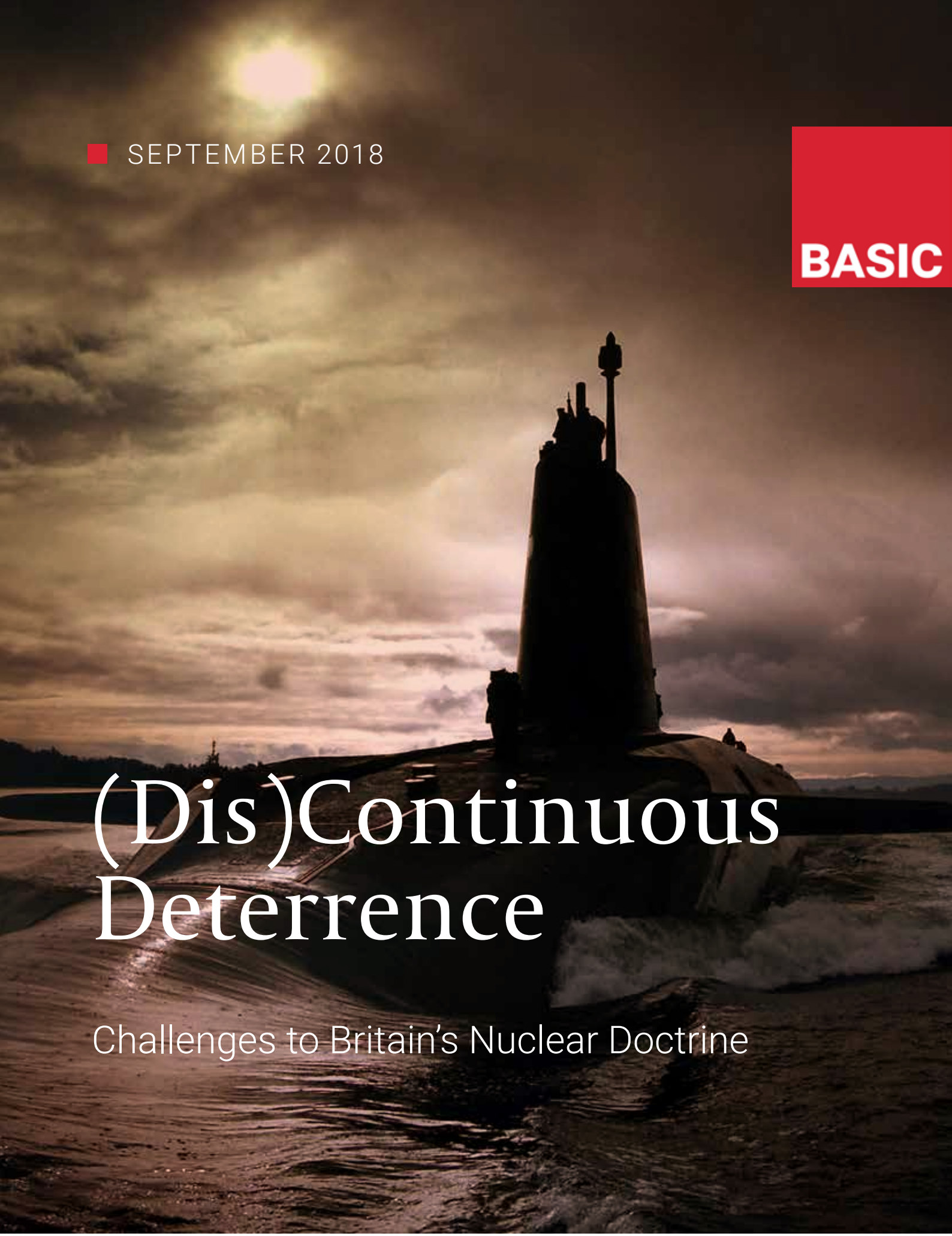

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BASIC

(Dis)Continuous Deterrence

Challenges to Britain's Nuclear Doctrine

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BASIC

The British American Security Information Council (BASIC) is an independent think tank and registered charity based in Whitehall, London, promoting innovative ideas and international dialogue on nuclear disarmament, arms control, and nonproliferation. Since 1987, we've been at the forefront of global efforts to build trust and cooperation on some of the world's most progressive global peace and security initiatives, advising governments in the United States, United Kingdom, Europe, the Middle East and Russia. Through an approach based on active listening, understanding and empathy, the charity builds bridges across divides and lay new pathways to inclusive security.

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Foreword

Economists are fond of the notion of "revealed preference" – that what we say as individuals is not nearly as revealing about our real preferences as what we choose. Of course, like many academic notions, this idea is hardly high theory. Plenty a barstool has heard "Put your money where your mouth is."

The United Kingdom has embarked on an extraordinarily expensive program to replace its existing fleet of Vanguard-class ballistic missile submarines with a new generation called the Dreadnought. By most reasonable standards, proponents of the UK's nuclear deterrence have put quite a lot of money behind the idea – although one might object that it isn't theirs precisely. And yet, it may not enough. Toby Fenwick has done an invaluable service by asking whether the cost and procurement schedule for the Vanguard-replacement are realistic and, since he finds they are not, what steps might be taken to mitigate that risk and provide for UK security on a more sustainable basis.

If the current procurement plan goes ahead, the Vanguard-class boats will begin to age out of service in 2030. The first replacement Dreadnought-class boat will not enter into service until 2034. The planned procurement schedule is intended to allow Britain to retain a continuous at sea deterrent (CASD) throughout the replacement process – but the situation will be extremely fragile. Any further delay in the Dreadnought-class will likely break the continuity of the at-sea deterrent. And looking at the history of defense procurement, in both the UK and elsewhere, we must conclude that further delays seem quite likely.

Rejecting the notion that one simply try to muddle through, Fenwick presents the obvious choice: If CASD is in fact as essential to UK security as some say than the UK must accelerate funding in order to push replacement through on time. London must put its money where its mouth is. And if continuity is not in fact essential – if proponents of the Dreadnought program are willing to choose a break in CASD – then Fenwick suggests this reveals that London has a much wider array of options for maintaining British security than is currently admitted officially.

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Executive Summary

Since 1969, Britain's strategic nuclear deterrent has been entrusted to successive generations of Royal Navy (RN) nuclear-powered ballistic missile submarines (SSBNs), with a least one submarine on patrol and ready to fire at short notice at all times, in an operational posture known as Continuous At-Sea Deterrence (CASD).

Governmental rhetorical support for CASD remains strong: as recently as 2016, MoD Minister of State, Lord Howe claimed that, "… CASD—the UK's minimum credible and assured nuclear deterrent … is the ultimate guarantor of our national security and way of life."[1] The existing *Vanguard*-class submarines are scheduled to be replaced by the Dreadnought-class in the 2030s, but as the recent BASIC paper, *Blowing up the Budget: The Cost Risk of Trident to UK Defence* demonstrates, a combination of *Dreadnought* delays and the risk of *Vanguard* unserviceability as the MoD attempts an unprecedented life extension for a UK submarine creates a real risk of CASD being broken between 2032 and 2034. Is this a problem, and if so, what should be done about it?

This paper examines how the UK arrived at a policy of CASD, and how it has handled previous challenges to continuous deterrence. It finds that the changeover from the first-generation *Resolution*-class SSBNs to their *Vanguard* replacements in the mid-1990s nearly resulted in breaking CASD, and during the V-Force era of an

airborne deterrent, the loss of the RAF's entire tanker force with the unplanned retirement of the Vickers Valiants in 1965 made a significant, public, diminution in the UK's global deterrent capability. Crucially, in both cases the MoD opted not to spend the money required to ensure a high level of confidence in the veracity of a continuous deterrent – in other words, their actions did not match their rhetoric.

The UK faces the same risk of a CASD break in the early 2030s, leaving the MoD with three broad approaches – if it remains committed to maintaining some form of nuclear deterrent at all. First, it could accelerate the build of the new *Dreadnought*-class SSBNs and/or refit HMS VANGUARD for a final commission; second, it could publicly move away from CASD on either a national or Alliance-wide basis with a clear geostrategic rationale; or third, it could gamble and hope for the best, as it did in the 1990s.

This paper rejects the last, and calls on the Government to publicly choose between the first two, and back its choice with the appropriate resources. What we cannot have is the current muddle where rhetoric and resources are misaligned, with the risk that UK strategic policy is revealed to be a Potemkin village of rhetoric built on foundations of sand if CASD is broken in the 2030s.

Governmental rhetorical support for CASD remains strong. Yet the UK faces a risk of CASD break in the early 2030s

Avro Vulcan B. Mk 2 with a BLUE STEEL missile: the cutting edge of the UK deterrent in the 1960s. © IWM RAF-T 3594

Introduction

Strategic theory teaches that defence procurement should be driven by force structures; force structure should be driven by the strategic concept and its rationale; strategy should be a national and alliance response to a defined threat. In considering the role of Continuous At-Sea Deterrence (CASD), this paper begins by an extended consideration of how deterrence was arrived at by the United States as a strategy by default after the successive failures of retaining the western nuclear monopoly, "Massive Retaliation" and active defence. The historical record suggests that current assumptions about the requirements for stable deterrence may not be accurate.

It then considers the development of UK doctrine, and how the UK alighted on continuous deterrence with a survivable second strike *before* it committed to a submarine-based system. However, despite a rhetorical commitment to the UK deterrent force, the manner in which successive UK governments have handled challenges to continuous deterrence shows that governments of all stripes are less committed in reality to CASD than their rhetoric suggests.

In the recent BASIC paper, *Blowing up the Budget: The Cost Risk of Trident to UK Defence*, it was shown that there is a significant risk that the UK will be unable to sustain CASD in 2033/34. In light of the UK deterrent's operational history, this paper sets out a number of scenarios and options for Government to choose between, ranging from the high cost / high assurance model of accelerating the *Dreadnought* programme and preparing for an additional life-extension to HMS VANGUARD, through to Alliance-based deterrence and/or non-Trident alternatives.

Development of Deterrence

Thus far, the chief purpose of our military establishment had been to win wars. From now on its chief purpose must be to avert them. It can have almost no other useful purpose.[2]

Bernard Brodie, 1946

Following the atomic attacks on Hiroshima and Nagasaki, the United States enjoyed a nuclear monopoly, but initially treated nuclear weapons as simply unusually destructive conventional weapons. The earliest post-WWII American planning for war against the Soviet Union were a natural functional development of the strategic bombing campaigns against Germany and Japan in the latter stages of WWII.[3]

What form did this take? Refined through six years of conflict in Europe, strategic bombing tactics, equipment and training finally delivered a recognisably strategic air offensive from mid–1944, when the RAF and the USAAC were delivering twenty times the monthly tonnage of bombs delivered in 1942.[4] Added to this, nodal analysis to direct strikes against target sets particularly susceptible to aerial attack and which would cause the greatest damage to the German war effort only occurred with the 'Oil Plan' on 8 June 1944.[5]

It is hard to conclude anything other than that much of the effort and sacrifice of the early war years was wasted, by a combination of bombing inaccuracy, poor target selection, and distributed German industry. Similarly, it was only with the availability of bomber bases on Saipan, Tinian and Guam in 1944 that strategic attacks against the Japanese home islands became feasible.[6] However, once truly strategic campaigns were launched, the effect was a significant - though not decisive - contribution to the defeat of Germany and Japan.[7]

Early thinking: disarming first strikes and Massive Retaliation

Against the backdrop of rapid demobilisation, early post-war planning was acknowledged to be unimplementable,[8] and in any event, in January 1947, the United States had

> *… just one deployable bomb in existence, few skilled personnel able to assemble other parts that were available and no capacity to manufacture more. The knowledge of how to build a bomb had been dispersed, and the existing design had many shortcomings.*[9]

It was only with the sustained budget increases of the late 1940s under the exacting leadership of General Curtis LeMay that Strategic Air Command (SAC) became capable of executing strategic nuclear strikes against Soviet Union, albeit initially from forward bases in Europe.[10]

This initial plan[11] foresaw a three-month atomic offensive designed to "destroy the Russian ability to wage war,"[12] but alone was not considered to be enough to decisively defeat the Soviet Union; a ground war in Europe was expected to follow, lasting up to another three years.[13] Up until the mid-1950s, it was technically feasible for the United States to mount a disarming first strike on the USSR with little fear of nuclear retaliation. Despite this window of vulnerability, the notions of rollback that were enunciated in 1950's

Boeing B-52 Stratofotresses provided the spearhead of manned US nuclear mission from 1955 until the 1980s, and the US Air Force is expected to continue to operate B-52Hs through beyond 2040.

NSC-68[14] (which resulted in the creation of the CIA-backed but ostensibly private "National Committee for a Free Europe"), these activities were pinpricks and largely compromised.[15] Support for pre-emptive nuclear war against the Soviets was never widely-held in either the Truman or Eisenhower Administrations.[16]

Eisenhower's Fiscal Year 1955 "New Look" sought fiscal savings in expensive conventional forces by replacing them with a policy of what Secretary of State John Foster Dulles described in January 1954 as a policy of "Massive Retaliation". Massive Retaliation called for the overwhelming use of force – premised on, but not limited to, nuclear weapons – in a range on contingencies, including the smallest "brushfire" conflicts, which would previously have been exclusively met and managed with conventional forces.[17] As Lawrence Freedman observes, it required leaders to "talk up their own recklessness," even if it was intended as a bluff.[18]

A precondition for the success of Massive Retaliation as a strategy was ensuring that the use of nuclear weapons did not attract restrictions – neither legal nor normative – different to those applying to conventional weapons. In other words, the use of nuclear weapons had to be normalised, and considerable effort was expended by the Eisenhower Administration to achieve this.[19] Massive Retaliation would narrowly succeed but strategically fail in the 1954–55 Quemoy and Matsu crisis, causing a major rift with Britain and NATO states, which could not support risking nuclear war over transparently strategically irrelevant territory.[20]

With the scale of the damage from a single nuclear weapon orders of magnitude greater than a conventional weapon,[21] few agreed with Herman Kahn that as late as 1960 it was feasible – or arguably meaningful – to talk of "fighting" or "winning" a thermonuclear war in the conventional meaning of the word.

Indeed, Kahn's assertion that it is the role of the policymaker to consider what form of post-nuclear war society one would choose, and then invest accordingly in order to deliver it, ignores the point that the role of the policymaker was to avoid the catastrophe of a nuclear war in the first place. It is all very well to ask "whether the survivors would envy the dead?" (no, in Kahn's view[22]), or to posit that by civil defence

investment, the number of US casualties could be cut from 40 million to 20 million ("a very worthwhile achievement"[23]), but short of knowing that there would be complete success of a disarming surprise attack, the chances of gains from victory outweighing the costs of achieving it were vanishingly small if even a small number of enemy nuclear weapons were used against your cities.

Towards an active defence

The destructive potential of atomic – and especially thermonuclear – weapons had decisively handed the advantage in conflict to offense over defence.[24] Previously, if the defender could inflict sustained loss rates of 10% per wave on a conventionally-armed attacking bomber force whilst riding out the damage inflicted, the bomber offensive would be defeated in a matter of days, as the crews and aircraft would be lost far more quickly than they could be replaced.[25]

However, in the nuclear age when a single weapon could destroy a city, each and every aircraft and missile warhead would have to be intercepted in order to mount a successful defence, massively increasing the size of the defensive task.[26] Writing in 1959, Bernard Brodie noted,

> *In general, the assumption is that the prospects for the radical improvements of active and passive defences against nuclear weapons are not bright … [but] when we recall the fantastic degree to which the coming of the A-bomb gave a lead to the offense over the defense and … that subsequent developments in nuclear weapons have tended to further that advantage, the assumption referred to looks fairly invulnerable.*[27]

Both superpowers were investigating technologies to intercept intercontinental ballistic missile warheads (ICBMs) from the 1950s.[28] Even allowing for the use of nuclear warheads on the defending missiles, the technical challenges were vast, and though both sides would deploy limited ABM programmes, the key finding from US analysis was that it was always cheaper to add more ICBM warheads to swamp a given level of defensive capability than to defend; for a comprehensive defence, this cost advantage could be as high as 6:1 in favour of the offense.[29] Similar Soviet analysis militated against a nationwide missile defence shield in 1967; British analysts had come to the same conclusion a decade earlier.[30]

It was this analysis that led Defense Secretary Robert McNamara to push for what became the 1972 Anti-Ballistic Missile Treaty (ABM Treaty),[31] in order to limit fruitless spending. [32] The United States only ever deployed a single ABM system to defend Minuteman ICBMs at Grand Forks Air Force Base, North Dakota, and the Safeguard system was quietly decommissioned 10 months after it had entered service in 1976.[33] By contrast, the Soviet Union's A-35 ABM system protecting Moscow was replaced by a second generation (A-135) in 1990.[34] Nonetheless, the Soviet systems only ever expected to defend against one or two ICBMs[35] and associated decoys at once, leaving them vulnerable to being swamped by multiple missiles, the use of decoys and Multiple Independently Targeted Re-entry Vehicles (MIRV).[36] Taken together, active defensive measures against ICBMs are of limited value.[37]

Deterrence by default

If a disarming surprise attack could not offer enough certainty that it would destroy all of an opponent's nuclear weapons, removing the risk of retaliation, and if active missile defences were too expensive to deploy nationally – and, in any event, of limited capability – another strategy was needed: deterrence, secured by – but not requiring – a survivable second-strike nuclear force.

Deterrence comes in a number of flavours, but at its root, deterrence is the attempt to coerce a potential or actual adversary to act in a specific way. Strategic deterrence is achieved by overt threats, but a state can also be deterred without the deterring state making an overt threat, a condition Lawrence Freedman describes as "internalised deterrence."[38]

Stable deterrence is presumed to require a secure second-strike capability – and indeed this is the theoretical basis for the United Kingdom's CASD posture – but the historical record shows that it is not required. During the 1962 Cuban Missile Crisis, even a significant US qualitative and quantitative nuclear edge did not translate into unlimited coercive power. Instead, in line with classical deterrence theory, deterrence was achieved by the Soviets ensuring US *inability* to *exclude* a Soviet nuclear strike causing unacceptable damage. Importantly, this was at a time when the United States knew how vulnerable the only Soviet ICBMs were, and where the launch sites were, meaning that US Strategic Air Command (SAC) was in a position to significantly reduce the threat of retaliation before an invasion of Cuba.[39]

Despite the potential for a disarming first strike, the Kennedy Administration did not take it, because of the fear that even a single multi-megaton warhead would destroy an American city, leading to deterrence even before Mutually Assured Destruction (MAD) was an operational reality. MAD premised on an effective Soviet second-strike capability would not arrive until the Soviet Project 667 *Yankee*–class nuclear-powered and nuclear-armed ballistic missile submarines (SSBNs) entered service in 1968.[40]

Deterrence undercut the classical logic of warfare premised on winning wars, instead focussing on avoiding conflict by ensuring a potential adversary could not rule out unacceptable damage from retaliation.[41] In this, Brodie's 1946 maxim was fulfilled.

Stable deterrence is presumed to require a secure second-strike capability, but the historical record shows that it is not required.

UK Doctrine: Development & Operations

Unless we can make a contribution of our own…we cannot be sure that in any emergency the resources of other Powers would be planned exactly as we would wish, or that the targets which would threaten us most would be given what we would consider the necessary priority, or the deserved priority, in the first few hours. These targets might be of such cardinal importance that it could really be a matter of life and death for us.[42]

Prime Minister Winston Churchill, 1 March 1955

Britain's doctrinal journey was similar to but distinct from the United States', reflecting operational, technical and fiscal realities and constraints. Not only was the UK addressing the problem of deterring the Soviet Union with a significantly smaller economy and military, it was much more vulnerable to a Soviet strike because of comparative geographical proximity and because the United Kingdom is much more densely populated than either the United States or the Soviet Union.

The first operational British atomic weapon (BLUE DANUBE) was delivered to RAF Wittering in November 1953, but until the delivery of the first operational Valiant bombers in mid-1955, the RAF had no method of delivering it.[43] BLUE DANUBE was essentially a prototype weapon, leading observers to comment that "[it] was more a process of learning than a finished product … It was deployed first and developed afterwards."[44]

As early as January 1946, UK military planning was for "hundreds rather than scores"[45] of atomic weapons, with the RAF ultimately planning to use 400–575 atomic weapons to defeat the Soviet Union by destroying 100 Soviet cities.[46] The RAF replicated the USAF mid-to-late 1940s experience of initially having a very small weapons stockpile that was wholly inadequate for their stated plans, and tiny numbers of operational bombers. Following the UK's first test in November 1952, the first BLUE DANUBE weapon was delivered to the RAF in November 1953, though the first Valiant aircraft able to deliver it would not arrive until June 1955.[47] The build-up was slow: only 58 BLUE DANUBE weapons were produced, of which only five existed by December 1954, and only 20 were in RAF service by the end of 1957 – when the RAF had approximately 80 bombers to deliver them.[48] By contrast, SAC in 1957 comprised 1,747 medium and heavy jet bombers, 195 jet reconnaissance aircraft, supported by 971 tankers, and SAC was still growing numerically and improving qualitatively.[49]

The UK Government recognised the obsolescence of BLUE DANUBE before it could be delivered, deciding in June 1954 to pursue a thermonuclear weapon,[50] a decision made public in the 17 February 1955 Defence White Paper.[51] This would result in the 1957–58 GRAPPLE tests, where the 3MT GRAPPLE Y test of 28 April 1958 became the most powerful ever UK nuclear weapon tested.[52] This technical achievement, combined with the launch of Sputnik 1 in 1957, led to the resumption of US–UK nuclear cooperation in 1958, which Matthew Jones notes, underlined:

> *the paradox of much [UK] nuclear policy in the 1950s was that the pursuit of independence also had as a goal the re-establishment of a nuclear relationship with the United States that some – at both home and abroad – would see as the compromising of national sovereignty.*[53]

The resumption of nuclear exchanges between the United Kingdom and the United States had a number of effects. First, it meant that all future UK nuclear weapons would be based on US designs,[54] starting with the thermonuclear 1.1MT YELLOW SUN Mk 2.[55] Second, following the Limited Test Ban Treaty[56] (LTBT) which banned atmospheric tests, the UK conducted underground nuclear testing at the US Nevada Test Site from 1962 to 1991.[57] Third, there would be significant exchanges of fissile materials, exchanges which continue today.[58] Fourth, it led to the direct supply of US nuclear weapons operating under joint "dual-key" controls – 168 freefall nuclear weapons under 'Project E'[59] and 60 PGM-17 Thor intermediate range ballistic missiles (IRBMs).[60] Fifth, and most importantly at the geostrategic level, it was an overt attempt to gain influence over American decision-making.

From as early as 1952, UK policy had been to partner and influence the United States, transferring the costs to the US whilst, in Anthony Eden's words "retaining for ourselves as much political control – and hence prestige and world influence – as we can."[61] Eden correctly noted that this required a maximum UK effort, and an independent nuclear capability. One useful upside of this would be that UK forces could, even in a combined atomic offensive, destroy Soviet targets which may have been peripheral to the main US effort, but that constituted a particular threat to the UK – notably bomber and submarine bases.[62]

British posture and procurement decisions being driven by a fear of American unreliability. This fear provided – and continues to provide – the strategic rationale for the independent British nuclear programme.

This – highlighted in Churchill's speech to the House of Commons of 1 March 1955 – was the UK's early counterforce doctrine, notably based on fear that the United States would not prioritise those targets that would keep Britain safe from retaliation at a time when the continental United States was largely immune. British posture and procurement decisions being driven by a fear of American unreliability becomes a recurring theme in British strategic thinking. In simple terms, would a US President trade Minneapolis for Moscow, New York for Nizhniy-Novgorod, and Los Angeles for Leningrad just because Soviet-backed East Germans occupied West Berlin? Ultimately, it is this fear that provided – and continues to provide – the strategic rationale for the independent British and French nuclear programmes. Speaking in the debate over the 1957 Defence White Paper, Minister for Defence Duncan Sandys expressed his fear that the US acquisition of ICBMs led to fear of strategic decoupling:

> *… can we really be sure that every American Administration will go on looking at things in quite the same way? We think that it is just as well to make certain that an appreciable element of nuclear power shall in all circumstances remain on this side of the Atlantic, so that no one shall be tempted to think that a major attack could be made against Western Europe without the risk of nuclear retaliation.*[63]

Entering service in 1955, the Vickers Valiant was the first of the RAF's "V-Bombers" and was the only one of the three designs to drop live nuclear weapons during the British nuclear tests from 1955 - 57.

Was the V-Force enough to deter alone?

Was the UK nuclear force capable of deterring the Soviet Union alone? It is impossible to be definitive on this question as the Soviets would make their own calculation about the costs that they could bear, and their own assessment of the technical capability of the British forces arrayed against them and likelihood that they would be used. As above, deterrence may succeed if, like Kennedy in October 1962, the state being deterred is unable to exclude the possibility that it would suffer unacceptable damage when compared to the gains it sought.

Such analysis does not itself explain how much damage would be sufficient to deter an opponent, and ultimately the deterring state needs to make a judgement about how much damage would be sufficient to ensure deterrence. Known as "nuclear sufficiency," this was carefully considered by a Ministerially-convened committee, the British Nuclear Deterrent Study Group (BNDSG) in 1958–59.[64] The BNDSG appears to have conceptually struggled with nuclear sufficiency, with one member noting that the UK nuclear force

> *…must be big enough to ensure that we can make an initial nuclear response if Russia should attack us, however improbable this may seem. It must also be big enough and varied enough to cause the US to regard it as a useful contribution and to want to share their information with us, and to supply our needs (a nuclear programme for prestige reasons, as contemplated by the French, would not satisfy this.)* [65]

In the event, and not for the last time, the RAF effectively reverse-engineered the answer of what would deter the Soviets from what the V-Force was able to deliver; a 144-bomber attack[66] would translate to 50% destruction of 40 Soviet cities.[67] By September 1958, this would be scaled down to 30 cities, with a full V-Force strike resulting in an estimated eight million killed and eight million injured,[68] though as the Air Ministry would later concede, "what level of threatened damage would deter Russia is a matter of opinion."[69] For a city of up to 1.5 million inhabitants, it was assessed that a single megaton-class weapon would meet

the damage criteria.[70] Despite debate, the V-Force's level of damage would become the standard for future British nuclear systems, including down to the Duff-Mason report in the late 1970s.[71]

"Counterforce" versus "Countervalue" Targeting

Initial British targeting thinking grew from minimising the threat of a counter-strike on the UK. This led to targeting Soviet offensive capabilities, notably bomber bases, under a doctrine of "counterforce". To its proponents, counterforce provided a credible approach to the practicalities of fighting a nuclear war: military forces – and especially air bases – were often remote from population centres, and their destruction would not necessarily destroy the Soviet state itself. As such, it was conceivable with atomic weapons that a war could be fought and, theoretically at least, the civilian population spared long enough for some form of truce or peace treaty to be enacted.

Early British counterforce proposals quickly shifted to countervalue targeting ("counter-threat" in the contemporary British lexicon) before the V-Force was fully operational in the late–1950s. British policymakers were surprisingly realistic about the strategic position, noting that under the national plan, the Chiefs of Staff "agreed it would not be wise to give Ministers the impression that we could deliver a blow that would necessarily be decisive."[72] As a result, April 1958 saw an independent UK national countervalue strike plan based on the COS(57)224 paper's guidance developed, at a time when 76 nuclear-armed V-bombers were available.[73] Jones characterises this change as a pragmatic response, and scale was key to the argument:

> *[Countervalue targeting] was considered the best means for a modest-sized nuclear force to assure the purest form of deterrence when the credibility of the US nuclear guarantee to the Western alliance could not always be assumed.*[74]

Astonishingly, the UK national strike plane based on COS(57)224 was approved by Duncan Sandys, but it does not appear to have been discussed or agreed by the Cabinet; nevertheless, it remained the basis of RAF national target planning into the 1970s.[75]

Deterrent credibility

Was the V-Force enough alone to maintain stable deterrence against the Soviet Union? Even if the damage from a successful V-Force strike were sufficient to deter, the creation of the V-Force did not by itself translate into an operational deterrent. Decision-makers believed that an assured second-strike capability was required, which in turn required planning and equipment to avoid Britain's bombers being destroyed on their bases in a disarming Soviet first strike – the notorious "bolt from the blue." When later responsibility for the strategic deterrent passed to the RN Polaris submarine force in 1969, these concerns resulted in the adoption of the current CASD posture.

The RAF's response to the threat of a disarming first strike to the V-Force was three-fold. In common with SAC, these were: early warning; dispersal; and a continuous airborne alert. Early warning initially built on the wartime radar system for detecting aircraft through the 1950s, with the speed and height of jet aircraft requiring significant investment in radar capabilities.[76] These systems were of limited use against ballistic missiles, leading to the December 1963 commissioning of the Ballistic Missile Early Warning System (BMEWS) at RAF Fylingdales in conjunction with the United States.[77] Fylingdales was essential, as the 300kT warhead of the R-5 / SS-3 SHYSTER IRBM – the first nuclear-armed Soviet ballistic missile – meant that the V-Force was theoretically vulnerable to a Soviet disarming first strike from 1956.[78] Upon its commissioning, Fylingdales BMEWS increased warning time of ballistic missile attack from Soviet territory to eight minutes,[79]

and as little as three minutes for missiles launched from eastern Europe or from submarines,[80] resulting in a three-minute target for the launch of the alerted V-Force bombers.[81]

Dispersal was fundamental to the V-Force concept of operations, and the force was designed to disperse to at least 36 airfields around the UK, with each base hosting two or four armed V-Bombers.[82] Dispersal was frequently practiced and involved programmed and no-notice exercises. In all cases, it was intended that the dispersed aircraft would be harder to target than at their home bases, and as a disarming first strike would have to simultaneously target all the airfields, dispersal would complicate Soviet targeting. During the 1962 Cuban Missile Crisis approximately 120 V-bombers[83] and 59 of the 60 British Thor IRBMs[84] were brought to Readiness State 05 – five minutes' notice to launch – on 27 October.[85] Notably, Prime Minister Harold Macmillan forbade the RAF from dispersing the V-Force during the Cuban Missile Crisis, as it was feared that this would be perceived as provocative.[86] Ironically, therefore, the only time that full dispersal would have been operationally useful, it was politically unacceptable to do so.

The move to continuous deterrence

The best solution to this dilemma was a continuous nuclear-armed airborne alert, with bombers in holding patterns awaiting the attack order, being replaced on station by further nuclear-armed bombers. As SAC demonstrated through their CHROME DOME missions, which in peacetime saw between four and 12 nuclear-armed B-52s airborne 24 hours a day, 365 days a year from January 1961 to February 1968, given sufficient resources it was possible to mount standing deterrent patrols.[87] These airborne patrols were surged in times of tension; during the Cuban Missile Crisis, 20% of SAC's bombers were on airborne alert.[88]

The RAF sought a similar capability, and actually conducted an airborne alert trial for two weeks during July 1962.[89] The results showed that although it was possible to keep a single armed Vulcan airborne continuously, to do so required between nine and 12 tanker sorties every 24 hours. This required the full resources of 214 Sqn, and due to the wear and tear on the available tanker aircraft, would not have been sustainable beyond the fortnight of the trial.[90] Adverse weather – rather than pliant midsummer – would have further complicated the maintenance of the airborne alert.

What the trial demonstrated was that though it was technically possible for the UK to mount a continuous airborne alert, to do so with a meaningful minimum number of aircraft – e.g., four Vulcans, each carrying a single thermonuclear weapon – was beyond the RAF's capability in 1962. An airborne alert would require more, larger tankers than the Valiant, and potentially an optimised missile/airframe combination; somewhere between 20 and 24 dedicated tanker aircraft and 27 and 36 optimised missile carriers would be required.[91] As a result, the RAF could not consider a SAC-style airborne alert without significant additional investment.

The fear of a "bolt from the blue" led the UK by 1960/61 to consider two options for deterrence into the 1970s: airborne alert with GAM-87 Skybolt Air-launched ballistic missiles (ALBM) or a move to the Polaris SLBM system. Both would use British warheads on US-supplied missiles, placing the UK deterrent's medium-term future at the goodwill of the United States to supply a successor to Skybolt in the 1970s.[92]

This was a major strategic decision, but one which was economically unassailable when compared with the costs of developing a wholly indigenous system. As Jones shows, in the early 1960s, the UK initially favoured the 1000nm range Skybolt,[93] initially from Vulcan B Mk 2s and then from between 27 and 36 dedicated carrier aircraft developed from the VC-10 airliner,[94] as there were concerns about the cost and ability for the UK to implement an SSBN solution at a time when HMS DREADNOUGHT, the UK's first nuclear powered submarine, had not entered service.[95] In the event, the US cancellation of Skybolt led to the 1962 Nassau Polaris Sales Agreement, less than two months after the Cuban Missile Crisis.

Skybolt's cancellation in December 1962 left the UK strategy bereft in the face of improving Soviet defences. Ironically, Skybolt was cancelled because it was insufficiently accurate for SAC to use in a counterforce strike against hardened Soviet targets, but at the time of cancellation, it was more than accurate enough for the UK's countervalue strategy of attacking Soviet cities, and the United States offered to continue to develop it for this purpose, very generously offering to cover half the development costs for a system they would not deploy.

However, as US Defense Secretary Robert McNamara recalled, the UK political optics meant that it was politically (if not strategically) essential for the UK not to have a missile that the US had cancelled on technical grounds, despite the fact that it would have been more than sufficient for Britain's countervalue strategy. The UK wanted a replacement in place before Skybolt was cancelled.[96] The "Skybolt crisis" that followed was the result of a premature US DoD announcement of Skybolt's cancellation without a replacement agreed with the UK, but led directly to the Polaris Sales Agreement (PSA). The relationship between Kennedy and Macmillan was key to unlocking Polaris over the objection of some of Kennedy's advisers, and is claimed to have been enhanced by the shared experience of the Cuban Missile Crisis, less than two months earlier.[97]

With the PSA signed, Polaris was secured for the UK, maintaining the UK deterrent through to the 1990s. CASD was deemed necessary to continue to meet the "bolt from the blue" threat. After all, if the Soviets believed that strategic decoupling was possible, then the British (and later, French) national deterrent forces were there to inflict unacceptable damage on the Soviet Union, albeit at the cost of total destruction of their homelands; but it was believed that this required a minimum survivable second-strike capability. Whilst Kennedy was sufficiently deterred from launching a pre-emptive strike on the Soviets in the Cuban Missile Crisis, the British had no intention of relying upon similar Soviet calculations. In these key elements, British nuclear weapons policy has changed little since 1962.

Rhetorical Support for CASD

The UK's CASD posture is ostensibly the most important element of the MoD. Official and Ministerial rhetoric has long supported this: speaking in a House of Lords debate in 2016, MoD Minister of State, Frederick Curzon, 7th Earl Howe claimed that, "… continuous at-sea deterrence—or CASD—the UK's minimum credible and assured nuclear deterrent that is the ultimate guarantor of our national security and way of life."[98] This echoes the 2006 White Paper, which justified CASD on the grounds that,

> *A deterrent system must be able to function irrespective of any pre-emptive action that might be taken by a potential aggressor. Also, it is important for safety and security reasons that our nuclear forces are protected properly at all times against actions ranging from a full scale strategic nuclear strike to a terrorist attack. There are a number of ways in which this might be achieved: by making the system invulnerable to attack; by having a sufficiently large capability that even a full scale attack would not prevent the launch of an effective counter strike; by making the system difficult to target, most obviously by making it undetectable; and by holding the system continuously at a sufficiently high level of readiness that it could be launched before any pre-emptive strike takes effect.*[99]

It is important to note that the UK Government consistently elides CASD as a posture with the notion of deterrent credibility, when they could – and should – be treated separately. Instead, CASD has accreted over years from theory to axiom, becoming understood as the sole measure for the credibility of the UK's nuclear force on the assumption that alternatives to CASD inherently fail the credibility test. Speaking in a Commons Debate in 1992, Sir Michael Neubert MP argued that,

> *If deterrence is to be effective, it must also be credible. That is why we are planning a four-boat Trident force to replace a four-boat Polaris force. The fourth boat provides the indispensable assurance that over the lifetime of the force, extending well into the next century, there will always be one boat on station at all times, day and night, deep beneath the sea, invulnerable to pre-emptive attack.*[100]

The 1998 Strategic Defence Review (SDR98) offered the perfect opportunity to step away from CASD, but instead defended its retention on strategic grounds – the UK would "maintain continuous at-sea deterrent patrols, not least to avoid misunderstanding or escalation if a Trident submarine were to sail during a period of crisis" however remote such a crisis was in 1998 – or even today.[101]

This position continues. The current "Dreadnought submarine programme: factsheet" states baldly: "CASD is the minimal, credible and independent deterrent against aggression towards the United Kingdom."[102] Indeed, it appears that CASD divided the BASIC Trident Commission, with a participant describing this debate as "one of the key points of disagreement within what was otherwise remarkable coherence within the Commission's report."[103]

Taken together, Malcolm Chalmers observed in 2010 that CASD:

> *… has remained largely unchanged since the 1960s, when a surprise attack on Western Europe by the Soviet Union was a central driver for UK force planning. The retention of this posture is now driven as much by institutional and political momentum as by strategic necessity. If the UK did not already have a CASD capability, it would be very difficult to make a case for investing large resources in order to obtain it.*[104]

Chalmers' view is persuasive: it would be possible, as Paul Ingram's written testimony to the House of Commons' Defence Select Committee (HCDC) 2007 Report on the 2006 White Paper illustrates, to distinguish between CASD as a posture and overall credibility of the deterrent value of the UK nuclear force without presupposing that only CASD can deliver credibility.[105] Instead, as we have seen, successive governments for more than 30 years have elected to conflate the two notions, and then claimed that the only credible deterrent is an SSBN-based solution operating in a CASD posture.

The UK Government consistently elides CASD with the notion of deterrent credibility, when they should be treated separately. CASD has accreted from theory to axiom, becoming understood as the sole measure for the credibility of the UK's nuclear force on the assumption that alternatives to CASD inherently fail the credibility test.

Managing Risks to Continuous Deterrence

As we have seen, continuous deterrence with a survivable UK nuclear force either at sea or airborne has been a cornerstone of UK strategic thinking since the early 1960s. With the demonstrable failure of a standing airborne deterrent force, this posture only became fully credible with the establishment of effective national strategic early warning via RAF Fylingdales in December 1963.[106]

Since the agreement of the PSA in 1962, however, there have been at least two occasions when Britain's technical capacity to maintain a continuous deterrent posture has been stringently tested, leading to serious stress in the system. Importantly, in both cases, the MoD took investment views that demonstrated their actual – rather than rhetorical – level of risk appetite. In so doing, these cases illustrate a much greater level of flexibility than the policy or political rhetoric around the UK deterrent force generally allows. This begs serious policy questions about how the UK should respond to the potential for a CASD gap in the early 2030s during the transition from the existing *Vanguard*-class to the forthcoming *Dreadnought*-class SSBNs.

New submarines for old

One of these occasions, namely the problems of running on the Resolution-class SSBNs until their replacement by the *Vanguard*-class SSBNs, is now well known, thanks to Peter Hennessey and James Jinks' history of the Royal Navy Submarine Service, *The Silent Deep* (2016). Coming into the late 1980s, the *Resolution*-class submarines were mechanically tired, and although it was last built and the last modified to fire the *Chevaline* modified Polaris SLBM, HMS REVENGE was the first *Resolution*-class to be retired in 1991/92.[107]

The MoD's plan for the transition from *Resolution* to *Vanguard* was clear: HMS RENOWN underwent a five-year refit at the cost of £443m in current values in the expectation that she would bear a disproportionate share of the remaining *Resolution*-class SSBN patrols.[108] Instead, she was only able to complete three additional patrols post-refit,[109] 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."[110] It is noteworthy that this left the final Resolution-class patrols in the hands of the Vickers (now BAE Systems) built pair, with the Cammell-Laird boats both being retired, perhaps reflecting the more troubled gestation of the Cammell-Laird built submarines.[111]

This left two serviceable SSBNs, meaning that any major mechanical problem with a single submarine would lead to a break in CASD. Indeed, rather than the standard 72-day patrol, during the transition period, *Resolution*-class patrols varied from 12 to 107 days, reflecting the mechanical condition of the available submarines.[112] The RN responded to the situation with extraordinary contingency planning, utilising either emergency reprovisioning of an SSBN at sea,[113] and a "worst case" scenario of "moving a Polaris submarine into Loch Long,[114] where it would dive and remain in a static location on Quick Reaction Alert." [115]

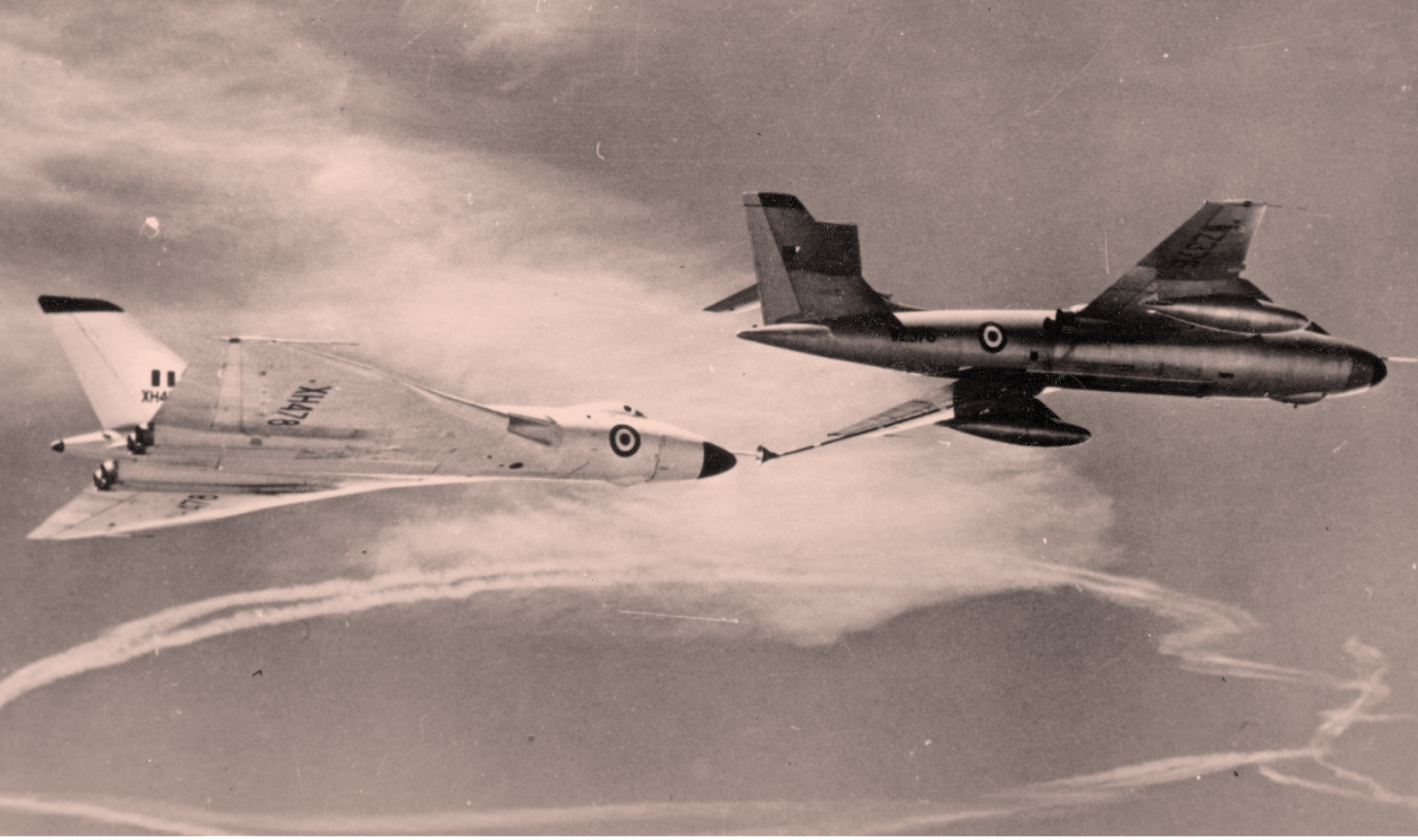
Neither of the contingencies were needed, but both would have broken key elements of CASD. The mid-ocean resupply would have been operationally very demanding, requiring the trans-shipment of food and supplies on the surface. For as long the SSBN was surfaced alongside a resupply ship it was vulnerable, its position was easily discoverable, and it could not fire; it risked compromising the entire patrol. Similarly, the danger of parking an SSBN in Loch Long deprived it of the protection of the ocean's vastness, with mobility providing a key part of the RN's proud record of avoiding detection during deterrent patrols.

In the early 1990s, any major mechanical problem with a single submarine would have led to a break in CASD. The Royal Navy responded with extrodinary contingency planning, utilising emergency reprovisioning at sea, or diving a SSBN in Loch Long.

"All of our tankers are missing!"

The second occasion happened almost three decades earlier. The UK deterrent had rested in the hands of the RAF V-Force of Valiant, Victor and Vulcan medium bombers, prior to the January 1969 handover to the RN.[116] Established in the mid-1950s, the V-Force grew to its full operational size of 144 bombers in 1962.[117]

Improved Soviet air defences in the early 1960s – unambiguously demonstrated by the 1960 shootdown of Gary Powers' U-2 reconnaissance aircraft over Sverdlovsk[118] – forced the RAF to adopt low-level attack profiles to maintain the credibility of the force from 1963. Though this reduced the risk of detection and interception, fuel consumption at low-level could be twice that at high level, severely cutting the bombers' range. Worse, the buffeting in the denser air at low level used up airframe life much more quickly than the medium level that the V-Force had been designed for, and only the Vulcan's rigid structure allowed long-term low-level operations.



Vickers Valiant B(K) Mk 1 WZ376 refuelling Vulcan B Mk 1 XH478. © BAE Systems

Once launched, it did not follow that the V-Force would automatically attack their targets. Instead, after launch the bombers would have proceeded to a Go/No-Go line at eight degrees east in Norwegian airspace. Once there, the bombers would have circled until the political decision to attack the Soviet Union or to recall the aircraft was made.[119] However, as the aircraft circled, they were burning fuel that was required for their missions, continuously reducing their likelihood of successfully returning to base after conducting their strikes. V-Force orders included,

> *an option to hold until [the aircraft] were down to a planned 1000 lbs of fuel – say five minutes flying – over [the] target. In that case … 'the recovery plan would be at the captain's discretion.'*[120]

In other words, *in extremis* the V-Force would be only have enough fuel to make it to its targets, precluding any return to friendly bases.

The switch to low level operations caused such severe stress to the aircraft's structure that following a main-spar failure in August 1964, all Valiants were grounded in December 1964, and retired from service in January 1965 when the cost of repair was deemed too high. This created an immediate capability gap, as Valiants had been expected to serve until at least 1968;[121] in particular, it immediately removed all UK air-to-air refuelling (AAR) tankers.

With the loss of the Valiant tankers, a crash programme to convert surplus Victor B Mk 1s to support both UK fighter defences and the V-Force in the strategic role began in late 1964.[122] Though conversion of Victor B Mk 1/1As to the tanker role had been planned since late 1962,[123] deliveries of the first of 25 Victor K Mk 1/1A tanker conversions capable of refuelling the V-Force would not begin until November 1965,[124] with the first operational refuelling not occurring until February 1966.[125] Thus, throughout 1965, the V-Force had no indigenous tanking capability.

What was the operational impact of this, given that the V-Force faced flying at low-level for up to 1000nm to their targets? [126] In analysing the nuclear strike mission,[127] it is clear that the additional fuel required for low-level sections of the mission – from central Sweden eastwards – would make very significant inroads on the V-bombers' unrefuelled range. For the nearest Soviet targets (e.g., Leningrad, the Baltic States and Belarus), an unrefuelled return to the UK was possible with a high-level egress and the use of auxiliary bomb-bay mounted fuel tanks.[128] For some other targets – Sqn Ldr John Reeve cites Kiev – the bombers planned to recover into Turkish NATO bases.[129]

However, for targets in and around Moscow, a low-level egress across the Soviet Union would have been required to maximise survivability, and this additional low-level flight meant that the aircraft were unlikely to have been able to return to friendly bases without air-to-air refuelling (AAR).[130] Indeed, the RAF had conducted a specific trial of low-level AAR for the V-Force in April 1963 because,

> *it might be desirable to extend the range of certain [Medium Bomber] aircraft by means of IFR. The objective of Trial No 467 was to determine the feasibility, by day or night, of IFR as a means of extending the low-level range.*[131]

In the absence of such tanker support, it was overwhelmingly likely that deep targets would become one-way missions – almost certainly mounted by the most capable aircraft flown by the most proficient crews.[132] Consequently, the loss of the Valiant tanker force significantly reduced the V-Force's capability to launch a second wave of attacks against Soviet targets.

It is clear with Trial 467 that the RAF by 1964 knew of the AAR requirement for the V-Force to ensure recovery of surviving bombers. Thus, when the Valiant fleet's fatigue problem became clear in the Autumn of 1964, the RAF assumed that the Valiants would be repaired and returned to service.[133] This assumption was bolstered by the fact that the RAF's Hastings transport aircraft had been manufactured with the same faulty aluminium-zinc-magnesium alloy as the Valiants,[134] and were subject to a comprehensive overhaul to remove all of the suspect metal; the last Hastings aircraft were not retired until 1977.[135] However, despite the practicality of the repair being demonstrated on one Valiant, fleet-wide repairs were not considered cost effective.[136] Thus, the decision was taken to have an air-refuelling capability gap until the Victor tanker conversions could enter service.[137]

Given the impact on worldwide RAF operations and V-Force credibility against the deepest targets in the Soviet Union, this decision demonstrates two unspoken but important points. First, that it is likely that the Valiant retirement decision was traded off against other RAF / MoD priorities in early 1965, a period in which the RAF and the MoD were fighting to save the largest and most expensive project in the MoD re-equipment plan, the TSR-2 strike aircraft, vulnerable because of cost over-runs and the election of a Labour Government committed to reducing an over-heated MoD budget.[138] Under these circumstances, it is easy to see how the initial repair bill of £250k for 40 aircraft,[139] which covered only the rear wing spar, did not appear to be an attractive option, even if the V-Force was operationally (and publicly) more credible with refuelling tankers available.

Second, unlike the challenge of maintaining CASD during the *Resolution* to *Vanguard* handover, the loss of the Valiant tankers was public, meaning that it was inconceivable that the Soviet leadership were unaware of the resultant reduction in V-Force capability. This was clearly judged insufficiently important to proceed with the Valiants' repairs, and it demonstrates that the level of deterrent capability deemed sufficient was not fixed in stone, even if this meant relying on the willingness of V-Force crews to conduct one-way missions. Ironically, the HMS RENOWN refit did not achieve its intended purpose, with reliance on HMS RESOLUTION beyond her retirement date, whereas the decision not to repair the Valiants appears to have passed unnoticed.

Implications for Managing the Transition

This paper's foray into history illustrates two seemingly contradictory facts. First, the "bolt from the blue" threat has often been taken seriously, even after the commissioning of BMEWS at Fylingdales that could reduce the danger of a pre-emptive Soviet attack completely wiping out any UK retaliatory strike capability. Second, when it has suited Governments of any and all political stripes to do so, the efforts to maintain a credible continuous deterrent have been less strenuous than the primacy of deterrence policy rhetoric would suggest. On this basis, what does this flexibility compared to the rhetoric provide in terms of options during the forthcoming *Vanguard*/*Dreadnought* transition?

The Doctrinal Problem

The doctrinal problem is simple: since the early 1960s, British policy has been premised on a continuous deterrent, and since 1969, on CASD. In doing so, as Nick Ritchie shows, successive British governments have explicitly coupled CASD with deterrent credibility, with the implicit message that a non-CASD deterrent would lack the credibility to deter, and therefore would be of limited value.[140] Ritchie rightly criticises this position as unrealistic, given the non-zero risk of retaliation results in a non-zero possibility of unacceptable damage for a potential adversary.[141] As Michael Quinlan wrote in 2006,

> *…the 1980s case for four SSBNs rested on a judgement that exceptionally high assurance of having one on immediate readiness station was essential in the Cold War circumstances of facing a massive superpower. The argument for such extreme assurance … scarcely seem[s] now to suffice as justification for the entire cost of a submarine.*[142]

The Operational Problem

Table 1: 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: In Service Date

OSD: Out of Service Date

Drawing on publicly available data and in-house analysis, Table 2 from BASIC's 2018 paper *Blowing up the Budget: The Cost Risk of Trident to UK Defence*[143] reproduced here, suggests that even if the *Dreadnought* procurement goes to plan and the second life extension planned for the Vanguard class delivers, there is likely to be a period in 2033/34 when the RN is down to a maximum of two operational SSBNs. With two operational SSBNs, CASD is possible for a number of months, but is extremely fragile; clearly with only a single SSBN, CASD is impossible. Any delay in the *Dreadnought* programme or unanticipated unreliability in the last remaining Vanguard class boats would widen this window of CASD vulnerability.

The source of this problem is clear: there has been consistent political delay in agreeing to replace the *Vanguard*-class. The first decision was taken by Tony Blair's first administration to extend the original 25-year design-life of the submarines to 30 years.[144] Blair pushed the decision back from 2001/02 until 2006 on the basis that a five-year life extension was possible, which as the MoD noted in the 2006 White Paper,

> *[T]he 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.*[145]

Any delay in the Dreadnought programme or unanticipated unreliability in the last remaining Vanguard class boats would widen this window of CASD vulnerability.

The same White Paper claimed that the concept-design-construction and testing of the new submarines would take 17 years for the first boat in its class. In histories and memoirs of this period, UK nuclear weapons policy is notable only by its absence. Tony Blair himself devotes a single paragraph of his extensive memoirs to the topic, and is equivocal on replacement, finally considering scrapping Trident "too big a downgrading of our status as a nation."[146] Instead, the Trident decision was couched in the politics of the Blair/Brown handover[147] and avoiding looking "weak" on defence;[148] the main concern of Ministers appears to have been having to rely on opposition (Conservative) votes to carry the Commons, as in fact happened.[149]

The second delay was also political: in their Coalition Agreement the 2010 Coalition Government agreed to:

> *…maintain Britain's nuclear deterrent, and have agreed that the renewal of Trident should be scrutinised to ensure value for money. Liberal Democrats will continue to make the case for alternatives.*[150]

The Coalition Government made a number of decisions on UK Trident policy, with the three key ones being:

1. The Trident Value for Money Review which reported at the same time as the Strategic Defence and Security Review in October 2010, which reduced the number of warheads carried on each *Vanguard*-class SSBN from 48 to 40 warheads, allowing a reduction in the UK warhead stockpile from 225 to 180 warheads by the "mid-2020s."[151]
2. A Trident Alternatives Review, which concluded in 2013 with a decision to support the existing policy.[152]
3. A delay the Main Gate investment decision to mid-2016, comfortably beyond the 2015 General Election.[153]

This last point, Hennessey and Jinks note, required extending the lives of each of the four *Vanguard*-class SSBNs to 37 years, representing "a technological leap in the dark which all concerned wish could have been avoided."[154] This echoed the 2006 White Paper which in defending the five-year life extension to 30 years, noted:

> *Therefore, while it should be possible to extend the life of the Vanguard-class into the 2020s, we believe that it would be highly imprudent now to plan on the basis that it will be possible to extend them further.*[155]

None of this continuous delay is consistent with successive governments of all three major national parties treating CASD as a national priority or an operational necessity, irrespective of their rhetoric. However, as this paper has already shown, this is hardly a new phenomenon, especially if the solution requires costly or politically inconvenient action to resolve.

Despite the rhetoric of the current government, this equivocation in the face of a serious risk to CASD remains. The state of the public finances remains parlous, and known risks in the MoD Equipment Budget threaten to take it £20.8bn (11.6%) above the available budget in the decade to 2027, leading the NAO in January 2018 to make an unusually direct critique: "The Department's Equipment Plan is not affordable".[156]

Current policy runs the serious risk of policy change obviously being forced on the UK by circumstance. It would be prudent for the Government to publicly consider a range of options to align the policy with the actual risk to CASD outlined above. The options run on a continuum from "maximum effort to maintain CASD" to "CASD can be abandoned;" four alternative scenarios are sketched out below.

Scenario A: Maximum Effort to Maintain CASD

If CASD truly is the cornerstone of UK security, then it must enjoy absolute budgetary and operational priority over all other MoD programmes. In this scenario, there appear to be three types of approach to the transition of fleets: speed up the delivery of *Dreadnought* class; re-fit HMS VANGUARD to serve until the mid/late 2030s, or a combination of the two.

Option 1: Accelerate Dreadnought-class production

The easiest way to ensure that there is no CASD gap in 2033/34 is to ensure that the first HMS DREADNOUGHT is fully operational before a third *Vanguard*-class submarine retires, and that the second and third *Dreadnought*-class SSBNs are operational before the final *Vanguard*-class retires. This would ensure that there are at least two and usually three operational SSBNs throughout the transition.

Though the *Resolution*-class was a simpler design than the *Dreadnought*-class will be, its speed of construction – less than five years from the signing of the PSA to HMS RESOLUTION beginning sea trials – was not the result of simplicity. Instead, as Peter Nailor details, there were significant recruiting drives for the specialist trades required by both Vickers at Barrow and Cammell-Laird at Birkenhead, with Vickers' workforce increasing by 45%.[157] This workforce was not always effectively utilised – at least 280,300 working days were lost to strikes – but the submarines were largely completed on schedule.[158]

If similar national priority status were applied to *Dreadnought*-class construction, then an uplift in employment across the supply chain would already be underway. It is likely that today, as in 1964, there will be shortages of skilled employees that could not be solved simply by additional recruitment,[159] but in a national priority programme this would be addressed through apprenticeships and training. This would mean the MoD accepting that at the end of the programme this would likely result in a larger workforce across the submarine enterprise than there was work for, with MoD having to fund redundancies or early retirements if additional work – e.g., submarine exports – was not forthcoming or appropriate. After all, if CASD is a critical national priority, then from the MoD perspective this is merely a project cost to be managed and minimised, necessary to the successful completion of the principal project.

Similarly, there is no reason why seven-day-a-week working, and, in time, double-shift working could not be instituted across the submarine enterprise. There is no doubt that this would be expensive, but acceleration would be explored if CASD were actually as important as the rhetoric asserts.

If CASD is the cornerstone of UK security, then it must enjoy absolute budgetary and operational priority over all other MoD programmes.

Option 2: Refitting HMS VANGUARD

Though the projected 37-year life of the *Vanguards* is the longest of any UK submarine, refitting HMS VANGUARD to allow her to re-enter service in 2032/33 for a brief period as HMS VICTORIOUS and HMS VIGILANT are retired will ensure that two relatively fresh *Vanguards* are available as the *Dreadnoughts* are brought into service. This provides cover against the risk of further *Dreadnought* programme slippage, hardly an unforeseeable event, given MoD/BAES's abysmal recent record in delivering submarines to time and

budget.[160] Current *Dreadnought* project performance is not encouraging: in each of the three most recent years available,[161] the Infrastructure and Projects Authority's (IPA) *Annual Report on Major Projects* 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."[162]

This Amber/Red rating places *Dreadnought* in the bottom quarter of major project performance in 2017.[163] 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.[164]

The challenge of an additional refit for HMS VANGUARD is that if the current life extension to get to 37-years is already "a technological leap in the dark," then the effect of an additional five years of operations makes future projections of what would be required a still greater leap. Moreover, the experience with HMS RENOWN shows that late-life refits cannot be presumed to be trouble-free, irrespective of their care and cost, and may fail completely. Consequently, this is an option that contains significant risk of being derailed by one of former US Defense Secretary Donald Rumsfeld's "unknown unknowns."[165]

However, if CASD is actually as important as the rhetoric asserts, then the MoD should be taking prudent preparatory steps as HMS VANGUARD returns to the operational fleet from its Deep Maintenance Project (Refuel) (DMP(R)) overhaul and HMS VICTORIOUS enters her DMP(R) programme about what a future overhaul for HMS VANGUARD would require in 2030.[166]

Two potentially fortuitous considerations apply. First, *Vanguard*-class overhauls are conducted by Babcock at HMNB Devonport, suggesting that an additional overhaul would not directly compete with the *Dreadnought*-class production programme in Barrow for skilled labour. Second, though most concern appears to be focussed on the ageing of the *Vanguard*-class's nuclear steam raising plant, it is helpful that it shares the Rolls-Royce PWR-2 reactor architecture with the *Astute*-class SSNs, meaning that spare parts and expertise should be easier to obtain than for equipment that lacks full OEM engineering support.

If the current life extension to get to 37-years is already "a technological leap in the dark," then the effect of an additional five years of operations makes future projections of what would be required a still greater leap.

Option 3: Accelerate and Refit

The safest, though most expensive, course, would be both to accelerate *Dreadnought*-class production *and* to prepare for a further life-extension for HMS VANGUARD to provide insurance against the failure of the acceleration programme. Accelerated deliveries of *Dreadnought* would always be preferable – *Dreadnoughts* will be both more advanced and once in service, have much less operational risk than a final commission for HMS VANGUARD – and so a parallel strategy in effect would in effect be HMS VANGUARD as insurance against further delays to the Dreadnought programme.

Scenario B: CASD if possible

This is the status quo option. During the period of maximum pressure on UK SSBN availability – projected to be 2032-34, CASD operations could continue, albeit with the significant risk that CASD would be broken in the case of serious mechanical failure to one or other operational SSBN, premature retirement of *Vanguard*-class submarines, or further delays to the *Dreadnought* programme.

Such a policy may work: after all, it is analogous to the policy during the transition from the *Resolution*-class to *Vanguard*-class. As we have seen, this was accomplished without a break in CASD, but this was a high-risk strategy, and very nearly did result in a break in CASD cover. Repeating the same strategy is to explicitly state that the real risk of a break in CASD is acceptable to the UK, even if it is undesirable. This may well be the case, but it is the failure to do so publicly – presumably in the hope that there will be no break in CASD coverage – that creates risks to the UK's official national strategy. Having set so much store by the importance of CASD, successive governments have heightened the political stakes around failing to deliver the requisite infrastructure.

This option offers significant policy and operational risk in return for not bearing the full cost of risk mitigation. It accepts that CASD is not, in fact, essential to UK security, but does so without preparing the public for this. It begs the question of the government's commitment to an independent nuclear deterrent and its willingness to put this at risk.

Scenario C: CASD no longer essential

Though the UK's stated position since the mid-1960s has been that CASD is sacrosanct, and that therefore the long-term minimum required force is four SSBNs, a third scenario would be to publicly and pre-emptively accept that CASD is no longer required for Britain's security. This would not be because the Government will not ensure sufficient funding to ensure CASD coverage, but because the "bolt from the blue" is no longer a credible threat – if indeed it ever were, rather than a conflict which arose from a sustained period of increasing international tensions. With CASD no longer required strategically, the range of postures and patrolling cycles that the 2013 Trident Alternatives Review explored would all be available.[167]

Some of these options were outlined in the 2014 BASIC Trident Commission report, under what was then termed "Near-CASD". This was described as:

> *The UK could adopt a posture involving a continuation of day-to-day continuous patrolling, but at a lower confidence level in times of no strategic threat (unplanned random breaks in patrol, or patrolling combined with training). In other words, there could be occasions when the UK might not have a submarine out at sea when there are no crises on the horizon, but retained a high confidence of being able to launch a boat at very short notice.*[168]

Deciding to move away from a fully operational CASD posture now – rather than being forced to do so by circumstance in the 2030s – could provide at least two positive impacts. First, it would remove the hit to UK policy credibility if a move away from CASD were subsequently forced upon us by an inability to deliver it. Second, a reduced patrolling cycle would extend the *Vanguard*-class life, in particularly in reactor life, meaning that the impact of further delays to the *Dreadnought* programme are minimised. [169]

Set against this are a number of doctrinal and operational questions. First, the CASD posture is justified in terms of UK national, rather than alliance, requirements. This has direct impacts on the force structure and the costs of the UK approach, in that if there needs for national requirements to be a high level of certainty that CASD can been maintained indefinitely, then procuring four SSBNs is appropriate. However, if some

A *Vanguard*-class submarine surfacing while returning to base.

breaks in CASD were acceptable, even without going as far as Scenario D's Alliance CASD option, then significant capital and operational savings are possible with two or three SSBNs and proportionately fewer crews.

Second, what would the impact on the UK's contribution to the Western Alliance and extended deterrence be of moving away from CASD? Clearly it would reduce the UK's contribution to nuclear deterrence, and the impact on the UK's contribution to overall deterrence – nuclear and conventional – will depend on what any savings are spent on, or, more likely, how much conventional capability is saved by not having to accelerate the *Dreadnought* programme, fund an additional refit of one or more *Vanguards* (or both)? Ultimately, the UK's standing with the United States, NATO and other allies will depend on how much they value the UK's nuclear contribution compared with the opportunity costs of conventional capability?

Third, if CASD is no longer imperative, why does the UK need to pursue a high-end survivable second-strike capability instead of a cheaper, less-capable nuclear system – or any nuclear system at all? There are a range of responses to this which would still support the procurement of *Dreadnought* – notably that *Dreadnought* SSBNs will serve until 2060, and that there are foreseeable circumstances under which a return to CASD may be strategically desirable – but the MoD does not strengthen the case for the *Dreadnought* programme by ignoring the CASD posture question in its entirety.

Fourth, would the resumption of a CASD patrolling posture in crisis be considered escalatory from a position where this is not the norm? Clearly yes, but this is not necessarily a negative – and it is perfectly reasonable to argue that the escalation of this sort provides a useful strategic signalling tool to those the UK seeks to deter. However, this presupposes that the crews and infrastructure are in place to move back to CASD. If this reversionary capability were maintained, the implication of this is that there will be few, if any, operational savings from a move away from CASD. However, a more radical approach that would see CASD only being maintainable for a number of months – e.g., with only two SSBNs in commission, and only four crews (as each commissioned submarine has two crews), significant operational savings could be made.

Moving to a posture of near-CASD has also been argued to pose challenges around maintaining operational focus and personnel morale, on the basis that the mission is apparently less valued than it was when the force was operating on a CASD basis. Though there are countervailing views, experience over the last 15 years with United States' Strategic Command (USSTRATCOM) demonstrates the challenge in maintaining operational standards amongst nuclear forces when the military's main effort is elsewhere. In 2007, the USAF was responsible for two inadvertent, unauthorised – and undetected – movements of nuclear-armed AGM-129 Advanced Cruise Missiles from Minot AFB, North Dakota to Barksdale AFB, Louisiana.[170] A USAF blue-ribbon panel concluded that effectively maintaining dual-role capability is challenging and requires active management.[171]

In 2014, the USAF and the USN both suffered from systematic cheating scandals in proficiency exams for their nuclear forces, with USAF ICBM launch crews and USN nuclear propulsion trainees affected.[172] Subsequently, the US DoD commissioned an independent review into their nuclear forces. In a strikingly transparent report, the DoD review panel reiterates the importance of the overt, top-level support and prioritisation of the nuclear mission,[173] the morale and efficiency benefits of dual conventional/nuclear roles when well executed,[174] and restoring the balance between mission effectiveness and inspections to certify mission effectiveness.[175] Taken together, this operational experience points towards the optimum posture being one that is a well-resourced, well-exercised and with a focus on operational excellence to maximise operational efficiency.

Moving away from CASD on a national basis is therefore neither cost-free nor without its presentational and operational challenges. It is, however, a better answer than betting on maintaining CASD under Scenario B without the necessary investment to deliver CASD, and then being forced to break it.

The UK could accept that CASD is no longer required for Britain's security, because the "bolt from the blue" is no longer a credible threat.

Scenario D: Alliance Deterrence

The more credible version of Scenario C is to publicly move, in concert with France and the United States, to re-emphasise the nature of the NATO nuclear guarantee and more closely coordinate patrols. This would recognise the primary contribution of these three states, along with the operational contribution of the five nuclear sharing states[176] which contribute strike aircraft to carry US B-61s or host the weapons under dual-key operation, and the seven additional SNOWCAT states,[177] which provides conventionally-armed support for the dual-key nuclear strike force, as well as NATO-wide role of the NATO Nuclear Planning Group.

In this conception, the UK position would focus on the mutual commitments in paragraph 8 of the December 1962 Nassau Statement on Nuclear Defense Systems, which states:

> *8. Accordingly, the President and the Prime Minister agreed that the US will make available on a continuing basis Polaris missiles (minus warheads) for British submarines. The U.S. will also study the feasibility of making available certain support facilities for such submarines. The U.K. Government will construct the submarines in which these weapons will be placed and they will*

also provide the nuclear warheads for the Polaris missiles. British forces developed under this plan will be assigned and targeted in the same way as forces described in paragraph 6.

These forces, and at least equal U.S. forces, would be made available for a NATO multilateral nuclear force. The Prime Minister made it clear that except where H.M.G. may decide that supreme national interests are at stake, these British forces will be used for purposes of international defence of the Western Alliance in all circumstances.[178]

Seen in this light, the whole purpose of the UK deterrent was primarily in support of NATO and the Western Alliance, and therefore programmed breaks in CASD during the transition from *Vanguard* to *Dreadnought* that are coordinated with the United States and France could ensure that there is no net loss of secure, second-strike target coverage at a NATO level. Moreover, unless policymakers remain transfixed by the "bolt from the blue," international tension ahead of a future conflict in which UK strategic forces would be relevant would build over time, providing an opportunity to make an SSBN ready and send it to sea.

What this proposal would remove is continuous UK-sovereign deterrent cover. Britain would not be able to decide to immediately launch a nuclear strike where "supreme national interests are at stake" and NATO's Article V guarantee does not apply. Given that this has never been defined, and UK-specific extended deterrence guarantees have never been explained, it is hard to assess what, if any, practical effect this would have. It is likely to be miniscule, if indeed it exists at all – after all, it would only occur in circumstances where another power threatens to use nuclear weapons against the UK or some (undefined) beneficiaries of UK extended deterrence, *where NATO, the United States and France are not interested or impacted*. It is hard to foresee circumstances where this could possibly be true, even in the Pacific: any attempts by North Korea to use nuclear blackmail against New Zealand – however incredible that is as a proposition – would immediately engage the United States and the rest of the Western Alliance. As a result, unless the UK Government comes to a much clearer public position on which states are uniquely covered by UK sovereign extended deterrence, and under what circumstances this guarantee is operative, it is impossible to assess how much impact the programmed periodic absence of UK nuclear patrols would have.

It is hard to foresee circumstances another power threatens to use nuclear weapons against the UK where NATO, the United States and France are not interested or impacted.

So-called "Capability Holidays" have been endemic in the UK forces since the mid-2000s – including aircraft carriers, maritime patrol aircraft, long-range anti-shipping missiles, anti-radiation missiles and land-attack missiles from surface ships – such that this is hardly a novel concept. Given that the principal mitigation – working with allies – is the same as proposed here, conceptually Scenario D breaks no new ground in principle, though given the totemic nature of the rhetoric around CASD, it would present significant presentational challenges.

Variants of Scenario D are conceivable, but the compromise is the same: is the UK prepared to forego absolute sovereign discretion for periods of time in favour of Alliance deterrence to ensure that there is not a hard break in CASD imposed by programme delays or mechanical failure? Only time will tell, but it should be carefully considered on a value-for-money basis in competition with the other scenarios.

Conclusion

This paper has charted the development of deterrence provided by a survivable second-strike capability as the natural result of a strategic action/reaction cycle from 1945 to the mid-1960s, and how British strategy moved along a similar arc to American and Soviet thinking, albeit constrained by fiscal and geographic realities to favour a continuous second-strike capability.

Yet despite consistent rhetorical support for the UK's nuclear forces being the cornerstone of UK security, we have seen how the reality has been much more nuanced when costly steps were required to provide a high level of assurance in the UK nuclear force's capability when in transition. In both the case of the Valiant tanker retirement and the *Resolution*-class to *Vanguard*-class handover, the MoD eschewed costly steps that could have provided the highest level of assurance in the continuous, unbroken capability of the UK nuclear force. In both cases, they gambled and won: the V-Force was not called to undertake low-level deep penetration missions without tanker support, and HMS RESOLUTION was able to bear the majority of the weight of CASD until the introduction of HMS VANGUARD, despite this not being the MoD's plan.

Given that the delays to the *Dreadnought* programme have made maintaining CASD reliant on the success of both the *Dreadnought* programme and the *Vanguard*-class life extension, it is time for the Government to set out what its strategy is to minimise risk in the transition. If they believed their own CASD rhetoric, the Government would move to one of the options within Scenario A, accelerating *Dreadnought* procurement and/or planning a further life-extension to HMS VANGUARD.

If CASD is not as essential as claimed, then the number of options substantially increases. These all require overt Government action that acknowledges that CASD is not critical, given our position within a large, nuclear Alliance context.

The costliest of all options in terms of Britain's international credibility is surely to attempt to avoid these difficult decisions, remain rhetorically committed to CASD and then suffer a break in CASD coverage due to *Dreadnought* programme delays, *Vanguard*-class unserviceability or a combination of the two. This Scenario B case is the worst of all possible worlds, because it sends the clear message that the UK refuses to spend the money required to match its own assessment of the needs of what is claimed to be the cornerstone of national defence. And if the cornerstone is undermined, what does this say about the value of the rest of the construct?

The Government needs to make clear how it will manage the identified threat to CASD, and why. Silence is not the bedrock of credible policy.

Endnotes

1 HL Deb 13 July 2016, vol 774

2 Brodie, B., (ed.) (1946) *The Absolute Weapon: Atomic Power and World Order*, Harcourt, Brace, New York, 76.

3 Kaplan, E., (2015) *To Kill Nations: American Strategy in the Air-Atomic Age and the Rise of Mutually Assured Destruction*, Cornell University Press, Cornell, 22, 23–24.

4 Brodie, B., (1959) *Strategy in the Missile Age*, Princeton University Press, Princeton, 110.

5 Brodie, B., (1959), 111.

6 Brodie, B., (1959), 127.

7 Brodie, B., (1959), 110–44.

8 Kaplan, E., (2015), 20.

9 Aylen, J., (2015) "First Waltz: Development and Deployment of Blue Danube, Britain's Post-War Atomic Bomb", *The International Journal for the History of Engineering & Technology*, 85:1, 33.

10 LeMay's success in transforming SAC's operational readiness in 1948–50 was remarkable; in 1948, no crew was able to simulate a bombing on Dayton Ohio within one mile of the target. Repeated in 1950, the average error across 84 crews was under 0.9 miles. SAC effectiveness would continue to improve through the 1950s as equipment was modernised and continuous exercises and alerts drove improved performance. Kaplan, E., (2015), 33–36; Boyne, W.J., (2007) *Beyond the Wild Blue: A History of the United States Air Force, 1947-2007* (2nd ed.), St. Martin's Press, New York, 102–08; LeMay, C. E. LeMay, Kantor, M., (1965) *Mission with LeMay*, Doubleday, New York, 1965, 429–54.

11 PINCHER from 1947, followed by OFFTACKLE from 1949.

12 Kaplan, E., (2015), 22

13 Kaplan, E., (2015), 21–22.

14 Trachtenberg, M., (1999) 'Making Grand Strategy: The Early Cold War Experience in Retrospect' *SAIS Review* 19:1, 34.

15 There was limited partisan activity in occupied Eastern Europe, but very little was achieved, as the 'resistance networks' were almost completely penetrated/controlled by the security services of the new communist administrations. Started under Truman, they were recognised as a failure by October 1952, and curtailed after the death of Stalin in 1953. See Grose, P., (2000) *Operation Rollback: America's secret war behind the Iron Curtain*, Houghton Mifflin, New York, 121–210.

16 This did not mean that the UK did not worry about the prospect of the United States exploiting the Soviet window of comparative vulnerability to mount a so-called "forestalling" attack. See Jones, M., (2017) *The Official History of the UK Strategic Nuclear Deterrent, Vol 1: From the V-Bomber Era to the Arrival of Polaris*, Routledge, London, 30–32.

17 Gaddis, J.L., (1981) *Strategies of Containment: A Critical Appraisal of Postwar American National Security Policy*, OUP, Oxford, 127–97; Jones, M., (2017), 27.

18 Freedman, L.D., (2004) *Deterrence*, Polity Press, Cambridge, 12.

19 Gaddis, J.L., (1990) *The Unexpected John Foster Dulles: Nuclear Weapons, Communism and the Russians*, in Immerman, R.H., (ed.) (1990) *John Fosters Dulles and the Diplomacy of the Cold War,* Princeton University Press, Princeton, 49; Malcomson, R.W., (1990) *Beyond Nuclear Thinking*, McGill–Queen's University Press, Montreal, 10; Gaddis, J.L., (1981), 132–34; Bowie, R.R., Immerman, R.H., (2000) *Waging Peace: How Eisenhower Shaped an Enduring Cold War Strategy*, OUP USA, New York, 44–48; 97–98; 184–86.

20 Chang, G.H., (1988) "To the Nuclear Brink: Eisenhower, Dulles, and the Quemoy-Matsu Crisis", *International Security*, 12(4), 106–07; Lee, D., (1995) "Australia and Anglo-American disagreement over the Quemoy-Matsu crisis 1954–55", *The Journal of Imperial and Commonwealth History*, 23(1), 110–111; Powell, R., (1990) *Nuclear deterrence theory: the search for credibility*, CUP, Cambridge, 13.

21 As early as 1949 the USAF was planning on the basis that a single nuclear armed B-29 was the equivalent of 220 conventionally-armed B-29s. Kaplan, E., (2015), 26.

22 Khan, H., (1960) *On Thermonuclear War*, Princeton University Press, Princeton, 40–95.

23 Khan, H., (1960), 20.

24 Kaplan, E., (2015), 80

25 Assuming a 10% loss rate per wave, after 10 waves, the bomber force would be at 35% of its initial strength, falling to 13% after 20 waves. At a 5% loss rate, the comparative figures would be 61% and 39%, and that was unsustainable over anything but the shortest campaign. The heaviest single loss rate for the RAF in WWII was the raid on Nuremberg on the night of 30–31 March 1944 when 95 of 795 bombers dispatched were lost – a loss rate of 11.9%. See Middlebrook, M., Everitt, C.,

(1996) *The Bomber Command War Diaries: An operational reference book 1939 – 1945*, Midland Publishing, Leicester, 486–88; Middlebrook, M., (2000) The Nuremberg Raid: 30–31 March 1944, Cassell, London, 274–81.

26 See Freedman, L.D., (2004), 37–38.

27 Brodie, B., (1959), 165.

28 Soviet theoretical studies had begun as early as 1948. See Podvig, P., (ed.) (2004) *Russian Strategic Nuclear Forces*, MIT Press, Cambridge MA, 412.

29 Kent, G.A., (2008) *Thinking About America's Defense: An Analytical Memoir*, RAND Corporation, Santa Monica, 49; Jones, M., (2017), 261.

30 Podvig, P., (ed.) (2004), 415; Jones, M., (2017), 66.

31 Treaty on the limitation of anti-ballistic missile systems, (adopted 3 October 1972, entered into force same day) 944 UNTS 13.

32 Kent, G.A., (2008), 49.

33 Finney, J.W., (1975) "Safeguard ABM System to Shut Down; $5 Billion Spent in 6 Years Since Debate", *New York Times*, New York, 25 November 1975, A-1; Werrell, K.P., (2017) *Hitting a Bullet with a Bullet: A History of Ballistic Missile Defence (BMD)*, US DoD, Washington, 15.

34 Podvig, P., (ed.) (2004), 417–18.

35 The speed of a missile and its warhead increases in proportion to its range. As a result, intercontinental range missiles and warheads will be travelling much faster than theatre or tactical ballistic missiles, against which advanced ground-based missiles (e.g., MIM-104 Patriot PAC-3, RIM-161 SM-3, THAAD, S-300VM, S-400, HQ-19, Arrow) can provide some defence.

36 Podvig, P., (ed.) (2004), 414; http://russianforces.org/blog/2012/10/very_modest_expectations_sovie.shtml (accessed 1 Jul 2018, 20:27).

37 Lettow, P., (2005) *Ronald Reagan And His Quest To Abolish Nuclear Weapons*, Random House, New York, 112–13.

38 Freedman, L.D., (2004), 27–32.

39 The only Soviet ICBMs that could have hit the continental USA in October 1962 were R-7 "Semyorka" / SS-6 SAPWOOD ICBMs, which was the missile version of the Sputnik 1 booster. SS-6 was cryogenically liquid fuelled, meaning that it could not be left fuelled for long periods, and took up to 20 hours to prepare for launch. A total of 30 SS-6 launchpads were constructed, but only 28 were available in October 1962. Podvig, P., (ed.) (2004), 181–82; Zaloga, S.J., (2002) *The Kremlin's Nuclear Sword: The Rise and Fall of Russia's Strategic Nuclear Forces 1945-2000*, Smithsonian Books, 82.

40 Zaloga (2002), 118.

41 Powell, R., (1990), 11–12.

42 HC Deb 1 March 1955, vol 537, col 1897. Poignantly, this would also prove to be the final Parliamentary Debate in which Winston Churchill played a leading role in his unparalleled career.

43 Aylen, J., (2015), 33; Wynn, H., (1997) T*he RAF Strategic Nuclear Deterrent Forces: their origins, roles and deployment 1946 – 1969*, HMSO, London, 98.

44 Aylen, J., (2015), 51.

45 Jones, M., (2017), 9.

46 Jones, M., (2017), 18; but see Brookes, A., (2015) *RAF V-Force 1955–69 Operations Manual*, Haynes Publishing, Yeovil, 48, which puts the required number of weapons at 800.

47 Wynn, H., (1997), 39–41.

48 By the end of 1957, there were 10 V-Force squadrons with eight aircraft per squadron. Valiant B Mk 1s equipped 7, 49, 90, 138, 148, 207, 214, 543 Sqns, and Vulcan B Mk 1s equipped 83 and 101 Sqns. Wynn, H., (1997), foldout opposite 500; Brookes, A., (2015), 48, 49; Moore, R., (2004) *The Real Meaning of the Words: A Pedantic Glossary of British Nuclear Weapons*, UK Nuclear History Working Paper Number 1, Mountbatten Centre for International Studies, 3.

49 Boyne, W.J., (2007), 108.

50 Jones, M., (2017), 31–32.

51 Jones, M., (2017), 33.

52 Yang, X., North, R., Romney, C., Richards, P.G., (2000) "Worldwide Nuclear Explosions", (Revision 3) (Technical report), SMDC Monitoring Research, 29. https://www.ldeo.columbia.edu/~richards/my_papers/WW_nuclear_tests_IASPEI_HB.pdf

53 Jones, M., (2017), 2.

54 VIOLET CLUB and YELLOW SUN Mk 1 both used the GREEN GRASS 400kT fission warhead, rather than being a true thermonuclear design using a fission primary using radiation implosion of a thermonuclear secondary. 37 YELLOW SUN Mk 1s would enter service by 1961, Moore, R., (2010) *Nuclear Illusion, Nuclear Reality: Britain, the United States and Nuclear Weapons*, 1958 – 64, Macmillan, London, 256; Brookes, A., (2015), 49.

55 YELLOW SUN Mk 2 combined an Anglicised US Mk 28 1.1 MT warhead (codenamed RED SNOW) in the existing YELLOW

SUN Mk 1 casing, which removed the need for additional tests for aircraft compatibility and airdrop. Moore, R., (2010), 85–91, 105; Wynn, H., (1997), 262; Brookes, A., (2015), 49. RED SNOW was also the warhead for BLUE STEEL.

56 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, (adopted 5 August 1963, entered into force 10 October 1963) 6964 UNTS 480.

57 Jones, M., (2017), 270–71.

58 Moore, R., (2010), 85. HC Deb 24 February 2016, vol 606, https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2016-02-11/27158/

59 On Project E weapons and the Valiants assigned to the NATO Tactical Bomber Force, see Wynn, H., (1997), 363–72; Brookes, A., (2012) *Valiant Units of the Cold War*, Osprey, Oxford, 80–83.

60 See Wynn, H., (1997), 280–97, 340–62; Boyes, J., (2008); *Project Emily: Thor IRBM and the RAF*, History Press, Stroud; Wilson, J., (2008) *Launchpad UK: Britain and the Cuban Missile Crisis*, Pen & Sword, Barnsley.

61 Jones, M., (2017), 22.

62 Jones, M., (2017), 22.

63 HC Deb 16 April 1957, vol 568, col 1761.

64 Jones, M., (2017), 160–61.

65 Jones, M., (2017), 161.

66 Sufficient British nuclear weapons were available to equip the V-Force with one weapon per aircraft by the end of 1961. Moore, R., (2010), 141.

67 Jones, M., (2017), 161.

68 Jones, M., (2017), 161.

69 Jones, M., (2017), 305.

70 Jones, M., (2017), 163.

71 Jones, M., (2017), 164–65; Hennessey, P., Jinks J., (2015) *The Silent Deep: The Royal Navy Submarine Service since 1945*, Allen Lane, London, 472–89.

72 Jones, M., (2017), 52.

73 Jones, M., (2017), 53.

74 Jones, M., (2017), 53–54.

75 Jones, M., (2017), 54.

76 Cocroft, W.D., Thomas, R.J.C., (2003) Cold War: Building for Nuclear Confrontation 1946–1989, English Heritage, London, 84–142; Clarke, B., (2005) Britain's Cold War, History Press, Stroud, 71–90.

77 Wynn, H., (1997), 303.

78 This risk was probably theoretical, as it would have required the 650nm range SS-3 being forward deployed to East Germany, western Poland or western Czechoslovakia, and it is not clear that they were. However, without consistent intelligence coverage of Eastern Europe, the UK could not be confident that the missiles had not been forward deployed. The first submarine launched ballistic missile would enter service in February 1959; Podvig, P., (ed.) (2004), 178–79.

79 Presumed to be the Kaliningrad exclave. Wynn, H., (1997), 304.

80 The Soviet Union was the first nation to operationally deploy land-attack ballistic missiles from a submarine, with the R-11FM / SS-1b SCUD entering service in February 1959. Though it was primitive – the submarine had to surface to fire, the missile had a range of approximately 100nm and it was liquid-fuelled, posing a threat to the submarine itself – it was able to deliver a 500kT warhead against previously invulnerable targets with minimal warning time. Podvig, P., (ed.) (2004), 309–11.

81 Wynn, H., (1997), 304. But losses were expected against alerted bombers before they got airborne; see Jones, M., (2017), 178–79, 285.

82 Wynn, H., (1997), 306–07.

83 Woolven, R., (2014) *What really happened in RAF Bomber Command during the Cuban missile crisis?,* in Gioe, D., Scott, L., Andrew, C., (eds.) (2014) *An International History of the Cuban Missile Crisis*, Routledge, Abingdon, 178.

84 Woolven, R., (2014), 177.

85 Woolven, R., (2014), 182–83.

86 Woolven, R., (2014), 189. In contrast for the official account, see Catterall, P., (2015) *Harold Macmillan's accounts of the Cuban missile crisis*, in Scott, L., Hughes, G.R., (eds.) (2015) *The Cuban Missile Crisis: A critical reappraisal*, Routledge, Abingdon, 79.

87 Sagan, S.D., (1993) *The Limits of Safety: Organisations, Accidents and Nuclear Weapons*, Princeton University Press, Princeton, 167–81.

88 Figures on the number of airborne alert aircraft vary from 66 (Woolven, R., (2014), 181) to 75 (Grant, R., (2011) "The Perils of Chrome Dome", Air Force Magazine, August 2011, 55).

89 Bomber Command Trial 448; private information.
90 Bomber Command Trial 448; private information.
91 The optimised missile/carrier aircraft combination would have been a VC-10 variant carrying four or six GAM-87 Skybolt ALBMs, see below.
92 Jones, M., (2017), 312.
93 It appears that Skybolt's range was heavily warhead dependent. Richard Moore's research suggests that with the very light W-47 warhead, Skybolt would have a 1000nm range, but Skybolt's range would fall to 600nm if it carried the UK's initially preferred RED SNOW warhead, which was 1,000lb heavier, which would have required RAF bombers to launch Skybolt against Moscow from inside Soviet airspace, negating the point of standoff. Moreover, even allowing for UK's objections to US high explosives, the W-47 design required much more fissile material than RED SNOW (four times as much highly enriched uranium and nearly twice as much weapons grade plutonium), a cost that the UK would have preferred not to have borne. In the end, however, range was deemed more important and UK Skybolt would have been armed with an Anglicised W-47. Moore, R., (2010), 118–21.
94 Jones, M., (2017), 287–97.
95 HMS DREADNOUGHT was commissioned in April 1963. Hennessey, P., Jinks J., (2015), 181–94
96 Horne, A., (1989) *Macmillan 1957 – 1986: Volume II of the Official Biography*, Macmillan, London, 435 (on the Skybolt Crisis in general, 432–51); Lamb, R., (1995) *The Macmillan Years 1957–1963*: The Emerging Truth, John Murray, London, 310–14.
97 Horne, A., (1989), 438.
98 HL Deb 13 July 2016, vol 774
99 *The Future of the United Kingdom's Nuclear Deterrent,* Cm 6994, December 2006, paragraph 4.2, 22.
100 HC Deb 3 February 1992, vol 203, col 44.
101 *Modern Forces for the Modern World,* Cm 3999, 8 July 1998, paragraph 66, 26.
102 HM Government (2018) "Dreadnought submarine programme: factsheet", 19 February 2018, https://www.gov.uk/government/publications/successor-submarine-programme-factsheet/successor-submarine-programme-factsheet
103 Interview B, 2018.
104 Chalmers, M., (2010) "Briefing Note: Continuous At-Sea Deterrence", RUSI, London, July 2010, 2.
105 HCDC (2007) T*he Future of the UK's Strategic Nuclear Deterrent: the White Paper: Volume II Oral and Written Evidence*, HC 225-II, 7 March 2007, Ev 99, 4.6.
106 There is some suggestion that from 1958 to 1963 the Lovell Telescope (then the Mark 1) at Jodrell Bank was used to provide early warning for the UK. The Lovell Telescope's signature achievement in tracking the *Sputnik 1* booster rocket, showed that the design had been modified to allow it to operate as a radar rather than merely as a receiver. However, it is unclear how much coverage it provided the RAF, as it would have been impossible for it to operate as an observatory whilst performing early warning duties. See Bromley-Davenport, J., (2013) *Space Has No Frontier: The Terrestrial Life and Times of Bernard Lovell*, Bene Factum, London, 190–95; Prime Minister Harold Macmillan noted it in the House of Commons on 29 October 1957, HC Deb 29 October 1957, vol 575, col 31.
107 Hennessey, P., Jinks J., (2015), 585.
108 HMS RENOWN's overhaul cost "approximately £200m" in 1987/88 values, or £443m in 2018/19 values. Hennessey, P., Jinks J., (2015), 585.
109 Hennessey, P., Jinks J., (2015), 585.
110 Hennessey, P., Jinks J., (2015), 585.
111 Hennessey, P., Jinks J., (2015), 268.
112 Hennessey, P., Jinks J., (2015), 455.
113 As this would require the SSBN to surface mid-patrol, it ran counter to all elements of the CASD doctrine which places a premium on not giving away the submarine's position throughout its patrol.
114 RNAD Coulport, where the UK SLBM warheads are stored, is located on Loch Long, over the ridge from HMNB CLYDE, Faslane.
115 Hennessey, P., Jinks J., (2015), 585–86.
116 Wynn, H., (1997), 317–18.
117 Wynn, H., (1997), foldout opposite 500.
118 Now Yekaterinburg.
119 Reeve, J., (2009) "The Vulcan Deterrent" in *The Vulcan*, 2(12), Vulcan To the Sky Trust, Summer 2009, 20.
120 Reeve, J., (2009), 22.
121 Wynn, H., (1997), 452; Blackman, T., Wright, A., (2014) *Valiant Boys: true Stories from the Operators of the UK's First Four Jet-Bomber*, Grubb Street, London, 169;

122 The first prototype Victor K Mk 1 three-point tanker (trials aircraft XA918) had begun conversion in December 1963, but the initial trials with this aircraft had cleared it first as a two-point tanker. Such was the need to support UK air defence aircraft, the six interim tankers replicated this interim fit to avoid the need for additional trials, allowing the first conversion (XH620) by mid-April 1965. These interim aircraft were only equipped for daylight, fighter refuelling. Brooks, R.R., (2007a) *The Handley Page Victor: The History and Development of a Classic Jet Volume 1*, Pen & Sword, Barnsley, 214–15, 217.

123 Brooks, R.R., (2007a), 217.

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125 Brooks, R.R., (2007a), 222.

126 Wynn, H., (1997), 453.

127 Reeve, J., (2009), 18–23.

128 For BLUE STEEL range performance, see Brooks, R.R., (2007b), 20–21.

129 Reeve, J., (2009), 23.

130 This was as true of the five BLUE STEEL standoff bomb equipped squadrons as the free-fall squadrons, as BLUE STEEL released at low-level had a range of only 40nm. Wynn, H., (1997), 216–17, 460–61.

131 Wynn, H., (1997), 450 (footnote 3).

132 As the most heavily defended targets were in and around Moscow, presumably these targets would have had the majority of the BLUE STEEL equipped aircraft targeted against them.

133 Wynn, H., (1997), 465–66.

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137 Wynn, H., (1997), 468.

138 TSR-2's first flight was made on 27 September 1964 ahead of the General Election on 15 October 1964, though as test pilot Roland Beamont later wrote, "The first flight was more a political gesture than a logical stage in a professionally conducted technical programme". The first prototype TSR-2 (XR219) would not fly again until 31 December 1964, after more than 80 modifications had been made. The whole TSR-2 programme was be cancelled in the 1965 Budget on 6 April 1965, after XR219 had completed just 25 flights. See Burke, D. (2014) *TSR2: Britain's Lost Bomber*, Crowood Press, Marlborough, 122–27, 140, 143–44.

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