department has not fully disposed of any of the 20 submarines it has taken out of service since 1980, and now has in storage double the number it currently operates. Seven submarines have been retired longer than they were in service, and this number is likely to increase (**Figure 4** overleaf). On average, the Department's fleet of 20 retired submarines were in service for 26 years and have been in storage for 19 years. Since 1980, the Department has spent an estimated £0.5 billion on maintaining and storing these submarines.

**1.9** There have been delays across all the disposal stages, with retired submarines at different points of the process (**Figure 5** on pages 22 and 23). Nine of the current 20 retired boats contain irradiated fuel, while two have started to be dismantled. Under current plans, the Department estimates it will have dismantled these boats, alongside a further seven currently in service, by the late 2060s.

## Figure 4

Comparison of time submarines spent in and out of service, January 2019

**To date, seven submarines have been stored for longer than they were operational**




**Note**

1 Based on current assumptions, the Ministry of Defence estimates it will have dismantled these boats, as well as a further seven still to leave service, by the late 2060s.

Source: National Audit Office analysis of Ministry of Defence data

## The Department's liabilities

**1.10** To recognise the longer-term costs of storing and disposing of out-of-service and in-service submarines, the Department has provided for a £7.5 billion liability in its 2017-18 accounts, extended over the next 120 years (**Figure 6** on page 24).[3] This equates to 38% of the total provision for liabilities and charges (£19.6 billion) included in its accounts. Of its liabilities figure for disposals, £2.2 billion relates to maintaining the 20 submarines currently out of service, along with the costs of using the Devonport site, with a further £1.5 billion set aside to dispose of these boats along with the remaining three Trafalgar-class and four Vanguard-class currently in service.

**1.11** In line with accounting standards, the Department's liability does not reflect the costs associated with disposing of and maintaining submarines that are not yet in-service, such as the four Astute-class submarines currently being built. It increased its liability by an average £100 million for each of the three Astute-class boats that have already been brought into service. Unlike the civil nuclear sector, the Department does not need to develop a disposal solution as part of its initial production business case, nor is it required to set aside funding for future disposal.

**1.12** The Department increased its submarine defueling and disposal liability by 50% (£2.5 billion) between 2016-17 and 2017-18. This resulted primarily from alterations to the discount rate set by HM Treasury, with subsequent rate changes likely to cause a decrease in 2018-19. There remain significant inherent uncertainties in the costs and assumptions used by the Department to calculate its nuclear liabilities. Its liabilities may materially change should outcomes differ from assumptions in relation to the time taken to complete disposal, technological advances, interdependencies with the Geological Disposal Facility and policy and regulatory changes.

## Roles and responsibilities

**1.13** The Defence Nuclear Organisation (DNO) leads development of the Department's disposal policy and sets the funding requirements. It holds the Submarine Delivery Agency (SDA) to account for managing projects across the disposal process (**Figure 7** on page 25).

**1.14** To implement projects, SDA primarily contracts with Babcock. Babcock currently owns the Devonport and Rosyth dockyards and supporting infrastructure, aside from the Devonport submarine storage basin; is the prime contractor for submarine maintenance; and both designs and conducts the defueling and dismantling processes. Each year, the Department pays Babcock an estimated £9 million to use the Rosyth nuclear-licensed site and an estimated £15 million to use nuclear-licensed areas in Devonport.[4] It also pays Babcock to upgrade and maintain facilities at these locations. In 2017-18, Babcock was the Department's second largest private-sector contractor.

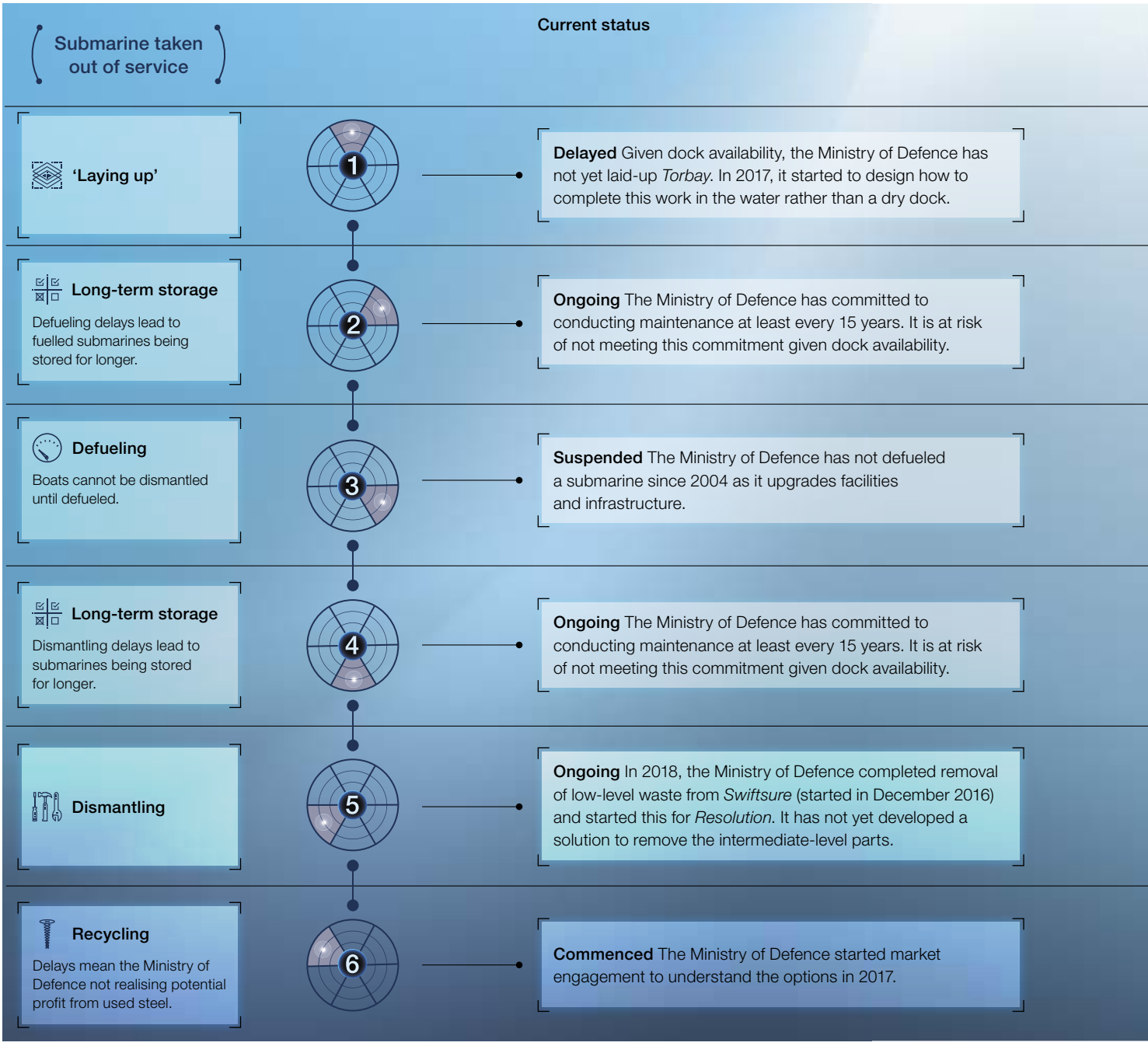
3 Ministry of Defence, *Ministry of Defence Annual Report and Accounts 2017-18*, HC 1272, July 2018.

4 The Department contracts with Babcock to use the Devonport site, where a range of naval tasks beyond submarine disposal also take place. It apportions 15% of its submarine fixed costs to the storage and annual maintenance of retired submarines, with additional contracts agreed for in-depth maintenance. The Department owns the Devonport basin where retired submarines are stored.

## Figure 5

The Ministry of Defence's progress in disposing of submarines, January 2019

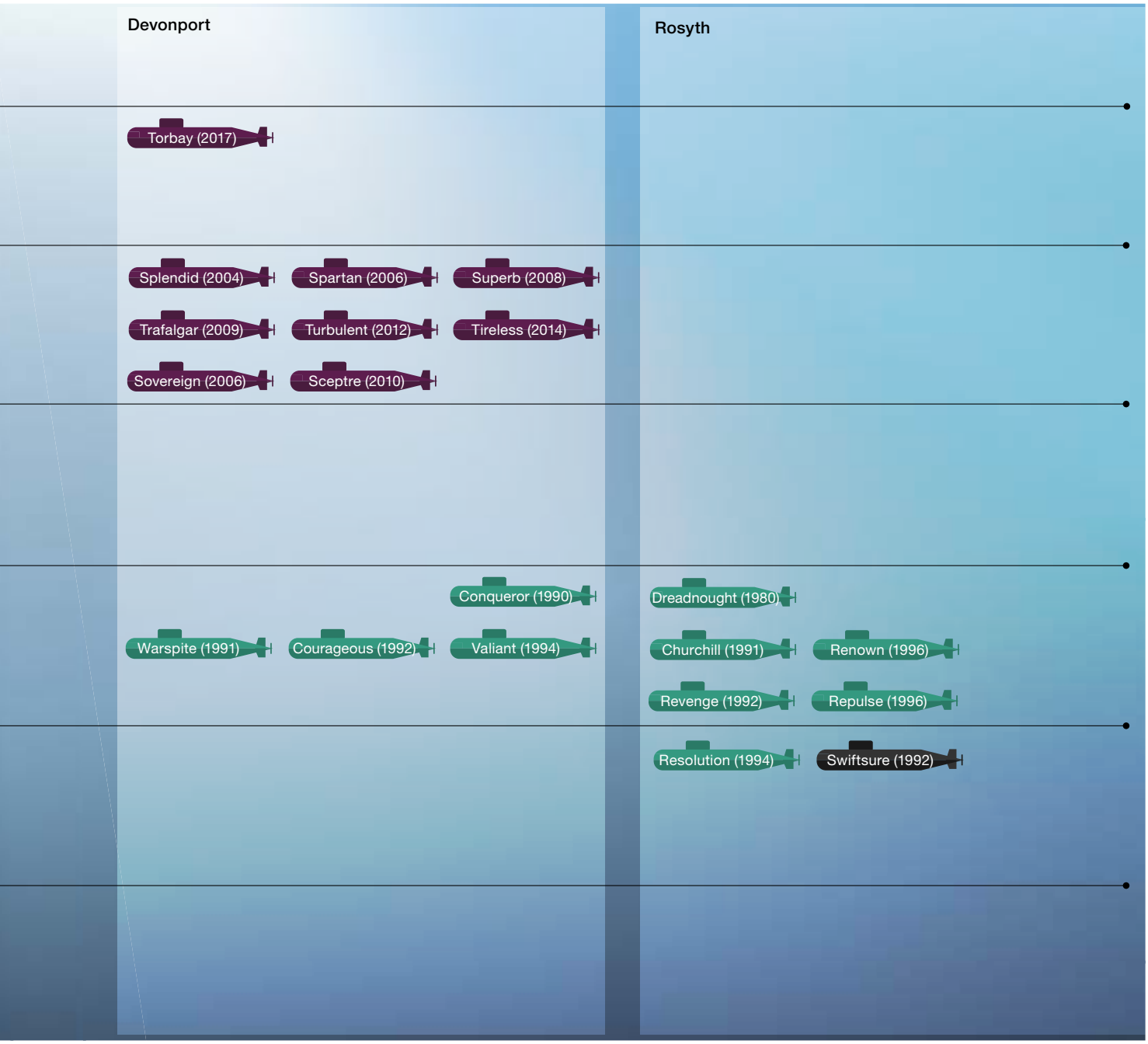
**The Ministry of Defence currently has nine decommissioned submarines waiting to be defueled**




**Note**

1 Demonstrator submarine refers to a submarine that is being used to test the dismantling approach before this is rolled out as the operational process.

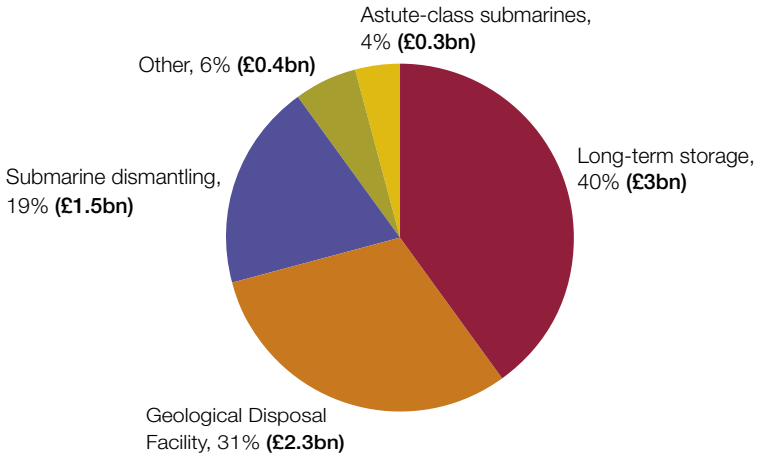
Source: National Audit Office analysis of Ministry of Defence data


Devonport
Rosyth
Torbay (2017)
Splendid (2004)
Spartan (2006)
Superb (2008)
Trafalgar (2009)
Turbulent (2012)
Tireless (2014)
Sovereign (2006)
Sceptre (2010)
Conqueror (1990)
Warspite (1991)
Courageous (1992)
Valiant (1994)
Dreadnought (1980)
Churchill (1991)
Renown (1996)
Revenge (1992)
Repulse (1996)
Resolution (1994)
Swiftsure (1992)

## Figure 6

Ministry of Defence's disposal-related nuclear liabilities, March 2018

**The Ministry of Defence has identified a £7.5 billon liability given its commitment to dispose of submarines stored and in operation**




**Notes**

1 The Ministry of Defence expects these programmes to extend over the next 120 years. Nuclear liabilities for individual submarines will only be recognised once they come into service.

2 Long-term storage includes £2.2 billion for maintaining the current retired submarines; £265 million for the defueling facility project; and other upgrade projects.

3 'Other' includes the liabilities associated with building a waste-size reduction facility and developing a Reactor Pressure Vessel transport container. It does not include the Department's provision for other nuclear liabilities such as fuel management.

4 Submarine dismantling currently covers 27 boats, including the Vanguard-class, but not the Astute-class, with the first three submarines of this class being recognised in the accounts separately.

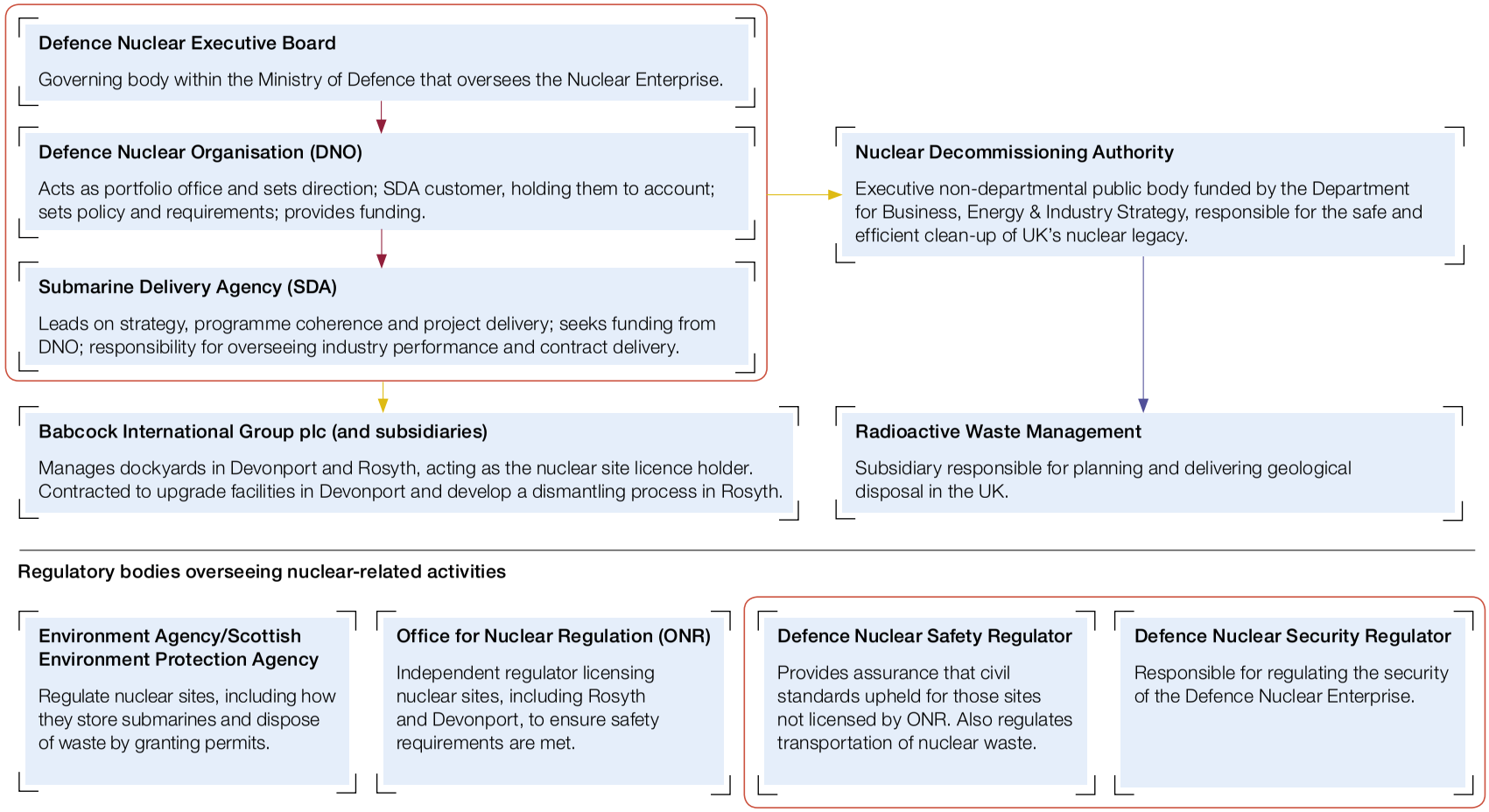
5 The Department is contributing 6% of the total Geological Disposal Facility costs, which the Department will use for waste from submarine disposal and wider activities.

Source: National Audit Office analysis of Ministry of Defence data

**1.15** The disposal process involves other government organisations such as the NDA, which provides storage facilities for the irradiated fuel at its site in Sellafield. It also sponsors Radioactive Waste Management, a wholly owned subsidiary, to develop the Geological Disposal Facility to dispose of irradiated fuel, along with intermediate-level waste, in the long term. The Department is contributing 6% of the total costs, equivalent to £2 million in 2017-18. A site for the facility is currently being selected.

## Figure 7
Submarine disposal roles and responsibilities

**The Defence Nuclear Organisation (DNO) sets the overarching policy, with the Submarine Delivery Agency (SDA) responsible for delivery**




**Notes**

1 Smaller contracts and sub-contracts have been excluded.

2 Nuclear regulators license the sites required for submarine disposal.

Source: National Audit Office analysis of Ministry of Defence data

## Governance

**1.16** In the past two years, the Department has started to consider disposal-related projects as an interdependent portfolio. It recognised that previous arrangements led to a lack of accountability and that there was insufficient incentive to understand interdependencies between projects. As a result, it could not manage projects effectively, leading to cost increases and a lack of long-term planning. The Department continues to recognise as a high risk the failure to manage its nuclear liabilities coherently and has made several changes to counter this risk. These changes include:

- **Establishing new governance**

  Since 2013, the Department has monitored progress and managed the risks and opportunities across the portfolio through a nuclear liability project board, which meets quarterly. It has also introduced quarterly meetings with the NDA to set joint objectives and share information. Given that these projects have not been identified as part of the Government's Major Project Portfolio, the Department does not have to seek independent assurance from the Infrastructure and Projects Authority. It has not sought assurance from them as part of its own arrangements.

- **Increasing senior-level oversight**

  In May 2018, the Department conducted its first director-general review of the portfolio, followed by a director-level review that reported in January 2019. In addition, the nuclear liabilities project board will be chaired by two senior staff alternately to ensure appropriate review. DNO has greater oversight over the defueling infrastructure project when budgetary control of this area transferred from the Royal Navy in April 2019.

- **Increasing staff numbers and skills**

  In 2018, the Department established a dedicated nuclear liabilities post within DNO to oversee the SDA relationship, set policy and manage the funding. SDA is itself creating a dedicated role to coordinate projects and interdependencies. For the first time, it conducted a strategic review of inter-related disposal projects. In 2016, the SDA established a Rosyth team, moving staff from the Bristol head office. Staff numbers have increased 30% (six) since then, with six vacancies remaining against the targeted 35 posts. The SDA has relied on contractors to enhance technical skills on the Submarine Dismantling Project, with two contracts totalling £9 million from 2014 to 2019.

- **Developing a new performance measurement tool**

  In 2018, the Department created new metrics for SDA to self-assess its compliance with nuclear liabilities policies. The SDA has currently assessed itself as not having fully developed plans in place to meet 67% of these disposal-related policies. This tool sits alongside DNO's monitoring of SDA against annually agreed targets, which include meeting project milestones, agreeing contracts and providing the necessary infrastructure and technology when required.

# Part Two

## Submarine defueling

**2.1** Once a submarine is taken out-of-service, the Ministry of Defence (the Department) removes the irradiated fuel from inside the submarine's reactor. This must be done before dismantling a boat and aligns with the UK's commitment to manage irradiated fuel safely, securely and cost-effectively. The Department suspended defueling in 2004 to upgrade its facilities. This part describes projects to re-establish this process, the progress to date and potential developments.

### Background

**2.2** The Department will defuel its retired submarines at its Devonport dockyard, which has been owned by Babcock International Group plc (Babcock) since 2007. To conduct defueling, it needs both nuclear-licensed dock space and facilities such as cranes (**Figure 8** overleaf). In 2004, the Office for Nuclear Regulation identified these facilities, such as the crane, as not meeting the latest regulatory standards. This meant that the Department had to suspend submarine defueling until it had upgraded the facility. In 2002, we reported on the Department's management of infrastructure interdependencies in Devonport following a major upgrade to nuclear-refitting facilities.[5]

**2.3** In 2007, the Department approved a project (the defueling facility project) to re-establish the facilities needed to remove irradiated fuel from the nine fuelled, stored submarines, and three further submarines retiring in the next 10 years.[6] To meet regulations, this involved constructing a new building to access the boat and replacing the crane. The Department initially aimed to re-start defueling in 2012, with all submarines defueled by 2024. The Defence Nuclear Organisation (DNO) oversees this project, and in October 2005 Babcock was contracted by the Department to provide the facilities within a broader £294 million contract currently expected to run until April 2019.

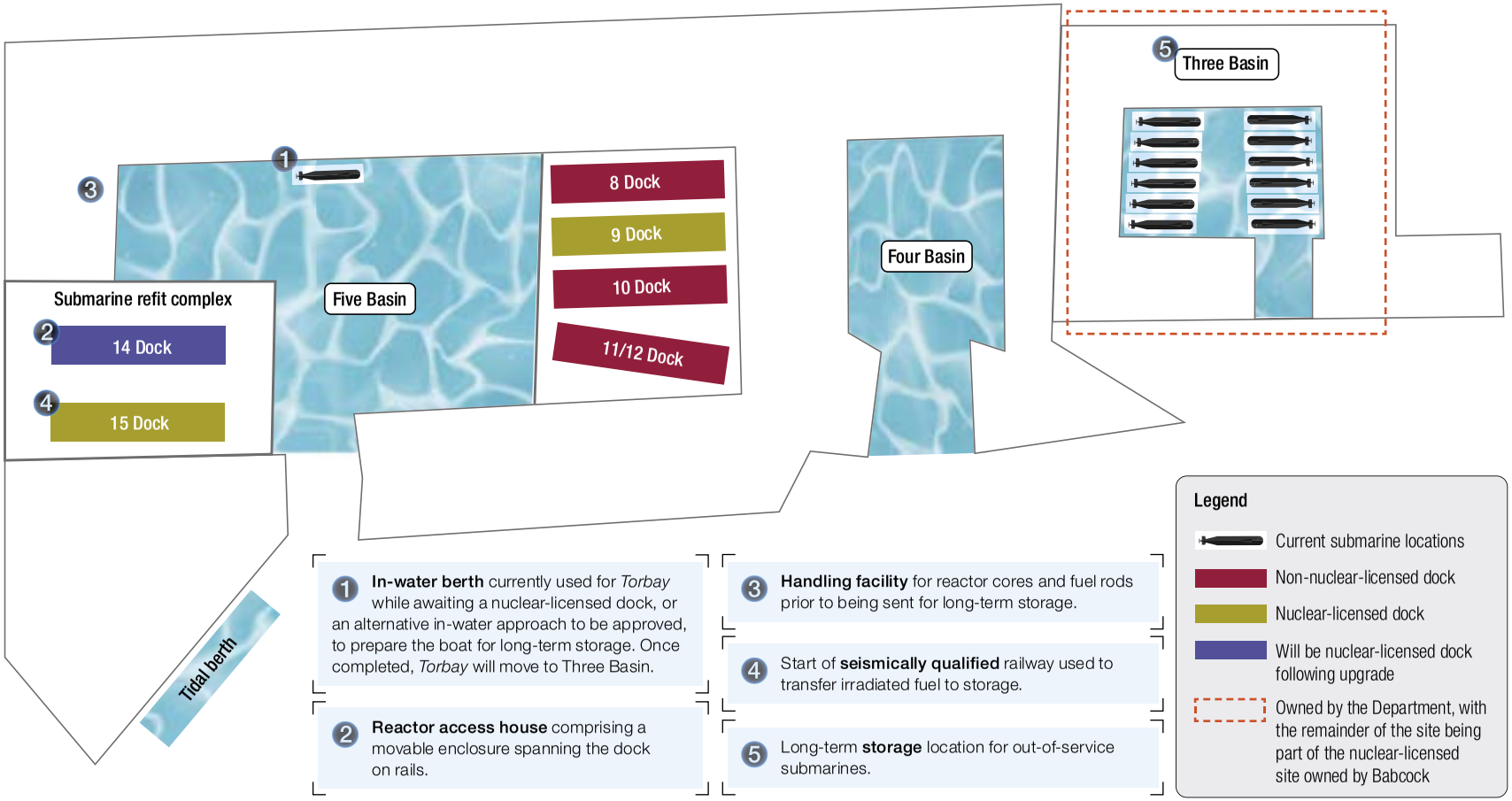
5 Comptroller and Auditor General, Ministry of Defence, *The construction of nuclear submarine facilities at Devonport*, Session 2002-03, HC 90, National Audit Office, December 2002.

6 The Department needs to establish different arrangements for other submarines, such as the Vanguard-class and Astute class, yet to leave service.

## Figure 8

Map of Devonport infrastructure, January 2019

**The Ministry of Defence is upgrading its infrastructure at Devonport to ensure it meets regulatory standards and that it has sufficient nuclear-licensed dock space**




**Notes**

1 The Ministry of Defence requires nuclear-licensed docks for maintaining in-service submarines, refuelling *HMS Vanguard*, maintaining fuelled submarines in long-term storage and preparing submarines for long-term storage. It is currently considering how to prepare submarines for long-term storage in the water, rather than a dry dock.

2 The crane used to defuel submarines up to 2004, which has now been removed, had been located between Dock 14 and Dock 15.

3 The wider Devonport infrastructure project includes a Dock 14 upgrade. The defueling facility project upgrades the submarine refit complex.

Source: National Audit Office

**2.4** The Department's ability to re-start defueling also depends on it completing wider Devonport infrastructure upgrades. This includes ensuring that Dock 14, within which the defueling facilities sit, complies with nuclear regulations. The Department assesses the availability of infrastructure to manage its nuclear liabilities as high risk. As part of a wider project, overseen by the Royal Navy until April 2019, the Department is updating Devonport to reduce the impact of external risks, such as earthquakes, as far as reasonably practicable. This includes dismantling the former crane pedestal, strengthening the roadway and building a floodwall to reduce the potential impact of flooding. The contractor estimates that this work will cost up to £125 million.

## Progress to date

**2.5** The Department's defueling facility project has been delayed 11 years. Its most recent estimate is that it will start defueling in 2023, although this is subject to ongoing scrutiny and departmental approval. This compares with an initial expectation of 2012 and a most recently approved start date of December 2017. In 2013, the Department assessed that although the project was the best option, based on historical performance of the contract and issues with providing the technical solution, it did not represent value for money. It subsequently re-scoped the project. Overall, the Department's project budget has increased 57% (£100 million), from £175 million in 2007 to £275 million in June 2018.

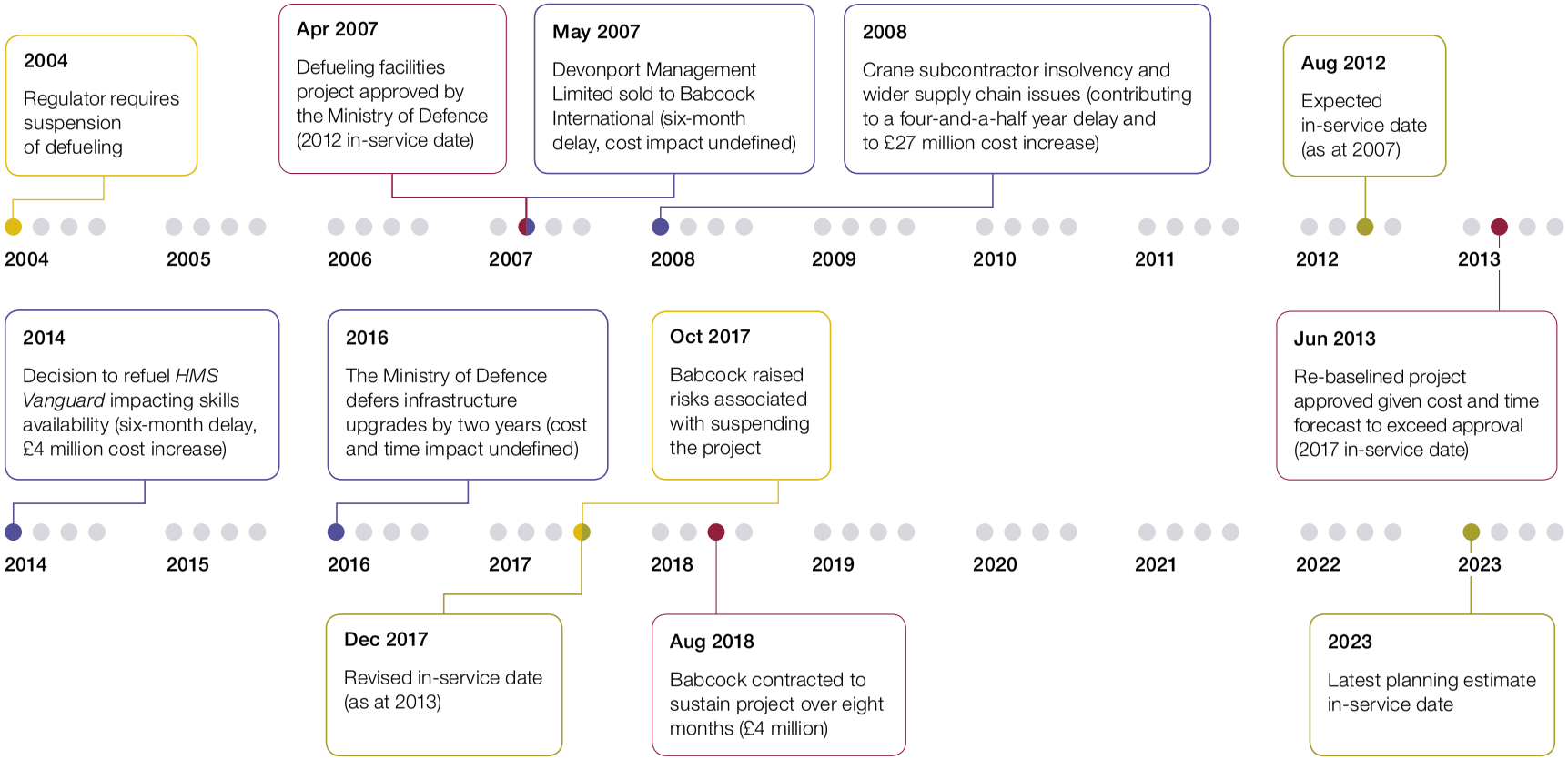
**2.6** Delays to the defueling facility project have occurred for several reasons (**Figure 9** overleaf). These include the 2007 sale of the Devonport dockyard to Babcock, which led to a six-month delay in contracting for design work, and the specialised crane contractor becoming insolvent. Along with wider commercial problems, these developments contributed to a four-and-a-half-year delay and a £27 million cost increase. The Department has also made decisions affecting the defueling facility project. These include:

- **an unplanned refuel to *HMS Vanguard***, announced in 2014, as a precautionary measure following issues with a nuclear reactor prototype being identified at the Dounreay testing facility. This caused skilled teams to be diverted from defueling to refuelling and led to an estimated six-month delay and a £4 million cost increase to the defueling facility project; and

- **the Department deferring upgrades to the Devonport infrastructure project as a savings measure**. In 2016, the Department approved the Royal Navy's proposal to delay infrastructure upgrades in Devonport, including to Dock 14, by two years to defer £19 million of spending. This contributed to the Department not being able to complete its defueling facility project which was an estimated 90% complete at this stage, with the reactor house and crane built. Outstanding work primarily related to testing. This delayed the Department's ability to re-start defueling. At the time, the Department recognised the impact of this measure across the Devonport site, but did not discuss it with the site owner and its prime contractor, Babcock. The Department subsequently started infrastructure upgrades in 2018.

## Figure 9
Defueling facility project timeline

**Since approval in 2007, the defueling facility project has incurred delays**




**Notes**

1 In-service date is when the Ministry of Defence can re-start defueling boats.

2 The Ministry of Defence's current planning assumption – to start defueling in 2023 – is subject to factors such as commercial negotiations, regulatory permission and financial approval.

3 The Ministry of Defence needs to revise its safety case to be able to increase the number of submarines it currently stores.

Source: National Audit Office analysis of Ministry of Defence data

**2.7** During 2017 and 2018, the Department considered various options in seeking to understand the impact on the defueling facility project of its earlier decisions. As a result, in August 2018 it contracted Babcock, to a value of £4 million, to sustain the project over the next eight months by conducting the minimum work required to control costs and prevent the loss of skilled personnel. At this point, the Department had paid Babcock £265 million for the defueling facility project.

**2.8** Given delays, the Department most recently estimated it would start defueling in 2023, although this date is subject to commercial negotiations, regulatory permission and financial approval. The agreed timeframe will have broader cost and dock space implications. The Department pays an estimated £12 million a year to maintain and store the nine fuelled submarines currently kept in Devonport. Broader consequences include:

- **Maintaining fuelled submarines for longer**

  The Department currently stores nine submarines containing nuclear irradiated fuel. These have been stored for an average of nine years each, with the oldest being stored for 15 years after retiring in 2004. Following delays, the Department is considering how to store fuelled submarines for up to 35 years and will need to demonstrate to regulators this can be done safely.

- **Additional pressures on nuclear-licensed docks**

  The Department needs nuclear-licensed docks that are more highly regulated to maintain fuelled, as compared to unfuelled, submarines. It also needs these docks to maintain in-service submarines and prepare retired boats for long-term storage. At present, the Department does not have the space to prepare *Torbay*, which was retired in 2017, for storage. To overcome this, it has begun a £1.5 million project to design a way of preparing the submarine for long-term storage in the water, rather than in a dry dock. This approach is estimated to cost £1.3 million more than the existing process. However, it means the Department does not have to invest in creating the additional dock space required in Devonport, which it assesses as significantly more expensive. Until they are stored, boats need to be partially crewed, which potentially affects the Department's ability to redeploy personnel.

- **Sustaining nuclear fuelling skills**

  Delaying the start of defueling results in an estimated four-year gap between the Department completing a refuel of *HMS Vanguard* and starting to defuel its retired submarines. During this period, the Department will need to sustain the skills of Babcock's nuclear fuelling team at Devonport.

## Looking ahead

**2.9** To start defueling, the Department needs to complete both its defueling facility project and the Devonport infrastructure works. In 2018, the Department brought together oversight of these projects and developed an integrated plan. From April 2019, the DNO will oversee both the projects having gained budgetary control for the latter from the Royal Navy.

**2.10** Following delays to the defueling facility project, the Department is currently renegotiating with Babcock to complete the work. As the Department assessed that the initial contract had not delivered within the cost and time required, it decided that a new contract should be agreed to complete the work. It does not yet know how much it will cost to complete this work given commercial negotiations are ongoing but it expects to pay more than initially forecast for the facilities. Because the future costs are uncertain, the Department has not set aside a budget to complete the defueling facility project, which will need to be considered alongside other departmental priorities.

**2.11** The Department estimates that, depending on the availability of nuclear skills and dock space, defueling will take two years per boat. It therefore could take at least 24 years to defuel the nine submarines currently in storage and the three Trafalgar-class submarines that will leave service in the next 10 years. The Department does not yet have a budget for defueling submarines once the infrastructure and facilities works have been completed. As part of its longer-term financial planning, it will need to consider this requirement alongside wider equipment and support priorities.

**2.12** Looking further ahead, the Department is considering where to store the in-service submarines yet to be retired. In Devonport, it currently stores 12 submarines in Three Basin, a purpose-built water-based dock, which is approved to hold up to 14 submarines. The Department plans to request regulatory approval to hold up to 16. Assuming it gains this, Three Basin can accommodate the remaining four Trafalgar-class submarines that need to be placed in long-term storage. If it does not, the Basin will reach capacity around the mid-2020s. For the next boats to be retired – the Vanguard-class, from the 2030s – the Department will need to make space and consider either reducing the boats' size or extending the basin. The Department will also need to consider how to defuel both these and the Astute-class submarines, which have different designs.

# Part Three

## Submarine dismantling

**3.1** Once the irradiated fuel is removed, the next stage of submarine disposal is dismantling. This involves the Ministry of Defence (the Department) removing all the radioactive parts from the submarine. This Part sets out the scope of the Submarine Dismantling Project (the dismantling project); progress to date; and potential developments.

### Background

**3.2** The dismantling project covers the Department's 23 earliest nuclear submarines, powered by the first type of pressurised water reactor, alongside the four Vanguard-class submarines that will begin to leave service in the 2030s and that use a second version of the reactor.[7] To date, 20 of these 27 submarines have already left service, and are stored in Devonport and Rosyth, with nine of them yet to be defueled. Submarines cannot be dismantled until they have been defueled.

**3.3** Through the dismantling project, the Department aims to design and demonstrate the most cost-effective and safest way to remove different types of radioactive waste from the submarine, transport them to appropriate storage, recycling or disposal facilities, and then break up the submarine. Parts such as the Reactor Pressure Vessel (RPV) are classed as intermediate-level waste due to their level of radioactivity.

**3.4** In completing the dismantling project, the Department will meet its policy commitment to dispose of submarines as soon as reasonably practicable. It will also reduce the number of stored submarines, avoiding the associated maintenance costs and relieving dockyard pressures, particularly in Devonport.

7 The Department used its first-generation pressurised water reactor in submarines brought into service before 1993, after which it used a second version. A third version will enter service with the Dreadnought-class in the 2030s.

**3.5** Dismantling delays increase the storage time for retired submarines and the associated costs; an estimated £30 million a year to maintain and store the current 20 retired submarines. To ensure submarines are stored safely and securely, maintenance includes annual checks as well as the more detailed dry-dock maintenance periods that the Department has committed to conducting at least every 15 years. This work includes cleaning and re-painting the hull to prevent corrosion. The Department conducts similar maintenance for both fuelled and defueled submarines, with the former requiring a nuclear-licensed dock to undertake maintenance work. Given the lack of nuclear-licensed dock space, the Department is at risk of not meeting its 15-year commitment. It is now considering conducting regular inspections of each boat to determine the specific maintenance required, and therefore, when work should be undertaken. This would extend the time-frame for more detailed maintenance beyond the 15-year period.

## Progress to date

**3.6** The Department first considered submarine dismantling in 2000, after recognising that it may run out of space to store submarines and given an increasing public perception that it lacked a disposal policy. Since then, progress has been delayed, with changes to both the project's scope and technical approach (**Figure 10** on pages 36 and 37).

**3.7** In 2003, as part of its ISOLUS project, the Department committed to starting submarine dismantling in 2011, but due to a lack of progress and new government policy, the Department re-scoped the project in 2009 and revised the date at which it would roll out a tried and tested process to 2016.[8] This was then revised to 2024 in 2013 when the Department also outlined its requirement to "dismantle 27 defueled submarines by 2050 in a safe, secure and sustainable manner which upholds [its] reputation as a responsible nuclear operator". Following delays, it now estimates to fully dispose of these submarines by the late 2060s, up to 19 years later than envisaged, and roll out its approach by 2026, representing a 15-year delay. It expects to formalise these latest planning estimates by summer 2020.

**3.8** In 2018, the Department told the Committee of Public Accounts that it would have fully dismantled its first submarine, the demonstrator (*Swiftsure*), by 2023. In 2004, the Department estimated that it would cost £1.6 billion to dismantle 27 submarines. In 2016, it revised this to an estimated whole-life cost of £2.4 billion, a £0.8 billion (50%) increase.

8 Project ISOLUS stands for the 'interim storage of laid-up submarines'.

## Project ISOLUS

**3.9** After establishing Project ISOLUS in 2000, the Department undertook two rounds of public consultation to seek the views of stakeholders and affected communities, and to help define its approach. In particular:

- in 2001, it asked the public and stakeholders what they considered important as part of the dismantling process. The Department subsequently invited industry to submit outline proposals to manage retired submarines; and
- in 2003, it sought the public's views on the outline proposals developed in 2001. The Department formed a panel with members of the public from potential sites, and a National Forum involving local authorities and advocacy groups associated with those sites.

**3.10** In 2005, the Department implemented a £50 million savings measure that deferred Project ISOLUS for four years. In 2009, having spent £5 million on gathering and considering the public's views, the Department re-scoped this project to align with the UK's long-term radioactive waste management policy. This policy, released by the UK Committee on Radioactive Waste Management in 2006, recommended geological disposal as the best long-term solution for handling intermediate-level waste. Given that this policy prescribed how waste would be handled, the restructured project (the Submarine Dismantling Project) focused on dismantling and the interim storage of waste until it could be disposed of in the UK's Geological Disposal Facility.

## Submarine Dismantling Project

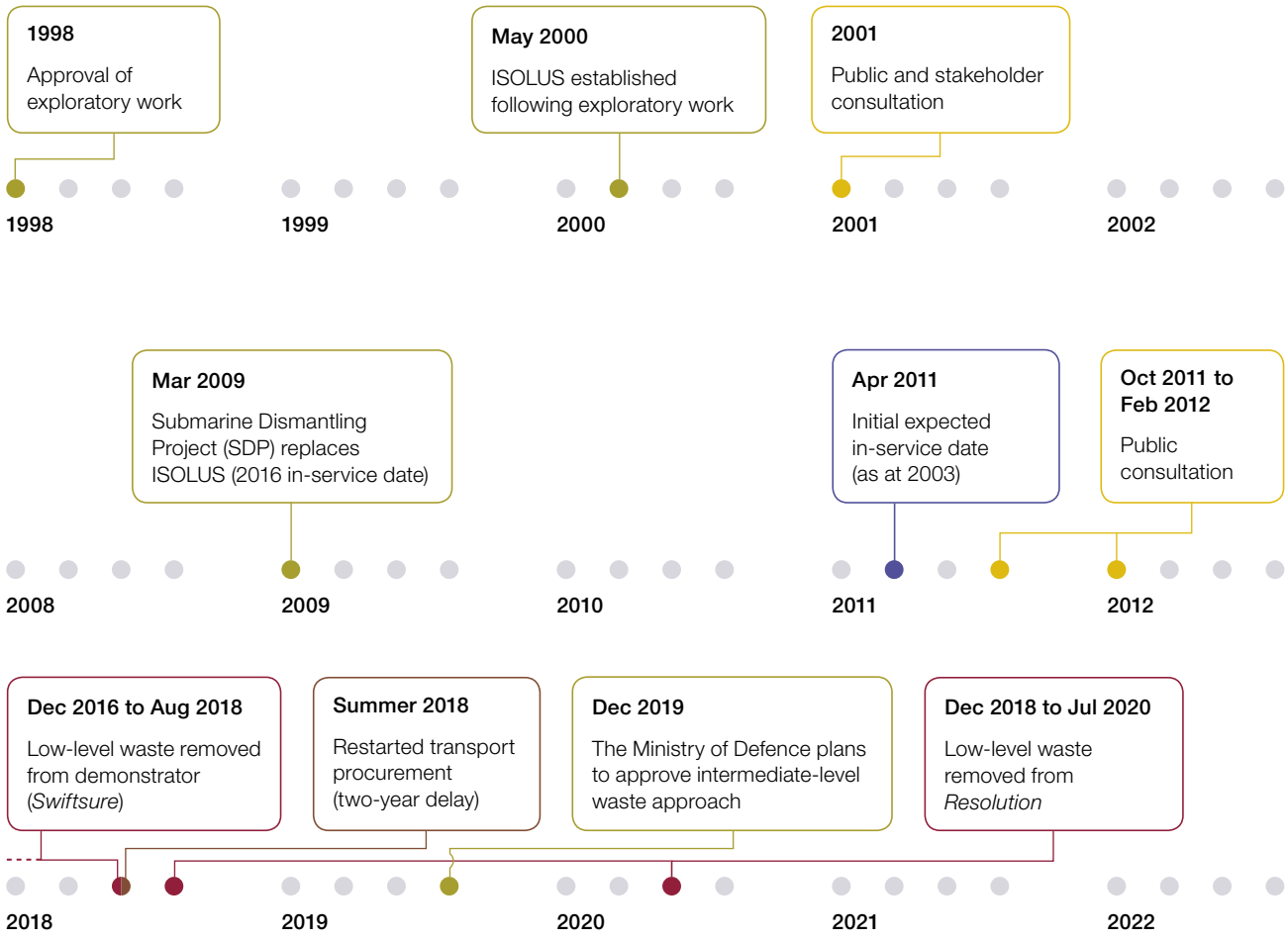
**3.11** Radioactive parts can be taken out of submarines in various ways. There are different approaches to removing intermediate-level waste, mainly the RPV from within the reactor compartment. These include:

- removing the RPV as a single unit, then transporting it whole to a storage facility in a bespoke container;
- removing the intermediate-level waste by cutting up the RPV into smaller parts within the submarine and transporting them to storage in industry-standard containers; or
- removing the entire reactor compartment, including the RPV, and taking it to another facility within a dockyard to either store it or have it cut up before being transported to storage in industry-standard containers.

**3.12** Other countries such as the United States, France and Russia have chosen to remove the nuclear reactor compartment whole from the submarine, rather than separate out the different types of radioactive waste. They then store the compartment indefinitely and recycle the boat. The US has stored its compartments in the desert, while France stores them at a Navy base in Cherbourg. To date, the US has dismantled more than 100 boats and France has dismantled three.

## Figure 10
Submarine Dismantling Project timeline

**The Ministry of Defence has been managing submarine dismantling projects for 19 years**

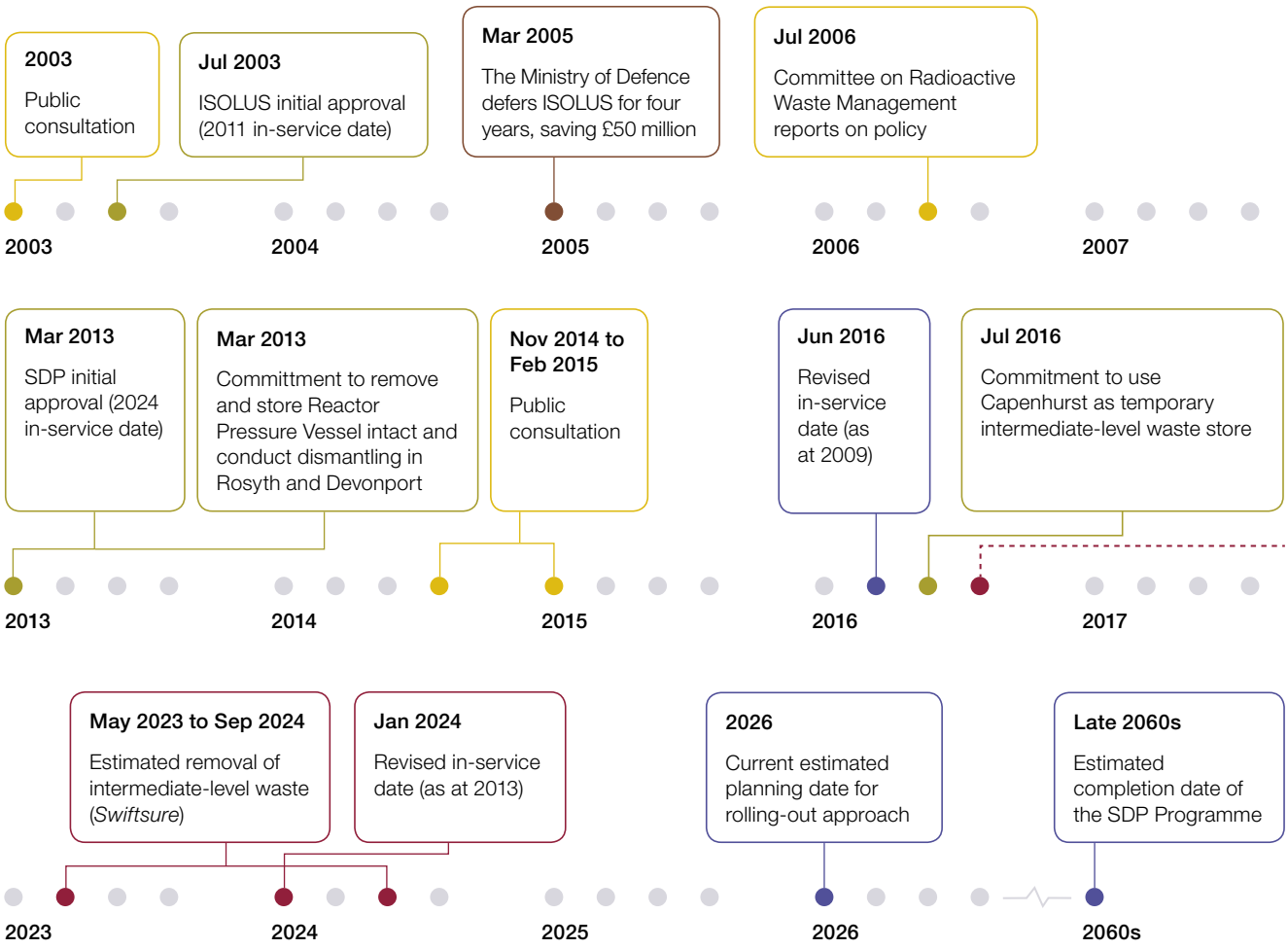



**Notes**

1 In-service dates refer to when a designed and tested dismantling process can be rolled-out for remaining submarines.

2 Project ISOLUS stands for the 'interim storage of laid-up submarines'.

Source: National Audit Office analysis of Ministry of Defence data


2003
Public consultation
Jul 2003
ISOLUS initial approval (2011 in-service date)
Mar 2005
The Ministry of Defence defers ISOLUS for four years, saving £50 million
Jul 2006
Committee on Radioactive Waste Management reports on policy
2003
2004
2005
2006
2007
Mar 2013
SDP initial approval (2024 in-service date)
Mar 2013
Committment to remove and store Reactor Pressure Vessel intact and conduct dismantling in Rosyth and Devonport
Nov 2014 to Feb 2015
Public consultation
Jun 2016
Revised in-service date (as at 2009)
Jul 2016
Commitment to use Capenhurst as temporary intermediate-level waste store
2013
2014
2015
2016
2017
May 2023 to Sep 2024
Estimated removal of intermediate-level waste (*Swiftsure*)
Jan 2024
Revised in-service date (as at 2013)
2026
Current estimated planning date for rolling-out approach
Late 2060s
Estimated completion date of the SDP Programme
2023
2024
2025
2026
2060s

**3.13** After re-scoping the project in 2009, the Department planned to conduct a further public consultation. This was delayed until late 2011 when it started a two-stage consultation to inform its decision on:

- how waste should be removed from submarines, where this process should be conducted and the type of sites where waste should be stored – this consultation started in 2011; and
- the location for the temporary intermediate-level waste store, focusing on five potential sites – this consultation started in 2014.[9]

**3.14** In 2013 and 2016, the Department announced its response to these consultations and committed to a two-stage approach to dismantling, with the first submarine to be dismantled in Rosyth and the process undertaken both there and in Devonport.[10] The approach would differ to that adopted internationally and involve separating:

- low-level waste, which would be transported to the UK's Low-Level Waste Repository in West Cumbria (Stage 1); and
- intermediate-level waste, principally the RPV, which would be removed from the nuclear reactor compartment whole and then transported whole to an interim store in Capenhurst, Cheshire until the Geological Disposal Facility becomes available (Stage 2).

**3.15** Given affordability constraints, in 2016-17 the Department deferred the dismantling project in order to stay within the available budget. This deferred £10 million of expected spending to 2020-21. As a result, the Department has contracted boat by boat and stage by stage, initially contracting with Babcock to remove the low-level waste from its first submarine, *Swiftsure*. It aimed to use this to demonstrate it could complete this stage and develop a standardised process for dismantling the remaining submarines within the project.

**3.16** Between December 2016 and August 2018, the Department removed low-level waste from *Swiftsure*, 24 years after the submarine was decommissioned. The work was completed on time and within budget at a cost of £13 million. The Department subsequently returned *Swiftsure* to long-term storage while it considers how to remove the intermediate-level waste. Taking account of its learning, in December 2018 the Department began removing the low-level waste from *Resolution* and expects to complete this by July 2020.

9 Shortlisted sites were Atomic Weapons Establishment (Aldermaston and Burghfield), URENCO Nuclear Stewardship (Capenhurst) and Nuclear Decommissioning Authority (Chapelcross and Sellafield) sites. Ministry of Defence, *Submarine Dismantling Project, MOD's Response to Consultation and Strategic Environmental Assessment Post-Adoption Statement about the Site for the Interim Storage of Intermediate Level radioactive Waste*, July 2016.

10 Ministry of Defence, *Submarine Dismantling Project, MoD's Response to Consultation*, March 2013.

**3.17** The Department cannot start removing the intermediate-level waste from *Swiftsure* until it has designed removal, transport and storage processes that have been approved by the regulator. To date, the Department has formalised where it will store waste, but not how to remove or transport it (**Figure 11**). It has assessed developing the transport solution as high risk. In 2018, it had to restart its procurement of intermediate-level waste transportation as the original competition in 2017 did not result in any compliant bids. The Department will now only contract for the design, with an option to then contract for the initial manufacture of a transport container. In re-opening the procurement, it told us it had conducted more market testing, provided greater certainty about its requirements, and therefore sought a more flexible fixed-price contract.

## Figure 11

Status of the Ministry of Defence's plans for intermediate-level waste, January 2019

**The Ministry of Defence requires approved designs to remove, transport and store intermediate-level waste**

| | Status | Detail |
|---|---|---|
| Waste removal | Technical approach being reviewed | The Ministry of Defence has developed initial concept designs to remove and store the RPV whole, still to be developed into technical processes approved by the regulator. It is reconsidering this in light of technological developments from the civil sector. |
| Waste transportation | Re-started procurement | In 2018, the Ministry of Defence re-started its procurement for the detailed design of bespoke containers to transport and store the RPV. This followed it not receiving compliant bids under a previous procurement. The design depends on how the intermediate-level waste will be removed. |
| Waste storage | Contracted | In 2017, the Ministry of Defence contracted URENCO Nuclear Stewardship Limited to provide an interim store at its nuclear-licensed site in Capenhurst, Cheshire through a four-year fixed cost contract valued at £5.5 million (an estimated £1.5 million a year). On current plans, the Department expects to use these facilities from the mid-2020s and intends to extend the current contract so facilities are available when required. |

**Notes**

1 RPV stands for Reactor Pressure Vessel.

2 The Department ultimately plans to dispose of its intermediate-level waste in the UK's Geological Disposal Facility, with the aim of it taking submarine-related intermediate-level waste from the 2050s.

Source: National Audit Office analysis of Ministry of Defence data

**3.18** Re-starting the procurement has led to delays in developing a dismantling process. The Department is assessing the impact of this delay, and now currently estimates it will roll out its approach for other submarines by 2026, resulting in a two-year delay. It expects to formalise this latest planning date by summer 2020. Given this delay, the Department continues to reserve the intermediate-level waste storage in Cheshire that it is not yet using. Should further delays affect the end date for dismantling submarines, which has been delayed 15 years to-date, the Department's costs will increase by £30 million a year for storage and maintenance.

## Looking ahead

**3.19** The Department has used the recent two-year project delay to assure itself that the current technical approach remains the most appropriate. This includes reconsidering options assessed in 2013 (paragraph 3.11) against more recent technology and lessons from the civil sector. The choice will affect the transport required and future milestones, given that some approaches will take longer to develop than others. Until decisions have been made and designs developed, the future costs remain uncertain. Should it take six months longer than the expected 18 months to remove the intermediate-level waste from boats being dismantled in two stages, and a similar delay dismantling the remaining submarines, the Department's £7.5 billion liability could increase by £0.9 billion given the additional maintenance costs.[11]

**3.20** In 2018, the Department committed to agreeing and demonstrating how to dismantle its first submarine, *Swiftsure*, by 2023. In working towards this commitment, the Department intends to decide how it will remove and transport the intermediate-level waste by December 2019. In doing so it will need to consider factors including the associated cost and available budget, dockyard constraints, timeframes and responses to the public consultation.

**3.21** To complete the disposal process, the Department needs to break down the boat, so that the parts can be sold or reused. This could be done in a non-nuclear-licensed dockyard. In July 2017, the Department started market engagement to understand how this could work. It has not yet determined whether it will have to pay, or will be paid, for handling the resultant scrap metal.

**3.22** Looking further ahead, the Department does not have plans in place to dismantle its seven Astute-class submarines, three of which are already in service, or the four Dreadnought-class submarines currently being built. These submarines have different designs and nuclear reactors, which may require a different dismantling approach. The Department has identified a £308 million liability to dismantle the three Astute-class submarines currently in service.

11 Ministry of Defence, *Ministry of Defence Annual Report and Accounts 2017-18*, July 2018.

# Appendix One

## Our investigative approach

### Scope

**1** We investigated the Ministry of Defence's (the Department's) disposal of nuclear submarines. Our report:

- explains the submarine defueling and dismantling process;
- describes the defueling-related projects and progress made; and
- describes the submarine dismantling projects and progress made.

**2** Our investigation does not examine the liabilities and disposal of non-submarine-related nuclear assets such as nuclear warheads. Our investigation focuses primarily on the decommissioning of nuclear submarines and the resulting nuclear liabilities. We do not assess the value for money of the process or individual programmes within the process.

### Methods

**3** In examining these issues, we drew on a variety of evidence sources including:

- interviews with staff from the Submarine Delivery Agency (SDA);
- interviews with the Defence Nuclear Organisation (DNO);
- analysis of the Department's financial data;
- analysis of project data; and
- a review of documentation including business cases and board papers.

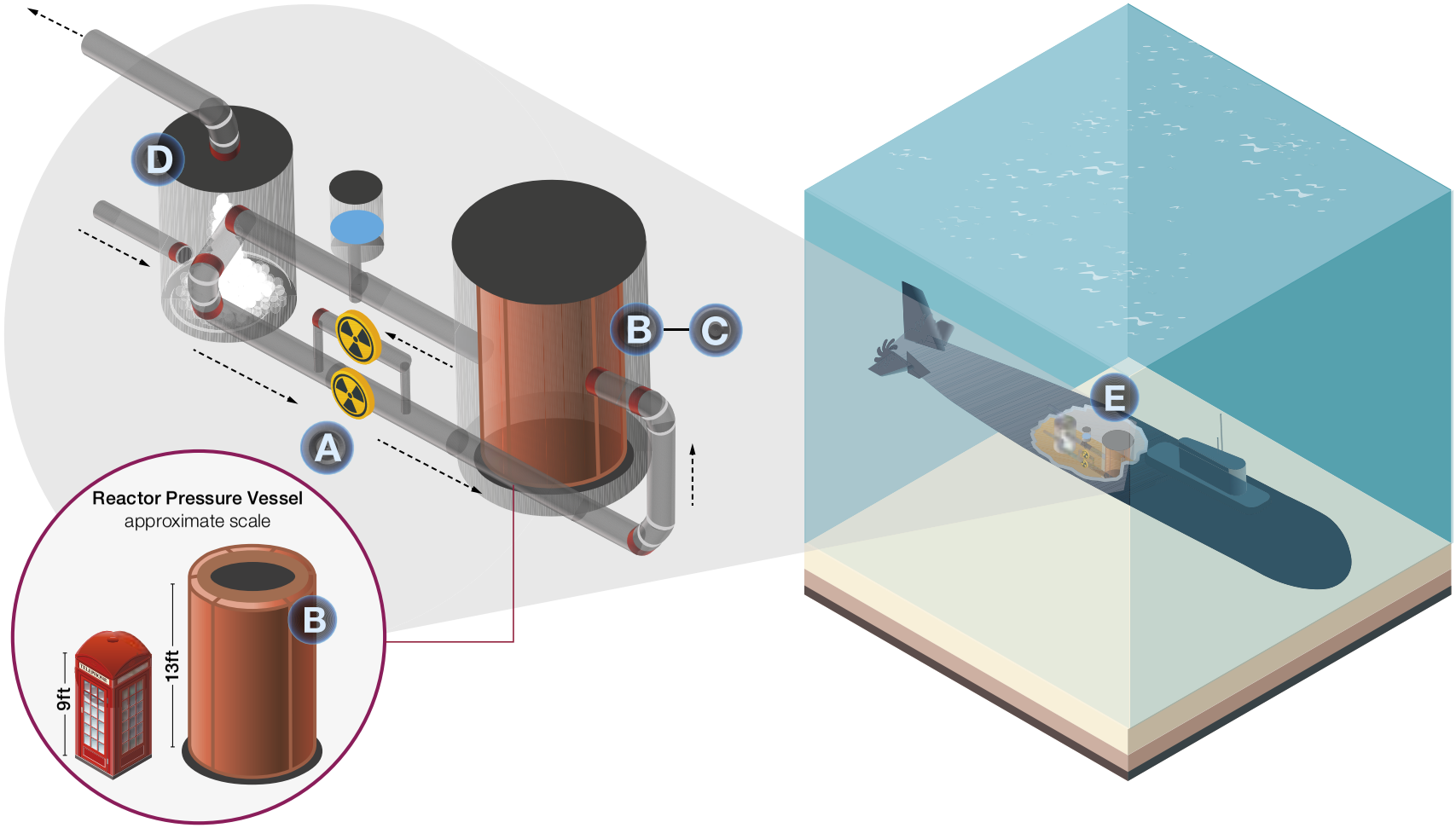
We conducted our own analysis on the costs of disposing of, maintaining and storing submarines. We also relied on the audited financial information prepared to support the Department's 2017-18 Annual Report and Accounts.

# Appendix Two

## Submarine components

## Figure 12
Submarine components

**Within the submarine, the Reactor Pressure Vessel contains the nuclear reactor core**




A Primary Circuit – low-level waste
B Reactor Pressure Vessel – intermediate-level waste
C Irradiated fuel
D Steam generator
E Reactor compartment

Source: Ministry of Defence

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National Audit Office

Design and Production by NAO External Relations
DP Ref: 007296-001

£10.00

ISBN 978-1-78604-255-2