

**Research Briefing**

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# Replacing the UK's nuclear deterrent: The Warhead Programme

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Since 2006 work has been underway on several programmes that will maintain the UK's nuclear deterrent beyond the life of the current system. Much of the focus in that time has been on the delivery of a new class of ballistic missile submarine (the Dreadnought class), which are expected to enter service from the early 2030s. However, a decision on replacing the UK's Mk4/A nuclear warhead was also awaited and work on possible options had been ongoing. After a decision was deferred in 2010, one was widely expected to be taken as part of the Government's [Integrated Defence and Security Review](#) in 2021.

In February 2020, however, a US official disclosed the existence of a UK replacement warhead programme, which the Government subsequently confirmed in a Statement to the House. That revelation prompted widespread criticism that a decision appeared to have been taken without an official Government announcement or appropriate Parliamentary scrutiny.

The programme is currently in its concept phase (the first phase in any Ministry of Defence procurement project). Details on timeframe and costings are expected to be matured as the programme progresses.

## 1 Background

A nuclear warhead is an explosive device that derives its energy from a nuclear reaction. The explosive force (or yield) is measured in terms of the quantity of conventional explosives (TNT) that would be required to produce a similar amount of energy (usually expressed in kilotons or megatons).<sup>1</sup>

Nuclear warheads can be delivered by air as a free fall gravity bomb or can be miniaturised to fit within the tip of a missile (either air-launched, ground-launched or submarine/ship-launched).

### 1.1 The UK's Mk4 nuclear warhead

The Mk4 (Holbrook) nuclear warhead is designed, manufactured, and maintained by the [Atomic Weapons Establishment](#) (AWE) in Berkshire. Public information about it is scarce but it is thought to be based on the American W76 warhead design and has a yield of around 100 kilotons. Certain non-nuclear components for the warhead are procured from the US on cost

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<sup>1</sup> One kiloton is equivalent to one thousand tons of TNT. One megaton is equivalent to one million tons of TNT (US Department of Energy, [The Manhattan Project: Processes](#))

effectiveness grounds.<sup>2</sup> It entered service in 1994 to coincide with the introduction of the Trident II D5 missile system.

## 1 Composition of the UK's nuclear deterrent

The UK is the only nuclear weapon state that operates a single deterrent capability: the submarine-launched Trident system. Other nuclear states also have the capacity to deliver a nuclear warhead by air and/or ground-launched ballistic missile. The UK's nuclear deterrent has three main elements:

- **Four Vanguard-class submarines (SSBN)**, armed with **Trident II D5 missiles**. The Trident II missiles are held in a communal pool with the United States. This constitutes the delivery system of the deterrent.
- The **Mk4/A (Holbrook) nuclear warhead** deployed on the Trident II D5 missile.

## 1.2

## The Nuclear Warhead Capability Sustainment Programme (NWCSP)

In 2005 the AWE began the Nuclear Warhead Capability Sustainment Programme (NWCSP). Over an estimated period of 20 years, and at an initially estimated cost of £20 billion, the NWCSP aims to sustain key nuclear skills and technological capability and deliver improved infrastructure, to both manage the UK's current nuclear stockpile and to underpin any future nuclear warhead replacement programme.

There are two main infrastructure projects underway at AWE under the remit of the NWCSP:

- Project MENSA – a new nuclear warhead assembly and disassembly facility at the AWE site in Burghfield. The project is expected to be

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<sup>2</sup> Collaboration with the US is conducted under the [1958 UK-USA Mutual Defence Agreement](#) and the [Polaris sales agreement](#) 1963, as amended for Trident ([Treaty Series 086/1980](#)) and ([Treaty Series 008/1983](#)).

completed in 2024, seven years late and more than £1.2 billion over its original forecast cost estimate.<sup>3</sup>

- Project Pegasus – a new enriched uranium storage and manufacturing facility at the AWE site in Aldermaston. The project was paused in 2018 following a review of the programme which concluded that an “overly complex technical solution” had been chosen which had resulted in significant additional construction and safety costs and led to severe delays to the programme.<sup>4</sup> The programme restarted in 2021 and will now be run in two phases: completion of the storage facility by 2025 and completion of the manufacturing facility by 2030. The original in-service date for the project was 2019.<sup>5</sup> Estimates for the overall project are expected to exceed the current approved cost of £634 million.<sup>6</sup>

The UK-French Teutates project on nuclear stockpile stewardship, which includes the construction of a new hydrodynamics facility in Valduc, also forms part of the NWCSP.<sup>7</sup>

The UK has also been undertaking work with the United States, through the UK-US Joint Technology Demonstrator (JTD) project examining warhead safety, security and advanced manufacturing technologies. In its 2016 Update to Parliament the Ministry of Defence (MOD) sought to reiterate that the JTD was not a new warhead programme but intended to:

help sustain skills and develop the capabilities, processes and technology needed to inform potential options being considered in future, and to reduce future technical, cost and schedule risks.<sup>8</sup>

The projects being undertaken through the NWCSP are funded as part of the annual in-service costs of the nuclear deterrent, which currently stand at around 6% of the defence budget.<sup>9</sup> Under planned defence expenditure, in 2023/24 the in-service costs of the nuclear deterrent will equate to £3 billion.<sup>10</sup>

In its [2023 Spring Budget](#), the Treasury announced an uplift in the defence budget of £11 billion over the next five years. £3 billion of that additional money will support investment in the defence nuclear enterprise (the

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<sup>3</sup> PQ34804, [AWE Aldermaston and AWE Burghfield](#), 15 July 2022 and PQ45, [AWE Aldermaston and AWE Burghfield](#), 18 May 2022. The project is examined in greater detail by the National Audit Office in its January 2020 report, [Managing infrastructure projects on nuclear-regulated sites \(PDF\)](#), HC19, Session 2019-20

<sup>4</sup> Ministry of Defence, [Project Pegasus Accounting Officer Assessment \(PDF\)](#), March 2021

<sup>5</sup> PQ34804, [AWE Aldermaston and AWE Burghfield](#), 15 July 2022

<sup>6</sup> Ministry of Defence, [Project Pegasus Accounting Officer Assessment \(PDF\)](#), March 2021 and PQ45, [AWE Aldermaston and AWE Burghfield](#), 18 May 2022

<sup>7</sup> Library briefing paper, SN04079, [The French Nuclear Deterrent](#), examines the Teutates project and the 2010 UK-French nuclear treaty in greater detail.

<sup>8</sup> Ministry of Defence, [The United Kingdom's Future Nuclear Deterrent: 2016 Update to Parliament](#), December 2016

<sup>9</sup> HL328, Trident submarines, 6 June 2016 and HC deb 11 November 2010, c450W

<sup>10</sup> The costs of the nuclear deterrent are examined in greater detail in [Library Briefing CBP8166, The costs of the UK's strategic nuclear deterrent](#)

overarching, and complex, network of programmes, infrastructure, equipment and people that support both the nuclear deterrent and the Royal Navy's nuclear powered submarine programmes), and fund the next phase of [the new SSN-AUKUS submarine programme](#). It is unclear whether any of that money will be invested in AWE. At the end of March 2023, then Defence Procurement Minister, Alex Chalk, said "the Department is currently working through the allocation of this funding".<sup>11</sup>

In November 2020 the MOD announced that [AWE would be brought back under direct Government ownership and control](#), in part to ensure AWE's ability to deliver the Replacement Warhead Programme.<sup>12</sup>

## Refurbishment of the Mk4 warhead

As part of the NWCSP AWE is currently refurbishing the UK warhead to replace obsolete components and incorporate the US-designed Mk4A arming, fusing, and firing system. In June 2016 the MOD said that this refurbishment did not equate to a new warhead and "does not change the destructive power of the weapon".<sup>13</sup>

## 2

## Timeline of decision making on a replacement warhead

A 2006 Government White Paper, [The Future of the United Kingdom's Nuclear Deterrent](#) (PDF), committed to retaining the UK's existing nuclear capability beyond the life of the current system, by replacing the Vanguard class submarines (SSBN) and participating in the US service-life extension programme for the Trident II D5 missile. It did not commit to a replacement programme for the nuclear warhead at that time.

As the existing nuclear warhead design was expected to last into the 2020s, the Paper suggested that such decisions would not be required until the 2010 Parliament. The Government did state, however, that:

In order to inform these decisions, we will undertake a detailed review of the optimum life of the existing warhead stockpile and analyse the range of replacement options that might be available. This will include a number of activities to be undertaken with the United States...<sup>14</sup>

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<sup>11</sup> [PQ172329](#), 28 March 2023

<sup>12</sup> HL5042, [AWE](#), 4 January 2022 and Defence Select Committee, Oral evidence: MOD annual report and accounts, HC1051, 8 December 2020, Q.26

<sup>13</sup> [Defence in the media](#), 8 June 2016

<sup>14</sup> The Future of the United Kingdom's Nuclear Deterrent, CM 6994, December 2006, para 7-4

## 2.1 SDSR 2010 – deferral of a warhead decision

The 2010 Strategic Defence and Security Review (SDSR) made a number of changes to the size of the UK's nuclear arsenal and its deployed capability. It also updated several assumptions in the 2006 White Paper about the nuclear deterrent replacement programme.

As a result of the work being done on the optimum life of the existing warhead stockpile, the SDSR changed the earlier assumption that a replacement warhead would be required in the 2020s. It concluded that “a replacement warhead is not required until at least the late 2030s” and as such “decisions on replacing the warhead will not therefore be required in this Parliament”. To drive value for money within the broader nuclear deterrent replacement programme, the decision was expected to defer £500m of spending from the following 10 years.<sup>15</sup>

## 2.2 SDSR 2015

The 2015 SDSR confirmed that work to determine the optimum life of the existing warhead stockpile and on the range of replacement options, continued. However, it also alluded to the possibility of retaining the current warhead in service longer than previously anticipated:

A replacement warhead is not required until at least the late 2030s, possibly later. Given lead times, however, a decision on replacing the warhead may be required in this Parliament or early in the next. In the meantime, we continue to invest significantly in the Atomic Weapons Establishment to maintain the facilities and skills necessary to assure the safety and security of the current stockpile, and to sustain the ability to develop a replacement warhead when we need to do so.<sup>16</sup>

Those lead times had already been examined as part of the 2013 [Trident Alternatives Review \(PDF\)](#). A panel of experts expressed the view that it would take 17 years to design, develop, certify and manufacture a new nuclear warhead.<sup>17</sup> That timeframe was subsequently reiterated by the Ministry of Defence in its [2014 Update to Parliament](#).

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<sup>15</sup> [Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review](#), Cm 7948, October 2010, para 3.12

<sup>16</sup> [National Security Strategy and Strategic Defence and Security Review 2015 \(PDF\)](#), Cm9161, November 2015, para.4.72

<sup>17</sup> Executive Summary, para 18. The long lead time is largely based around the length of time required to certify a new nuclear warhead, in the absence of live nuclear testing. The UK signed the Comprehensive Test Ban Treaty in 1996 and ratified it in 1998. Although the treaty has yet to enter into force the UK is committed to its principles.

As a result of the 2015 SDSR, a decision on a replacement warhead was therefore earmarked for around the end of the decade. In its [2017 Update to Parliament](#) the MOD subsequently stated that “a decision on replacing the warhead will be required in this Parliament [before the end of May 2022] and work continues on developing replacement options”.

When asked about a decision on the replacement warhead during a debate in the House in April 2019, the Minister replied that:

work continues to transition. We continue to refine the options and the technical solutions that will inform the final Government decision, bearing in mind that the replacement is not really required until the late 2030s or possibly even later.<sup>18</sup>

In December 2019 the MOD published its [2019 Update to Parliament](#). That report merely stated that “work also continues to develop the evidence to support a government decision when replacing the warhead”.<sup>19</sup>

### 3 Confirmation of a replacement warhead programme

In February 2020 the US Commander of United States Strategic Command, Admiral Charles Richard, revealed during an evidence session of the Senate Armed Services Committee that work on its new W93 warhead was being conducted in parallel with a UK programme for a new replacement warhead:

The Nuclear Weapons Council has established a requirement for the W93/Mk7 warhead. This warhead will provide USSTRATCOM and the Navy a means to address evolving ballistic missile warhead modernization requirements, improve operational effectiveness, and mitigate technical, operational, and programmatic risk in the sea-leg of the triad.

This effort will also support a parallel Replacement Warhead Program in the United Kingdom whose nuclear deterrent plays an absolutely vital role in NATO's overall defense posture. Without a coordinated, joint effort to develop and field the W93/MK7 as a system, the bulk of our day-to-day deterrent force will be at increased risk in the early 2040s due to aging legacy systems.<sup>20</sup>

The revelation came less than two months after the MOD's 2019 Annual Report to Parliament had stated that “work continued” on the evidence to support a government decision on a replacement warhead.

The US disclosure prompted widespread criticism that a decision appeared to have been taken without an official Government announcement and

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<sup>18</sup> HC Deb 10 April 2019, c418

<sup>19</sup> Ministry of Defence, [Annual Report to Parliament 2019](#)

<sup>20</sup> Senate Committee on Armed Services, [Statement of Charles A. Richard, Commander United States Strategic Command \(PDF\)](#), 13 February 2020

appropriate Parliamentary scrutiny. On 25 February 2020 the Secretary of State for Defence, Ben Wallace, subsequently made a Written Statement to the House [confirming the existence of a replacement warhead programme](#).

In its [2020 Annual Report to Parliament](#), and in [subsequent parliamentary questions](#), the MOD has confirmed that:

- The warhead will be designed, developed, and manufactured in the UK.
- The warhead will be housed in the US Mk7 aeroshell, which will also house the US W93 warhead. The Mk7 aeroshell will be procured from the US along with some other non-nuclear components under existing nuclear treaty arrangements.<sup>21</sup>
- The UK will continue to work with the US to ensure that the warhead remains compatible with the Trident missile system.<sup>22</sup>

## 3.1 Parliamentary scrutiny

Several commentators accused the Government of taking a decision to replace the UK's nuclear warhead without appropriate parliamentary scrutiny.<sup>23</sup>

The Government is not legally or constitutionally obliged to seek parliamentary approval on a programme to replace the nuclear warhead and successive Governments have never made a political commitment to do so.

In its statement on the replacement warhead programme on 25 February 2020, the Government pointed to two previous votes in Parliament which had endorsed the overall programme to replace the UK's nuclear deterrent beyond the 2030s: [a vote in March 2007](#)<sup>24</sup> and a subsequent vote in July 2016.<sup>25</sup> It was this latter debate and vote that enabled the SSBN replacement programme to move forward into its manufacturing phase, which will see the construction of four new Dreadnought class ballistic missile submarines that will begin to enter service in the early 2030s.

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<sup>21</sup> See Footnote 2

<sup>22</sup> Ministry of Defence, [Annual Report to Parliament 2020](#) and PQ166353, [USA: Nuclear weapons](#), 15 March 2021

<sup>23</sup> See for example: Campaign for Nuclear Disarmament, [Press release](#), 25 February 2020

<sup>24</sup> That motion was passed on division by 409 to 161 votes (Division No.78, 2006-07 Session)

<sup>25</sup> The motion was passed on division by 472 to 117 votes (Division 46, 18 July 2016). Parliament had also voted in support of the Government's plans to replace the nuclear deterrent in response to SNP-led Opposition Day debates in January 2015 and November 2015.



The Government has also said that it will feed into the scrutiny process by continuing to provide updates in its annual report to Parliament.<sup>26</sup>

## 3.2

# Compliance with the UK's international legal obligations

### Article VI of the NPT

“Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control”.

There is a longstanding argument that replacement of the UK's nuclear deterrent is not compliant with the UK's international legal obligations under the Nuclear Non-Proliferation Treaty (NPT).

David Cullen, Director of the Nuclear Information Service, supports this view and has argued that the warhead announcement “would take us in the opposite direction” to the UK's NPT obligations.<sup>27</sup> Hans Kristensen of the Federation of American Scientists shares this opinion:

Britain and the US have come a long way from being leaders in reducing the role of nuclear weapons and contemplating the possible road toward potential disarmament to re-embracing nuclear weapons for the long haul. They are obviously not alone in this, with Russia, China and France doing their own work. So, overall, this is a serious challenge for the international non-proliferation regime.<sup>28</sup>

Successive British Governments have, however, argued that the NPT contains no prohibition on updating existing weapons systems and gives no explicit timeframe for nuclear disarmament.

In March 2020 the MOD reaffirmed its view that work on the replacement warhead “will continue to be fully compliant with our obligations under the Treaty on the Non-Proliferation of Nuclear Weapons”.<sup>29</sup>

<sup>26</sup> HCWS125, [Nuclear Deterrent](#), 25 February 2020

<sup>27</sup> “Pentagon reveals deal with Britain to replace Trident”, *The Guardian*, 22 February 2020

<sup>28</sup> “Pentagon reveals deal with Britain to replace Trident”, *The Guardian*, 22 February 2020

<sup>29</sup> PQ24309, Nuclear weapons: USA, 11 March 2020

## 4 What stage is the replacement programme at?

The Replacement Warhead Programme is currently in its concept phase, which is the first phase in any MOD procurement project, having gained Cabinet Office approval of its Strategic Outline Case in September 2021.<sup>30</sup>

The Concept phase is an opportunity to examine the feasibility of different procurement options and to identify performance, cost, and time parameters for the programme.

### 4.1 Potential costs

Given that the Replacement Warhead Programme is still in its early stages, the MOD has said that “it is too early to provide cost estimates... as much will depend on the eventual design requirements”.<sup>31</sup>

In evidence to the Defence Select Committee in December 2020, MOD officials indicated that the complexity of the programme, any commercial arrangements, and the level of collaboration with the United States and its W93 programme would have an impact on any cost estimate.<sup>32</sup>

In June 2021, the MOD revealed that planning for a replacement warhead, had incurred the following costs since 2018:

The Ministry of Defence spent £116 million up to the end of the financial year (2018-19). A total of £98 million was spent on the Replacement Warhead readiness phase over the subsequent two financial years (2019-20 and 2020-21).<sup>33</sup>

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<sup>30</sup> PQ128233, [Nuclear weapons: Procurement](#), 1 March 2022. Most MOD equipment procurement programmes are conducted according to the generic CADMID cycle which has six defined stages: Concept, Assessment, Demonstration, Manufacture, In-service and Disposal. In the past there have been two main investment approval points, or “gates” within that cycle which allow a programme to proceed: after the Concept phase (Initial Gate) and following the assessment phase (Main Gate). In 2020, however, the MOD adopted [Treasury guidance on project approvals](#) (PDF) which now sees three points of approval in any procurement programme: a Strategic Outline Case prior to the Concept phase, an Outline Business Case, similar to Initial Gate and a Full Business Case, akin to Main Gate. The MOD has adopted a different procurement approach with respect to the procurement of the Dreadnought SSBN programme, which will be subject to several stages of investment and multiple financial control points. This is examined in more detail in Library briefing, [Replacing the UK's nuclear deterrent: Progress of the Dreadnought class](#)

<sup>31</sup> PQ165426, [Trident submarines: Finance](#), 17 March 2023

<sup>32</sup> Defence Select Committee, Oral evidence: MOD annual report and accounts, HC1051, 8 December 2020, Q.29

<sup>33</sup> PQ21809, Nuclear weapons: expenditure, 30 June 2021

The MOD has confirmed that work is currently underway to agree cost estimates and funding arrangements,<sup>34</sup> which would suggest that the programme may be funded and managed independently of the NWCSP.

In the original 2006 White Paper on replacing the nuclear deterrent, the Department had suggested that the cost of a replacement warhead programme would be in the region of £2-3 billion (£2.8-£4.3 billion in 2022/23 prices).<sup>35</sup>

## Box 2: Further Reading

- CBP08010, [Replacing the UK's nuclear deterrent: progress of the Dreadnought class](#)
- CBP08166, [The cost of the UK's strategic nuclear deterrent](#)
- CBP09175, [Integrated Review 2021, Increasing the cap on the UK's nuclear stockpile](#)
- CBP07353, [Replacing the UK's 'Trident' nuclear deterrent](#), July 2016
- Ministry of Defence, [Defence Nuclear Organisation](#)
- Ministry of Defence, [Future of the UK's Nuclear Deterrent: Annual Updates to Parliament](#)
- [Extreme circumstances: The UK's new nuclear warhead in context](#) (PDF), Nuclear Information Service, August 2022
- House of Lords International Relations and Defence Committee, [Oral evidence: Defence concepts and capabilities](#) (PDF), 17 May 2022
- [Dependent deterrent? US support for the UK's new nuclear warhead](#), RUSI Commentary, 3 March 2021
- [The UK's new nuclear warhead: issues for Parliament](#), RUSI Commentary, 11 January 2021
- [No Go for GOCO: the UK renationalises its warhead factory](#), RUSI Commentary, 6 November 2020

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<sup>34</sup> PQ165426, [Trident submarines: Finance](#), 17 March 2023

<sup>35</sup> HM Government, [The Future of the United Kingdom's Nuclear Deterrent](#) (PDF), Cm6994, December 2006

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