SEPTEMBER 2018

BASIC

Blowing up the Budget

The Cost Risk of Trident to UK Defence

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Overview[1]

On 18 July 2016, the House of Commons voted[2] to replace the UK's *Vanguard*-class ballistic missile submarines (SSBN), in effect committing the UK to operating the Trident II D5 submarine-launched ballistic missile on a Continuously At-Sea Deterrence (CASD) posture beyond 2060, at a 2015/16 capital cost of £31bn with an HM Treasury-guaranteed £10bn contingency: a total of £43.3bn in current values.[3] This makes the *Dreadnought* the second-largest public capital procurement programme in the next decade, comparable only with the High Speed 2 railway line from London to Manchester and Leeds.[4]

Though Trident has faded as a political issue, in an era dominated by the UK's departure from the European Union, it is programmed to consume between a quarter and a third of the Ministry of Defence (MoD) procurement budget from the mid-2020s to the late 2030s. Given the cost and time overruns on the *Astute* submarine programme, which by 2011 were 30.4% above the initial budget in real terms,[5] and the poor track record of the MoD and industry in delivering to time and cost, the risk that *Dreadnought* cost overruns mean further cuts to the MoD's procurement budget for the reequipment of the UK's conventional forces in the 2020s and 2030s is significant. Already rated Amber/Red[6] by the Government's Infrastructure and Projects Authority for 2015, 2016 and 2017,[7] further delays in the *Dreadnought* programme would require either a further life-extension to one or two

of the *Vanguard* submarines to maintain Continuous At-Sea Deterrence (CASD).

Project risks are exacerbated by the fall in value of sterling against the US Dollar in the aftermath of the Brexit Referendum, increasing the cost of US-sourced components by 8–10%. Assuming that 40% of the *Dreadnought* programme by value is invoiced in US Dollars, this alone means a cost increase of at least £1.0bn, and further falls in sterling's value will proportionately increase *Dreadnought* costs, increasing pressure on the MoD Equipment Budget.

This paper finds that short of a sustained sterling rally, the cost pressures are all on the upside, meaning it is unlikely that the programme will be delivered within the existing £43.3bn budget, which includes an unprecedented pre-agreed contingency from HM Treasury. Absent a significant increase in defence spending to address current and foreseeable pressures, the MoD's conventional equipment procurement budget faces further pressures from the mid-2020s onwards, undermining the UK's ability to project conventional force worldwide as a key part of the UK's conventional deterrence posture. As a result, the Government will either have to increase the Defence Equipment budget, reconsider the strategic rationale for CASD, or move to minimum deterrent alternatives to the Dreadnought-class.

It is unlikely that the Dreadnought programme will be delivered within the existing £43.3bn budget.

HMS Victorious, a *Vanguard* class submarine, arriving at HM Naval Base Davenport

Assessing Trident Cost Estimates

At one level, the July 2016 Commons vote capped a debate over the UK's nuclear force that has existed since the 1950s, cementing the UK's position as what Paul Schulte, Senior Visiting Fellow in the Centre for Defence Studies at King's College London, has described as "the most equivocal of the nuclear powers."[8] Though detailed public polling on Trident is rare, YouGov in 2013 tested Britons' sentiments and discovered that cost was a key factor in the level of support for Trident. Excluding "Don't Know," YouGov found like-for-like replacement was supported by 30% of respondents, a cheaper, less-capable system by 41%, with only 28% supporting unilateral disarmament.[9]

A constant of the Trident debate has been disagreement on the costs of the programme. However, beyond the principled unilateralism of the Campaign for Nuclear Disarmament (CND), the Green Party,[10] the Scottish National Party,[11] and Plaid Cymru,[12] some multilateralists seek the cheapest possible minimum deterrence nuclear force, in order to achieve the deterrence effect, and to have a UK nuclear system to bargain with in future multilateral nuclear disarmament talks.[13] A version of this position is set out in the 2015 CentreForum publication, *Retiring Trident: An Alternative Proposal for UK Nuclear Deterrence*.[14]

However, of those who favoured retaining a UK nuclear deterrent, cutting continuous deterrent capability to save money was rejected 58% / 42%.[15] What this means is that a cheaper-but-continuous minimum deterrent programme commands a block of up to 30% of the electorate, which could produce an anti–Trident majority if *Dreadnought* programme costs are judged to be excessive. Table 1 sets out the evolution in *Dreadnought* cost estimates, and which elements of the overall programme they cover.

Table 1					
Year	**Source**	**Cost***	**Year**	**2018/19 cost***	**Basis of estimate**
2006	MoD[16]	15 – 20	2006/07	18.5 – 24.7	Deterrent System
2006	MoD[17]	11 – 14	2006/07	13.6 – 17.3	SSBNs only
2011	MoD[18]	25	2011/12	28.4	Deterrent System
2012	BASIC[19]	87	2012/13	97.49	Through life
2013	MoD[20]	17.5 – 23.4	2013/14	19.2 – 25.7	Deterrent System
2013	CND[21]	100	2013/14	109.8	Through life
2015	Centreforum[22]	24.8 – 33.1	2014/15	26.4 – 35.2	Deterrent System
2015	MoD[23]	31 – 41	2015/16	32.8 – 43.3	Deterrent System
2015	Reuters[24]	167	2015/16	176.5	Through life
2016	Crispin Blunt MP[25]	180	2016/17	186.1	Through life
2016	CND[2626]	205	2016/17	212.0	Through life

**All costs £bn*

The MoD's cost estimates & project performance

With cost being central to a section of public opinion that provides the majority support for the UK nuclear programme, it is regrettable that the Ministry of Defence's (MoD) cost estimates have been consistently underestimated. Currently, the MoD's cost estimates are 75.3% higher in real terms than the 2006 White Paper,[27] and the In-Service Date (ISD) has slipped from 2024 until "the early 2030s,"[28] with the first submarine being delivered in 2030.[29]

Confusion in this debate was exacerbated by MoD consistently repeating 2006 costs rather than current-year costs until 2011, when it was admitted that costs were then 15.0% higher than the highest 2006 estimate.[30] With the 2015 restatement of the costs and timelines, costs rose by a further 68.4%.[31]

None of this is surprising. As early as 2008, the National Audit Office found that the MoD:

> *accepts that the [2006] White Paper [Trident] cost estimates are not sufficiently robust to provide: an accurate baseline against which progress can be measured and budgetary control exercised; a sufficiently detailed cost model which can be used to manage cash flow and make informed decisions about the balance between time, cost and capability constraints; or confidence among suppliers that sufficient funding will be available to support their investment in the programme.*[32]

These are significant failings. Worse, the MoD's cost estimating performance for both nuclear and non-nuclear programmes has remained poor since 2008, as chronicled in the NAO's *Major Project Report* until 2015, its more recent successor, the assessment of the MoD Equipment Plan on a 10-year planning horizon,[33] and the Infrastructure and Projects Authority's (IPA) *Annual Report on Major Projects*.[34] The travails of the Astute programme have been well-chronicled in these reports, and points to systemic management problems within MoD and their key contractors: BAE Systems and Rolls-Royce.

Nuclear submarines' costings have proved particularly difficult to correctly estimate. In 2017/18 alone, the 10-year cost of nuclear submarine production increased by £941m, leading to the seventh and final *Astute* submarine exceeding its budget.[35] Underlining the particular challenges of submarine programmes, this £941m increase accounted for fully 52% of the total increase in cost for the equipment plan from the previous year.[36]

Astute Class submarine Audacious under construction

It has been asserted that the travails of the *Astute* programme were driven by the skill losses occasioned by the gap between the end of the *Vanguard* build and the beginning of the *Astute* programme: in the words of a Senior Official, "BAE had to learn how to design and build submarines again."[37] As such, the working assumption has been that with the pain borne by the *Astute* programme, *Dreadnought* will proceed smoothly. Unfortunately, *Dreadnought* does little to inspire more confidence than Astute did: in each of the three most recent years available,[38] the IPA has rated *Dreadnought* Amber/Red, meaning that the IPA assesses that: "Successful delivery of the project is in doubt, with major risks or issues apparent in a number of key areas. Urgent action is needed to address these problems and/or assess whether resolution is feasible."[39]

This Amber/Red rating places *Dreadnought* in the bottom quarter of major project performance in 2017.[40] Worse, the linked Core Production programme, which will produce a new submarine reactor core production facility at Rolls-Royce Raynesway, Derby, is the MoD's only Red rated project, and one of only four in the IPA universe, placing it in the worst performing 3% of UK Government major projects.[41]

Thus, whilst it is encouraging that the Head of MoD Finance is proactively reprofiling the *Dreadnought* budget by bringing forward £1.5bn of spending to "driv[e] productivity,"[42] and that she is confident that the £31bn budget will be adhered to,[43] previous programme performance has been so poor that it has prompted HM Treasury to demand unprecedented control over the programme, and to guarantee a £10bn contingency fund; given that £600m has already been committed for 2018/19, it would be extremely surprising if the full contingency were not spent by the time the delivery of the fourth and final *Dreadnought* in the late 2030s or early 2040s.[44]

In analysing the position of the whole Defence Nuclear Enterprise – incorporating AWE and strategic weaponry, existing *Vanguard*-class Trident operations, future *Dreadnought* procurement and the conventionally-armed *Trafalgar* and *Astute*-class submarines, and the completion of *Astute* procurement – the NAO concluded in May 2018 that there was a £2.9bn funding shortfall in the period 2018–28. Worse, this comprises a £3.2bn shortfall in the first eight years of the period, followed a small offsetting surplus £222m in the final two years.[45] Given the recent MoD submarine procurement record, it would be surprising if these out-year surpluses were achieved, inflicting additional cost pressures on the MoD capital budget in 2026/27 and 2027/28.

Impact on the MoD Budget

Though it reflects the totality of the MoD Equipment Programme, rather than just the *Dreadnought* programme, in January 2018 the NAO found the MoD had programmed a minimum £4.9bn (2.7%) overspend into the 2017–27 Equipment Plan.[46] Worse, even this systematically understated the MoD's costs: the MoD ignored its own independent cost analysis unit whose assessment was £3.2bn (1.8%) higher than the plan; it had not used the market sterling–US dollar exchange rate, adding £4.6bn (2.6%) to the costs; and it had assumed that an additional £8.1bn (4.5%) in savings measures would be delivered.[47] Taken together, these risks could inflate the cost of the Equipment Plan to £200.5bn, £20.8bn (11.6%) above the available budget of £179.7bn for the same period.[48] The NAO's unusually direct critique is as simple as it is devastating: "The Department's Equipment Plan is not affordable."[49]

Unfortunately, the MoD's normal methods of dealing with an overheated budget – delaying purchases, reducing capability, reducing equipment numbers – are of limited use in dealing with the *Dreadnought* programme. Timelines are already extended in a manner that could undermine core CASD policy objectives; capability is fixed, as are the number of submarines required to maintain CASD. At a time when the MoD is already deferring construction of infrastructure required to defuel decommissioned nuclear submarines at Devonport[50] and taking a two-year delay to the *Astute* replacement to save £1.2bn from the procurement budget,[51] both of which will increase medium-term costs to the MoD, *Dreadnought* is a programme that presents unique difficulties in execution and dangers to the rest of the MoD budget.

Given that MoD published an Equipment Plan that ignored their own independent cost analysis, relied on unrealistic exchange rates, and was therefore manifestly undeliverable, the Department provides very little confidence that the current *Dreadnought* budget will be adhered to. The expectation must be that in the absence of additional funds, money will be diverted from conventional forces' reequipment programmes to complete the Dreadnought programme in the 2020s.

Other cost risks

So far, we have only considered the risks inherent in the new *Dreadnought*-class design. Beyond the technical challenge of building the submarines themselves, two major areas of cost risks remain for the MoD to manage: life extending the *Vanguard*-class until the introduction of their *Dreadnought* replacements, and the exchange rate with the US Dollar, where a sustained devaluation would have an immediate adverse impact on the affordability of the programme.

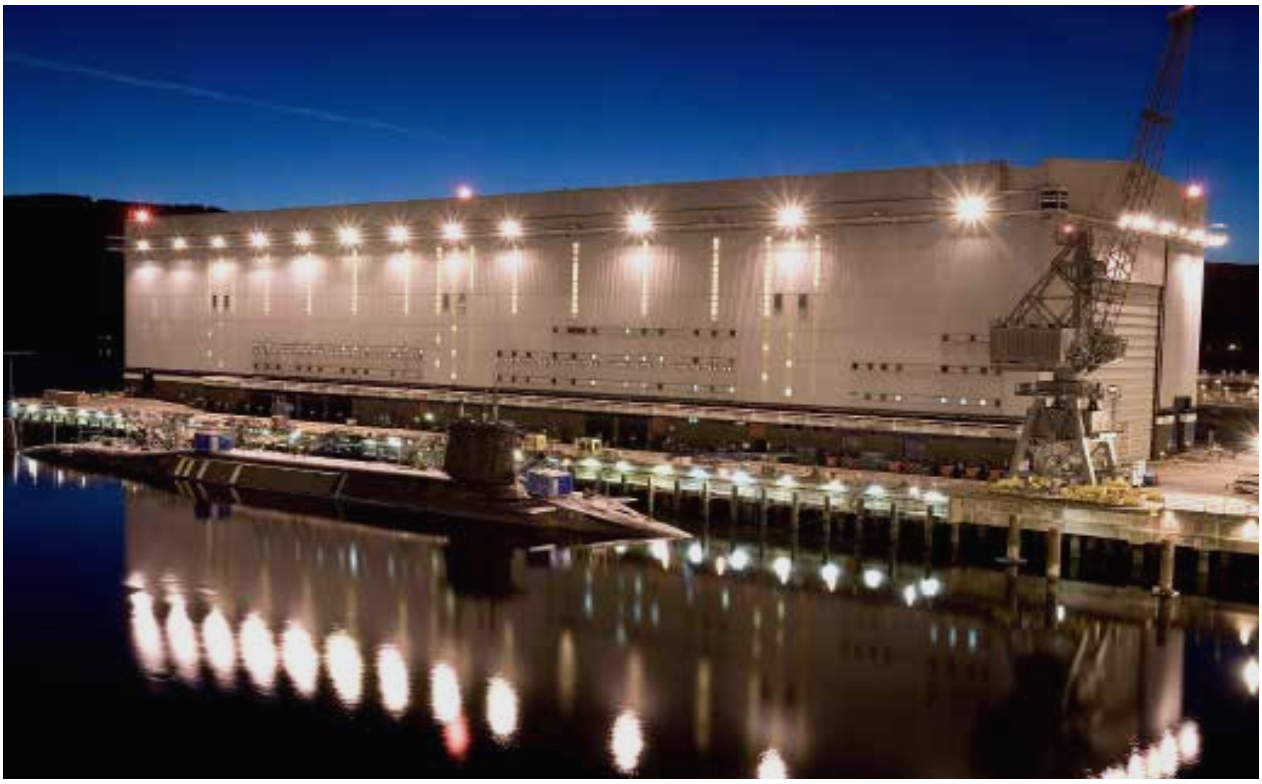
Of these, the potential need for a further life-extension of the *Vanguard*-class is the more operationally important, and the one that has had the power to break the Royal Navy's (RN) proud record of maintaining CASD unbroken since 1969;[52] by contrast, an adverse exchange rate movement will simply demand increased funding from other parts of the MoD budget.

Lessons from the Resolution-class to Vanguard-class transition

In preparing for the transition from the *Vanguard*-class to the *Dreadnought*-class, it is valuable to examine the experience of transitions from the *Resolution*-class to the *Vanguard*-class in the 1990s. Writing in the officially sanctioned history of the RN Submarine Service, Peter Hennessy and James Jinks demonstrate just how close the RN came to breaking CASD cover during this transition.[53]

Ahead of the transition from the *Resolution*-class to the *Vanguard*-class, the MoD undertook active preparations to ensure that CASD was maintained through the transition. This took the form of HMS RENOWN undergoing a five-year refit at the cost of £443m in current values from 1987 to 1992, in the expectation that HMS RENOWN would bear a disproportionate share of the remaining *Resolution*-class SSBN patrols.[54] Instead, HMS RENOWN was only able to complete three additional patrols post-refit,[55] leaving HMS RESOLUTION, due to decommission in 1991 as "the workhorse of the Polaris fleet as the RN struggled to maintain [CASD] whilst repairs to HMS RENOWN and HMS REPULSE were carried out."[56]

This led to contingency planning for emergency reprovisioning of an SSBN at sea,[57] and a "worst case" scenario of "moving a Polaris submarine into Loch Long,[58] where it would dive and remain in a static location on Quick Reaction Alert." [59] Fortunately, these plans were not required. However, that they were seriously considered serves to illustrate the scale of the challenge – and scope for additional, unplanned, expenditure inherent in taking complex equipment (well) beyond its design life.



HMS Vigilant, a *Vanguard* Class submarine, docked in Faslane Naval Base

Vanguard life-extension

Vanguard submarines were designed for a 25-year life, and by the time of the original 2006 White Paper, political delays in approving the *Dreadnought* programme meant that a five-year extension was already required. As the MoD noted at the time,

> *We have undertaken detailed work to assess the scope for extending the life of those submarines. Our ability to achieve this is limited because some major components on the submarines … were only designed for a 25-year life. The submarines have been, and will continue to be, subjected to a rigorous through-life maintenance regime and we believe that … it should be possible to extend the life of the submarines by around five years.*[60]

Hennessy and Jinks note that with the 2010 Coalition Government, the decision was taken to delay the first *Dreadnought* from 2024 to 2028, extending the lives of each of the four *Vanguard* submarines to 37 years, the longest operational life of any RN submarines in history.[61] Citing RN and MoD personnel, Hennessy and Jinks note that this "is a technological leap in the dark which all concerned wish could have been avoided."[62] Table 2 sets out the movement of the putative Out of Service Dates (OSDs) of the *Vanguard*-class.

Table 2: *Vanguard*-class life chart

				Implied OSD		
Submarine	**Laid Down**[63]	**Launched** [64]	**Commissioned**[65]	**25 years**	**30 years**	**37 years**
VANGUARD	03 Sep 86	04 Mar 92	14 Aug 93	2018	2023	2030
VICTORIOUS	03 Dec 87	29 Sep 93	07 Jan 95	2020	2025	2032
VIGILANT	16 Feb 91	14 Oct 95	02 Nov 96	2021	2026	2033
VENGEANCE	01 Feb 93	19 Sep 98	27 Nov 99	2024	2029	2036

From publicly available data, it is hard to be definitive about the planned Out of Service Date (OSD) of individual *Vanguard* submarines. However, it is assessed that the Long Overhaul Period and Refuel (LOP(R)) at 42 months and £350m in 2015 values[66] is the life extension programme foreshadowed in the 2006 White Paper to achieve a 30–year life.[67] With the completion of LOP(R) for HMS VENGEANCE in December 2015, the first stage life-extension was completed on all four *Vanguards*.[68]

The current Deep Maintenance Project (Refuel) (DMP(R)) is assessed to be the second life extension programme – Hennessy and Jinks' "technological leap in the dark" – required to achieve a 37–year life. [69] Beyond the technical challenge, there appears to be significant constraints on *Vanguard* overhauls, with Babcock at HMNB Devonport apparently only capable of overhauling one *Vanguard* at time.[70] This meant that Babcock at HMNB Devonport began the DMP(R) life-extension on HMS VANGUARD to extend her life to 37 years only with the departure of HMS VENGEANCE from LOP(R) in 2015.[71] Based on the available open source information, Table 3 sets out the assessed overhaul and OSDs of the four *Vanguard*-class submarines.

Table 3: *Vanguard*-class life extensions: LOP(R), DPM(R) and 37–year OSD

Submarine	Commissioned[72]	LOP(R)[73]	DPM(R)[74]	37–year OSD
VANGUARD	14 Aug 93	2002–04	2015 – 18	2030
VICTORIOUS	07 Jan 95	2005–08	2018 – 21*	2032
VIGILANT	02 Nov 96	2008– ?	2022 – 25*	2033
VENGEANCE	27 Nov 99	2012–15[75]	2026 – 29*	2036

*Estimates

Maintaining CASD through the transition

In the words of the MoD's 2013 *Trident Alternatives Review*, a "3 boat SSBN fleet could sustain back-to-back patrols for a period but could not sustain CASD for its service life without planned (and, probably, unplanned) breaks."[76] This is why the RN has operated a four ballistic missile submarine force, as one of the four *Vanguard* submarines is expected to be in long-term refit at any one time. Assuming that the DPM(R) overhauls take three years, it is likely that the RN will continue to maintain CASD through to 2029 using three operational SSBNs at a time, as set out in Table 4.

Hennessy and Jinks outline the significant challenge in maintaining UK CASD patrolling during the handover between *Resolution* and *Vanguard* classes in the 1990s. This was partly due to the inherent difficulties of keeping ageing equipment serviceable, but was exacerbated by a major defect that meant HMS RENOWN was largely sidelined post her 1987–92 refit.[77] If anything, maintaining CASD during the handover from the *Vanguard*–class to *Dreadnought*–class is likely to be even more demanding than from *Resolution* to *Vanguard*. With HMS VANGUARD OSD expected to be 2030 without a further refit, as Table 4 sets out, current plans show there is now almost no flexibility in the overhaul and procurement cycle if CASD is to be maintained with two submarines in 2033–34.

There is now almost no flexibility in the overhaul and procurement cycle if CASD is to be maintained.

Table 4: CASD transition: *Vanguard* OSD / *Dreadnought* ISD										
	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
VANGUARD	OSD									
VICTORIOUS	•	•	OSD							
VIGILANT	•	•	•	OSD						
VENGEANCE	•	•	•	•	•	•	OSD			
DREADNOUGHT					ISD	•	•	•	•	•
DREADNOUGHT 2					ISD	•	•	•	•	•
DREADNOUGHT 3							ISD	•	•	•
DREADNOUGHT 4									ISD	•

Key:

• : In service

ISD: Inservice Date

OSD: Out of Service Date

Thus, any slippage in the *Dreadnought* programme or unanticipated unreliability in HMS VIGILANT or HMS VENGEANCE (repeating the experience with HMS RENOWN) would almost certainly lead to a break in standard CASD operations, forcing the RN to consider the emergency contingency measures described by Hennessy and Jinks.[78]

This analysis produces two conclusions about the UK's attachment to CASD. First, in order to provide certainty of maintaining CASD, it would be sensible for the MoD to establish whether it is possible to overhaul HMS VANGUARD and HMS VICTORIOUS to provide an additional three to five years of service. If this is possible, MoD should plan for this now, to maximise the chances of maintaining three SSBNs throughout the transition period. It is impossible from the outside to establish how much work this will involve and what the costs might be, but it seems reasonable to presume that given the submarines' age, the level of work required is likely to be greater than either LOP(R) or DMP(R). If such plans exist for 2029 onwards, they should appear in future NAO reports on the MoD Equipment Plan or Defence Nuclear Enterprise from next year. Short of that, this paper will assume an admittedly speculative 2018/19 cost of £0.5–1.0bn per submarine in the long-term costings, below.

The second, more radical, conclusion is that though the Government remains strongly rhetorically committed to CASD, its current actions do not demonstrate the same level of practical commitment. It is noteworthy that after concluding the Polaris Sales Agreement in April 1963,[79] the four *Resolution*-class submarines were commissioned between October 1967 and December 1969. HMS RESOLUTION was ready to conduct the UK's first Demonstration and Shakedown Operation (DASO) in early 1968, culminating in the first UK Polaris firing on 15 February 1968 – described in Matthew Jones' Official History as, "a remarkable achievement for a programme that had only begun five years previously."[80]

Jones is hardly guilty of hyperbole: the UK had built – but not yet commissioned – precisely one nuclear submarine[81] at the time of the *Resolution*-class order, and had no experience of building ballistic missile submarines at all. Nonetheless, four SSBNs were delivered over approximately two years, and whilst two shipyards were involved,[82] what the *Resolution*-class had was clear national priority project status. The two shipyards' workforce increased by 40%,[83] and infrastructure was built at "a breakneck speed."[84] After some hiccups in the build, and delays to other submarine programmes, the four *Resolutions* were delivered in time to assume the UK nuclear deterrent mission from the RAF V-Force from 30 June 1969.[85]

We see the converse today. The slowing of the production of HMS AGINCOURT, the seventh and final *Astute* submarine,[86] in order to ensure that there is a seamless transition to HMS DREADNOUGHT demonstrates that there is already additional build capacity at BAE Systems, Barrow, meaning that work on *Dreadnought* could be speeded up. Thus, either the *Dreadnought*-class design is immature and the first of class could not in any case be completed by the previous

target of 2028, or the MoD are prepared to risk gaps in CASD cover to save short-term funding costs, because CASD is no longer the national priority it was in the 1960s.

In light of the reprofiling of the *Dreadnought* spend detailed in March 2018, the author assesses that it is more likely that the cause of delay to the *Dreadnought* programme is funding. And if this is the case, then the Government is making an implicit statement that maintaining CASD is not the national priority that they claim, opening up the question of moving away from CASD and coordinating deterrent patrols with the United States of America and France, or fundamentally reassessing whether the *Dreadnought*-class and UK Trident operations are in fact still required in the manner claimed in government statements. In these cases, the Government's actions and budgets speak far louder than their words, and instead of burying this policy decision, they should be opening it up for a national debate.

Summary

It is clear from the NAO's reporting, and the HM Treasury Winter 2017 MoD Supplementary Estimate[87] that the MoD budget remains under significant short- and medium-term pressure. The accretion of political delays in approving the construction of the *Dreadnought*-class has imported unprecedented time and cost risks into the CASD programme, which as was seen with HMS RENOWN may not be foreseeable even given the best contingency planning. If these risks crystallise in the *Vanguard*-class, the most likely outcomes are an expensive additional retrofit programme or the interruption of CASD patrolling for the first time since 1969.

Thus, whilst it is to be hoped that the early access to the contingency funding will allow the MoD to, in the words of the MoD Head of Finance, "'de-risk' the programme, maintain the build schedule, and ensure the [*Dreadnought*] programme remains within the total £31 billion lifetime cost commitment,"[88] the combination of time pressures and recent submarine build performance mean that the most likely outcome remains that all £10bn of contingency will be used.

Where there is uncertainty – for example, a permanently weaker Pound post-Brexit, or a major refit of one or two *Vanguard* submarines to ensure CASD coverage through transition – the cost risks are all on the upside. The significance of this is that absent a significant and permanent increase in the MoD budget, any additional costs of maintaining CASD as Dreadnought is introduced will be borne by the conventional forces' equipment budgets.

If time and cost risks crystallise, the most likely outcomes are an expensive additional retrofit programme or the interruption of CASD patrolling for the first time since 1969.

Establishing Cost Estimates

Having considered the problems with some of the existing estimates, this section of the paper will attempt to produce realistic updated cost estimates based on the publicly available information. First, we will consider the *Dreadnought* capital programme, before turning to through life costs.

Capital Costs

At £10.5bn (£10bn 2015/16 values), the *Dreadnought* contingency is 32% of the budget, similar to the 30.4% overspend on the Astute programme by 2011.[89] Will it be sufficient? On one hand, *Dreadnought* has already been rebaselined, and as Table 1 shows, the current budget plus contingency is already 75.3% larger than the highest figure in the 2006 White Paper in real terms. Moreover, the fiscal flexibility that the *Dreadnought* programme now appears to enjoy seems to have allowed the reprofiling of the programme to maximise efficiency, leading the MoD DG Finance to express her confidence that the revised £32.8bn (£31bn 2015/16 values) will be met.[90]

However, MoD's programme management performance record is poor, and as shown above, there is no room for *Dreadnought* programme slippage if CASD is to be maintained in the early-mid 2030s. It is assessed that it will become necessary to further life–extend one or two *Vanguard*-class submarines beyond 37 years in order to ensure CASD is not broken, at a cost that could be as high as £2bn. Similarly, if the sterling is permanently weaker against the US Dollar as a result of Brexit, the additional costs could be in the range on £0.5–2bn.

On this basis, it would be reasonable to allow another £1.0–2.0bn for additional life extension and £1.0–£2.0bn for sterling weakness (c. 10%[91]) over the budget to cover above-average inflation, additional costs to meet time constraints, and to provide a measure of budgetary headroom for permanently weaker sterling. These estimates are set out in Table 5.

Table 5	
Item	Cost*
Capital	32.8
Contingency	10.5
Additional Vanguard life extension for up to two submarines	<2.0
Sterling devaluation	<2.0
Estimated Dreadnought capital costs	**<£47.3**

*All figures £bn, 2018/19 prices

Decommissioning Costs

The UK's Defence Nuclear infrastructure over time will be decommissioned, and the nuclear wastes will be disposed of into a permanent Geological Disposal Facility. These costs are assumed to be large, but as they are programmed to be incurred over the next 120 years, the assumptions around amount of waste, available technologies, and HM Treasury discount rates can produce significant variation in the current value.

The NAO's very welcome May 2018 report, *The Defence Nuclear Enterprise: a landscape review, Annual Running Costs*, neatly demonstrates this in Figure 15, reproduced below as Table 6.[92] The NAO reports that the 186% increase in MoD nuclear liabilities since 2015 is primarily, though not exclusively, due to a change in HM Treasury discount rates. [93]

Table 6			
	As at 31 March 2018		
Liability	2015*	2016*	2017*
Fuel Management and Disposal	550	2,335	2,678
Geological Disposal Facility	383	1,305	1,329
Nuclear Propulsion	72	145	141
Site decommissioning and disposal	1,794	3,213	2,773
Submarine decommissioning	176	1,827	1,931
Submarine defuel and disposal	625	1,535	1,393
Other	0	57	61
Total	**3,600**	**10,417**	**10,306**

*All figures £m

Source: NAO, May 2018

Currently, the UK has 20 decommissioned nuclear submarines; 13 are berthed at Devonport, Plymouth, and seven at Roysth.[94] Together with three further *Trafalgar*-class and four *Vanguard*-class submarines, the MoD in 2016/17 held a £3.3bn provision for decommissioning these 27 submarines, or £126m in 2018/19 values per submarine. [95] At the same rate, the forthcoming 11 submarines will add £1.4bn to the decommissioning bill by 2065, of which *Dreadnoughts* will account for £0.5bn.[96]

Annual Running Costs

Calculating *Dreadnought* through life costs is difficult as it relies on a set of assumptions extending out beyond 2060. Therefore, as the proposed *Dreadnought* fleet, operating model and basing plan closely maps existing *Vanguard* operations, it is reasonable to assume that the costs will be similar to the current costs.

The NAO's report T*he Defence Nuclear Enterprise: a landscape review*, provides much more transparency over the interlocking nature of the policy choices the MoD faces in managing the nuclear enterprise than was heretofore available. The NAO reports that the total cost of the Defence Nuclear Enterprise is budgeted at £5.2bn, 14.3% of the MoD budget.[97] However, this figure includes both procurement and steady-state operating costs, and covers both current and future attack submarine and ballistic missile submarines, making it hard to extrapolate steady-state annual running costs for the *Vanguard*-class from these figures. It would be very helpful if future analysis from the NAO broke out these elements individually.

Before May 2018, the MoD consistently presented Trident operating costs as "5–6% of [the] [core[98]] defence budget,"[99] rather than as an amount of money. This makes sense only when core defence spending is close to flat in real terms, which is a reasonable approximation of the MoD's position in the period 2004–17. However, as MoD spending is due to increase by £1bn pa by 2020, this analysis stops at the end of the 2016/17 financial year.[100] The maximum variation in the MoD definition is £743m,[101] meaning that the middle case of £2.2bn[102] provides a satisfactory heuristic for this analysis. Over the 30-year operational life of the *Dreadnought*-class, this suggests running costs in the order of £66bn.

Total Dreadnought Programme Costs

Taken together, this suggests a total Dreadnought through-life cost of £110–14bn in 2018/19 prices, as detailed in Table 7.

Table 7	
Item	Cost*
Capital budget	32.8
Contingency	10.5
Additional *Vanguard* life extension for up to two submarines	<2.0
Sterling devaluation	<2.0
Estimated *Dreadnought* capital costs	<£47.3
***Dreadnought* decommissioning**	0.5
***Dreadnought* running costs 2030 – 60**	66.0
***Dreadnought* programme costs**	**<113.8**

**All figures £bn, 2018/19 prices*

Dreadnought's through life cost is likely to cost £110-14bn.

Conclusion

Keeping the *Dreadnought* programme within the £43.3bn budget, which is more than 75% higher in real terms than the 2006 estimates, is heavily dependent on the management of the *Dreadnought* programme improving over both the *Astute* and *Dreadnought* programme management performance to date. This is important, as the £10.5bn contingency is approximately the same as the *Astute*-class cost overruns by 2011. Thus, any further problems will mean that the £43.3bn budget will be very hard to meet, and additional costs will happen at the expense of the MoD's conventional forces.

It is important to note that any significant delay to *Dreadnought* ISD or significant reduction to the availability of HMS VIGILANT or HMS VENGEANCE after their second life-extension is likely to lead to a break in CASD patrols in the early to mid-2030s. It is already clear that UK SSBN availability in 2033 and 2034 is looking particularly challenging. To mitigate this risk, MoD would either need to accept the need to extend HMS VANGUARD and HMS VICTORIOUS for a further five years in the mid-2030s, or increase funding to ensure HMS DREADNOUGHT is ready for operations in 2031/32 and *Dreadnought 2* is available for operations in 2033. Either option would impose significant additional unbudgeted costs on the MoD which would need to be funded from the conventional forces.

Appendix: Cost Estimates

Critiquing the CND cost estimates

Cost estimates provided by some of Trident's opponents have tended to model through-life costs. This analysis is welcome, but it must be made clear that a decision to scrap *Dreadnought* would mean that savings would accrue between now and the early 2060s; too often through-life costs have been quoted to suggest that very large sums – £100bn or more – would be available in the near term for other public spending priorities if *Dreadnought* were to be cancelled. This is misleading and undermines Trident critics' arguments.

On a technical level, the reason that the 2016 through life cost estimates produced by Crispin Blunt MP and CND were above £180bn was because they assumed that the 5–6% of the MoD budget would be constant as the defence budget increased. There is no reason to expect this to be the case – why would adding extra squadrons of Typhoons to the RAF or additional tank units to the Army increase the cost of operating ballistic missile submarines? Instead, it is much more likely that the steady-state running costs will be an approximately fixed amount of cash rising in line with inflation, independent of the rest of the defence budget.

Endnotes

1 Unless otherwise stated, all amounts in this paper are in 2018/19 pounds, with values discounted to 2018/19 values using the March 2018 HM Treasury deflator series (https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-march-2018-quarterly-national-accounts).

2 The final vote tally was 472–117, a majority of 360; HC Deb 18 July 2016, vol 613, col 655.

3 HC Deb 18 July 2016, vol 613, col 564. NB, this is £31bn and £10bn contingency in 2016/17 values, which equates to £32.1 and £10.3bn in 2018/19 values for a total of £42.4bn.

4 The 2015 budget set HS2's budget for the whole Y-shaped network at £55.7bn (£58.9bn in 2018/19 values). Source: "High Speed Two: From Crewe to Manchester, the West Midlands to Leeds and beyond: Moving Britain Ahead", Department for Transport, CM 9355, November 2016, 32. Given the 40% contingency in the HS2 Phase 2 2017 budget of £28.6bn, it remains possible (if unlikely) that HS2 outturn costs will actually be lower than the Dreadnought programme. See *High Speed Two Phase Two Financial Case: Moving Britain Ahead, Department for Transport*, July 2017, paragraph 2.3, 7, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629165/high-speed-two-phase-two-financial-case.pdf

5 The 30.4% cost increase is for *Astute* boats 1–6 and is detailed in Figure 2 of the 2011 NAO Major Projects Report. *Major Projects Report*, NAO, HC1520-I Session 2010-12, 15 November 2011, Figure 2, 11.

6 *Annual Report on Major Projects 2016-17*, Infrastructure and Projects Authority, HM Government, 18 July 2017, Annex A, 16. Available from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629622/IPA_Annual_Report_2017.pdf

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8 Interview A, Summer 2014.

9 Author's analysis of survey data from YouGov / Sunday Times Survey Results, page 11, http://d25d2506sfb94s.cloudfront.net/cumulus_uploads/document/zinooici1f/YG-Archive-Pol-Sunday-Times-results-120713.pdf Fieldwork was conducted 11 – 12 July 2013, with a sample of 1857 GB adults.

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31 Author's analysis; see Table 1.
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33 *The Equipment Plan 2017 to 2027*, NAO, HC 717, Session 2017-2018, 31 January 2018.
34 *Annual Report on Major Projects 2016-17*, Infrastructure and Projects Authority, HM Government, 18 July 2017, 19. Available from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/629622/IPA_Annual_Report_2017.pdf
35 *The Equipment Plan 2017 to 2027*, NAO, HC 717, Session 2017-2018, 31 January 2018, paragraph 2.13, 19.
36 *The Defence Nuclear Enterprise: a landscape review*, NAO, HC 1003, Session 2017-2018, 22 May 2018, Paragraph 3.10, 36.
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46 *The Equipment Plan 2017 to 2027*, NAO, HC 717, Session 2017-2018, 31 January 2018, Figure 9, 31.
47 *The Equipment Plan 2017 to 2027*, NAO, HC 717, Session 2017-2018, 31 January 2018, Figure 9, 31.
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102 5.5% of the average spend across the period (£40.0bn), or £2.2bn. Source: "UK Defence Expenditure appendix", *House of Commons Library*, 22 February 2018. Figures deflated to 2018/19 values. http://researchbriefings.files.parliament.uk/documents/CBP-8175/CBP-8175-Appendix.xlsx

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