"Related to the question of policy on manned aircraft": a new view of the Blue Streak cancellation

Richard Moore
Visiting Research Fellow, Centre for Science and Security Studies, Dept of War Studies, King's College London[1]

At a time when large defence equipment programmes and the future of Britain's nuclear weapons, unusually, are matters of some domestic political controversy in the United Kingdom, it may be of interest to reconsider some of the difficult defence procurement decisions of the past. One such example was the Blue Streak medium-range ballistic missile, cancelled in 1960. Labour opposition leader Harold Wilson, speaking in the House of Commons defence debate two years later, clearly felt this decision had been especially significant: "the failure of Blue Streak was the moment of truth for this country so far as the independent deterrent was concerned".[2] Indeed, when the cancellation was announced by Defence Minister Harold Watkinson on 13 April 1960, there was "bedlam" in the Commons.[3] Soon afterwards, a high-water mark was reached in popular opposition to nuclear weapons in Britain. In response, Labour's nuclear defence policy was changed significantly, bringing to an end a previously comfortable bipartisan political consensus in this area. Because its immediate replacement as a nuclear delivery system was the American missile Skybolt, Blue Streak also became a symbol of British decline, and a particular controversy began over the independence (or not) of Britain's nuclear weapons, which still reverberates today.[4] Prime Minister Harold Macmillan recalled in his memoirs that "the decision on Blue Streak had been difficult and even heart-breaking".[5]

The fate of Blue Streak has attracted much comment from historians in the succeeding fifty years. In authoritative general histories, cancellation tends to be explained in terms of cost and technical and strategic obsolescence. Dominic Sandbrook, for example, comments that "by February 1960 ... some £60 million had been spent on developing Blue Streak, but at this point it was becoming painfully clear that it was already out of date. As a [Ministry of Defence] report put it, if the Soviet generals pre-emptively fired their missiles at the British rocket silos, they 'could wipe out Blue Streak without any possibility of reply'. Blue Streak was accordingly, and embarrassingly, cancelled".[6] Peter Hennessy, more succinctly, says that "the UK's attempt to construct its own land-based ballistic missile, Blue Streak, had to be abandoned in 1960 on grounds of both cost and vulnerability".[7]

1 Research for this article was conducted while the author was a Visiting Research Fellow at the Mountbatten Centre for International Studies, Southampton University, and an early version was presented to the British Rocketry Oral History Project conference at Charterhouse in Spring 2010.

2 *House of Commons debates*, vol.655 col.230 (6 March 1962).

3 *The Guardian*, 14 April 1960, p.1.

4 The best account of the political aftermath of the cancellation remains Andrew Pierre's *Nuclear politics: the British experience with an independent strategic force 1939-70* (Oxford UP 1972), esp. ch.8.

5 Harold Macmillan, *Pointing the way 1959-61: Memoirs vol.5* (Macmillan 1972), p.258.

6 Dominic Sandbrook, *Never had it so good: a history of Britain from Suez to the Beatles* (Little Brown 2005), p.228.

7 Peter Hennessy, *The secret state: Whitehall and the cold war* (Penguin 2002), pp.60-1.

Today, some commentators argue despairingly that mere expense and irrelevance are no obstacle to the development and procurement of weapons of war. The Royal Navy's new aircraft carriers, for example, have been described by the Commons Public Accounts Committee as setting "a new benchmark in poor corporate decision making".[8] The Eurofighter Typhoon, critics claim, may become "the all-time most expensive and pointless British military aircraft, for a few years at least".[9] We should certainly beware, however, of projecting twenty-first century concerns about arms procurement backwards in time, and imagining that Blue Streak's failings were primarily of technology or management. In this article, on the contrary, I shall argue that Blue Streak was a technical and management success.

Alternative explanations for the Blue Streak cancellation began to be put forward in the 1990s by strategic and diplomatic historians. Their work was based on close reading of then newly declassified documents from senior political and military decision-makers: ministers, the Chiefs of Staff and the cross-governmental British Nuclear Deterrent Study Group (BNDSG), set up in 1959 specifically to consider the most appropriate future nuclear delivery system or systems for the United Kingdom.[10] These careful works lend much colour to the story, and whilst they touch on the cost of the Blue Streak programme and some of its technical problems, they tend to conclude that nuclear strategy, moderated in various ways by bureaucratic self-interest, was the paramount concern. For Ian Clark, for example, "there can be no doubt that the decisive factor at the end was the overwhelming military case which the Chiefs of Staff mounted against the missile in early 1960".[11] For John Baylis too, cancellation "reflected a growing consensus in military circles at the time that, as a result of the rapid technological changes taking place, deterrence had to be based on survivable, retaliatory capabilities if it was to be effective".[12] Clark, Baylis and others situate Blue Streak within a wider British debate over many years around nuclear strategy, Anglo-American relations and delivery systems. Blue Streak, according to these accounts, failed because it was a "fire-first" and not a second-strike weapon, and because politicians could see cheaper American alternatives, perhaps more likely to succeed technically and certainly more likely to reinforce Britain's most important international political and military partnership. Bureaucratic opposition to Blue Streak, notably from the Admiralty and the Treasury, was marshalled in the BNDSG, chaired by Ministry of Defence (MoD) Permanent Secretary Sir Richard Powell, whose blockbuster report at the end of 1959 provided the necessary ammunition for the Chiefs of Staff, and then ministers, to damn Blue Streak as militarily useless.

I hope to show that this strategic and bureaucratic narrative, like the parallel story of cost and obsolescence, is simplistic and in places wrong. Instead, following the ground-breaking work of Guy Finch, whose doctoral thesis addressed views on

8 Public Accounts Committee, *The major projects report 2010: 23rd report of session 2010-11*, HC 687 (The Stationery Office 2011), p.3.

9 Lewis Page, *Lions, donkeys and dinosaurs: waste and blundering in the armed forces* (William Heinemann 2006), p.121.

10 See especially Martin Navias, *Nuclear weapons and British strategic planning 1955-58* (Oxford, Clarendon Press 1991); Ian Clark, *Nuclear diplomacy and the special relationship: Britain's deterrent and America 1957-62*, (Oxford, Clarendon Press 1994), ch.5; Wynn, *RAF strategic nuclear deterrent forces*, ch.23; John Baylis, *Ambiguity and deterrence: British nuclear strategy 1945-64* (Oxford, Clarendon Press 1995), ch.9.

11 Clark, *Nuclear diplomacy*, p.185.

12 Baylis, *Ambiguity and deterrence*, p.286.

Blue Streak and other deterrent projects specifically within the Air Ministry,[13] I shall reconsider contemporary political, military and official views of Blue Streak, and the story of the cancellation decision itself, in greater detail. I shall argue that financial and strategic logic, although of some interest to participants in the decision-making process, were not, in the end, of primary importance. I shall suggest, instead, that personal views and tactics were the determining factors; and in particular, that the most senior Royal Air Force (RAF) customers for Blue Streak, struggling at the time to ensure any future for manned military aircraft, ultimately found two birds in the bush – in the shape of a new air-launched missile and, importantly, a new high-performance bomber – preferable to a bird in the hand.

The MRBM: technical and project success

The Blue Streak project was begun in response to the Air Ministry's operational requirement number OR.1139, finalised in August 1955, for a land-based medium-range ballistic missile (MRBM) system to carry a megaton nuclear warhead over a 2000-mile range.[14] Specific work on the MRBM had been underway for at least two years, and associated research of various kinds for some time before that. The lead contractor for the missile, De Havilland Propellers, had been selected before the final issue of the requirement, and agreement had also been reached between Britain and the United States on several relevant areas of technology transfer, including propulsion and guidance, in 1954. When OR.1139 was issued, Vickers Valiant bomber squadrons, capable of carrying Britain's first free-fall atomic bombs, had only recently formed. Missiles would be introduced alongside these and other, more advanced "V-bombers", the Handley Page Victor and the Avro Vulcan; the primary requirement stated was for "a missile system complementary to the bomber force, to serve both as a deterrent and as an effective means of delivery in war".[15] The Air Ministry wished to diversify because it was looking to a future, around 1965, in which its bombers might become too vulnerable to anti-aircraft defences in the USSR to constitute a credible strike force on their own.

Blue Streak was to be a large, twin-engined, liquid-fuelled missile, ten feet in diameter, over 60ft long and over 200,000lb in weight. Notable challenges to be overcome during development ranged from physics to engineering and management, including in particular warhead design, re-entry studies, guidance, underground launch, and decoys and penetration aids against possible Soviet anti-ballistic missile (ABM) defences. Judged against its the response to these challenges, the Blue Streak project was essentially a success.

The story of work at the Atomic Weapons Research Establishment (AWRE) at Aldermaston to design and test a two-stage megaton thermonuclear device, suitable for use on Blue Streak, has been told elsewhere.[16] At first, AWRE scientists had no workable idea for an MRBM warhead, but they managed a successful test of the large single-stage Orange Herald device in May 1957, and two further successful

13 Guy Finch, 'Replacing the V-bombers: RAF strategic nuclear systems procurement and the bureaucratic politics of threat', PhD thesis, University of Wales at Aberystwyth, 2001.

14 The story of the project is covered in greater detail for example in the official history by Humphrey Wynn, *RAF strategic nuclear deterrent forces: their origins, roles and deployment 1946-69* (The Stationery Office 1994), ch.23; Nicholas Hill, *A vertical empire: the history of the UK rocket and space programme, 1951-70* (Imperial College Press 2001), ch.5-6; and Roy Dommett, 'The Blue Streak weapon', in *Prospero* 2 (Spring 2005), pp.7-33.

15 Quoted in Wynn, *RAF strategic nuclear deterrent forces*, p.374.

16 See in particular Lorna Arnold, *Britain and the H-bomb* (Palgrave 2001).

tests of two-stage 'Granite-type' warheads in November 1957 and April 1958. These devices yielded 0.7, 1.8 and 3 megatons respectively, and all three were light enough to be carried by Blue Streak. Under pressure because of political moves to suspend nuclear testing, AWRE was unable to weaponise any variant of the Granite-type design, being told instead in November 1958 to 'anglicise' an American warhead, known in British use as Red Snow. This was essentially because the US design was, in engineering terms, more mature. It is clear, however, that Aldermaston scientists had the knowledge to produce a design of their own for Blue Streak *before* gaining access to information and assistance from their US counterparts; indeed the demonstration of this knowledge was crucial to obtaining such help.

To study the basic science of atmospheric re-entry, a test rocket codenamed Black Knight was designed and built by Saunders-Roe. Test flights, at the massive Woomera range in Australia, commenced in September 1958. Possible designs for the Blue Streak re-entry vehicle were successfully flown and recovered using Black Knight, and ionisation and other phenomena relevant to penetration of an ABM defence were observed.[17] Sir Steuart Mitchell, Controller of Guided Weapons and Electronics at the Ministry of Aviation (MoA) and one of Britain's leading defence scientists, was able to describe British work on re-entry for Blue Streak with considerable satisfaction: "The design of the re-entry head which we finally ended up with for Blue Streak is: (a) of British origin; (b) it is now joint UK/US information; (c) it is agreed by the US to be much better than their designs as regards invulnerability and US has now copied it; (d) as regards invulnerability it is so advanced that neither the US nor ourselves can conceive a counter to it".[18]

Guidance for Blue Streak posed considerable problems, as Britain was some way behind the state of the art in the US in inertial navigation systems for long-range use at hypersonic speeds in ballistic missiles. To achieve the required accuracy, the guidance contractor Sperry was eventually forced to use American Kearfott gyroscopes, built under licence by Ferranti at brand-new facilities in Edinburgh, along with Ferranti's own design of accelerometer. An alternative radio guidance concept, using ground stations to generate signals for the missile to follow but potentially vulnerable to physical destruction or jamming, was abandoned along with a competing inertial guidance system designed by English Electric. Nevertheless Sperry produced an acceptable prototype of the intertial navigation system by early 1960.[19]

Blue Streak would have been launched from underground silos, intended to withstand the blast and heat from a nearby nuclear explosion and permit a retaliatory missile launch. The liquid oxygen and kerosene used by Blue Streak were not as hazardous, for example, as the high-test peroxide used in the contemporary Blue Steel guided bomb, but rapid fuelling was required to react to changes in alert status and both fuel handling and vibration damping underground were significant challenges. There was a suggestion that silo construction would have used a large part of Britain's concrete production, contending for priority with the early motorway

17 Hill, *A vertical empire*, ch.9.

18 Quoted in *ibid.*, pp. 135-6.

19 *ibid.*, p.81; Dommett, 'The Blue Streak weapon', pp.16-17; Benjamin Cole, 'Soft technology and technology transfer: lessons from British missile development', *The Nonproliferation Review* (Fall 1988), pp.61-2; on the Ferranti facility in Edinburgh, opened by Minister of Supply Aubrey Jones and coyly described as "essential for inertial navigation systems used in aircraft, missiles and ships", see *Flight*, 11 Sep 1959, p.198.

network.[20] Work on a prototype silo at the Spadeadam test site in Cumberland was underway at the time of cancellation.

As fears grew in the intelligence community of Soviet progress in ABM defence, and as Britain's own scientists worked on similar problems, the question arose, as early as 1957, of decoys and other penetration aids to get Blue Streak through to its targets. This problem too was also well on the way to solution by early 1960, prefiguring later British work on Polaris and Chevaline in the 1970s and 1980s. Defence scientists reckoned that this advanced work was "more than enough to flatten the opposition", indeed that "this is a top secret field in which we are well ahead of the Americans".[21]

There were certainly concerns, as with any large engineering project, around cost and timescale. The ambitious programme of static testing and flight trials necessary to prove the design, necessitating capital investment in huge new facilities in Britain and especially Australia, dominated the critical path in project-management terms. Political decisions were taken in 1958 alternately to investigate speeding up and slowing down work on Blue Streak, adding considerable and unwelcome uncertainty.[22] But a recent assessment of the "soft" management and engineering skills needed for Blue Streak reckons the programme a success. There were technical integration problems to be resolved, for example when Rolls Royce's vibration calculations failed initially to take account of the sensitivity of Sperry's guidance instruments, but none of the ruinous personal or organisational rivalries that affected some other cold war defence projects. De Havilland Aircraft and Rolls Royce, the makers of Blue Streak's missile body and rocket motors, had the advantage of access to technical information from Convair and North American Rocketdyne, their respective counterparts on the US Atlas inter-continental ballistic missile programme, but their leading-edge engineering skills enabled them not only to use but to improve US technology.[23]

By the end of 1959, the MoD believed six Blue Streak sites could be operational by the end of 1965 – the date originally specified, ten years previously, for full operational capability – and the rest by the end of 1967. The total cost for development, production and deployment would be around £465 millions, surprisingly rather *less* than the figure of £480 millions quoted to ministers a year earlier.[24] Blue Streak missiles had been delivered to Spadeadam and static firings were about to begin early in 1960, a matter of months behind the schedule agreed in 1957.[25] Early in 1960, a full operational date of 1968 was quoted, along with a

20 Dommett, 'The Blue Streak weapon', pp.24-6; Wayne Cocroft and Roger Thomas, *Cold war: building for nuclear confrontation 1946-89* (English Heritage 2003), pp.46-7; Peter Morton, *Fire across the desert: Woomera and the Anglo-Australian joint project 1946-80* (Canberra, Australian Government Printing Service 1989), pp.436-7.

21 PRO, Cornford to Zuckerman, 18 Jan 1962 in DEFE 19/115; Sir Steuart Mitchell, quoted in Hill, *A vertical empire*, pp. 135-6.

22 Wynn, *RAF strategic nuclear deterrent forces*, p.379; PRO, CWP/P(58)3 of 16 Apr 1958 in AVIA 65/1428.

23 Cole, 'Soft technology and technology transfer'. Professor Ian Smith's short article on 'The Blue Streak propulsion system' in the proceedings of the Royal Aeronautical Society's conference on the *History of the UK strategic deterrent*, 17 Mar 1999, ch.9, lists several ways in which Rolls Royce improved on Rocketdyne's work.

24 UK National Archives (formerly Public Record Office), Kew (hereafter PRO), BND(SG)(59)19(Final) of 31 Dec 1959 in DEFE 7/1328; Wynn, *ibid.*, p.384.

25 For Spadeadam firings, see Charles Martin, *De Havilland Blue Streak* (British Interplanetary Society 2002), p.187; for the 1957 schedule, I am grateful to Roy Dommett for finding the minutes of the 4th meeting of the joint UK/US Medium-range Ballistic Missile Advisory

somewhat higher final cost of £513 millions including additional contingency.[26] But the Blue Streak story is not one of mismanagement and of astronomical overruns in cost and time. Instead the MRBM appears to have been a successful product of Britain's 'warfare state'. As Prime Minister Harold Macmillan later recalled with satisfaction, "the Blue Streak ballistic rocket was undoubtedly a triumph for the vigour and skill of our scientists and technicians. There is no doubt that had we persevered it would have been technically successful".[27]

Diverse views on strategic delivery systems: the BNDSG

Although, as I shall argue, the work of the BNDSG was based on curious strategic assumptions and ultimately peripheral to the Blue Streak decision, the group's work remains of considerable interest. Its very creation, over several months in early 1959, was politically controversial and it does provide a useful starting-point for an analysis of the views of the various political and bureaucratic interests involved in the analysis of deterrent delivery systems.

Admiral of the Fleet Lord Mountbatten, the First Sea Lord, appears to have been the early champion of a study group on deterrent systems chaired by the independent Powell. The Chief of the Air Staff (CAS), Marshal of the RAF Sir Dermot Boyle, viscerally distrusting Mountbatten, initially preferred a study under the existing Defence Research Policy Committee, chaired by MoD Chief Scientific Advisor Sir Frederick Brundrett who, as we shall see, was a particular friend of Blue Streak. The combative Minister of Defence, Duncan Sandys, also resisted setting up a group under Powell, and after several months the Prime Minister himself had to insist.[28] Powell was joined by senior officers of all three armed forces and other senior officials from the MoD, the Ministry of Supply, the Atomic Energy Authority, the Foreign Office and the Treasury. The BNDSG finally began to meet in July 1959, charged "to consider how the British controlled contribution to the deterrent can most effectively be maintained in the future, and to make recommendations".[29]

The formula of a "British controlled contribution" was important. It was not universally popular; Boyle, for example, was briefed by his staff as late as December that it was a "phoney and undefined concept" and that instead "it must continue to be HMG's policy over the next ten years to have a nuclear force under independent control capable of deterring Russia from threatening UK vital interests".[30] But it meant that the BNDSG's foremost concern, on paper, was not to preserve an ability for Britain to deter the USSR *alone*, but in concert with the US and the NATO alliance. In 1959, the RAF's V-bombers had two strike plans: an independent British plan to attack Soviet cities only, and (part of) a coordinated Anglo-American plan to attack a wider variety of targets.[31] Paradoxically, the BNDSG took, as its practical

Committee, 20/21 Jun 1957, in the RAE archive at Farnborough. Firings eventually began in the autumn of 1960, having been delayed a little longer specifically to allow new work to adapt Blue Streak for space research.

26 PRO, D(60)1st meeting of 24 Feb 1960 and D(60)17 of 1 Apr 1960 in CAB 131/23.

27 Macmillan, *Pointing the way*, p.251.

28 PRO, COS(59)1st mtg, 1 Jan 1959 in DEFE 4/115; Sabatini (Sandys's private secretary) to Powell, 4 Jun 1959 in DEFE 13/617; summary of Chequers discussions, 7 Jun 1959 in AIR 8/1961; Wynn, *RAF strategic nuclear deterrent forces*, p. 387.

29 PRO, BND(SG)(59)19(Final) of 31 Dec 1959 in DEFE 7/1328, p.1.

30 PRO, undated (Dec 1959) brief to Boyle for [7 Dec?] FPC meeting, in AIR 8/1961.

31 Twigge and Scott, *Planning Armageddon*, pp. 71, 105, 113; Baylis, Clark [[check]].

definition of a suitable British "contribution", the ability of the existing V-force to destroy 40 Soviet cities in the *independent*, not the joint Anglo-American scenario.

The group began by studying the period up to the early 1970s, considering the merits of Blue Streak against three potential rivals, together loosely described as "mobile" in the sense they would not be launched from fixed silos on land. These were the British air-launched cruise missile Blue Steel 2; the American air-launched ballistic missile WS138A, later and better known as Skybolt; and the American submarine-launched ballistic missile Polaris. The advanced Blue Steel 2 fell by the wayside when it became clear that its development put at risk parallel work on the original Blue Steel and the TSR.2 aircraft.[32] Thus, in the BNDSG's final analysis, Blue Streak effectively went head-to-head with Skybolt and Polaris.

The Admiralty and Royal Navy were deeply ambivalent about nuclear weapons in general, and Polaris in particular, as I have argued at length elsewhere.[33] Indeed by December 1959, somewhat counter-intuitively, we find the *naval* representative on the BNDSG, Admiral Sir Laurence Durlacher, championing the suggestion that, rather than Polaris, "we go for V-bombers plus WS138A from 1966 (or thereabouts), as being – if we can get it – the most effective method we can see of maintaining the deterrent in the second half of the decade".[34] Although Mountbatten showed great enthusiasm for Polaris at times, exchanging breathless letters with his American counterpart Admiral Arleigh Burke – "we shall need all the ammunition we can get to support our case for a naval deterrent"[35] – his senior colleagues were far more reticent. At an important internal Admiralty meeting on 16 April 1959, it became very clear that a British Polaris programme would interfere with other naval equipment priorities, including the nuclear hunter-killer submarine HMS *Dreadnought*. When Admiral Sir Charles Lambe took over from Mountbatten in May, on the latter's promotion to Chief of the Defence Staff (CDS), the Navy's enthusiasm for Polaris evaporated. Lambe wrote to his ministerial superior, Lord Selkirk, to say "I am certain that we in the Admiralty need a much clearer picture than we have at present of the probable repercussions of a Polaris programme on the rest of the Navy before we start any official pro-Polaris propaganda. Indeed, I doubt whether it is right for the Navy to undertake any such propaganda at all ... My advice for the present would thus be to let sleeping dogs lie".[36] Selkirk's reply showed that the Admiralty, whilst it opposed Blue Streak, did so not because of Polaris but because the nuclear deterrent in general, and the "disadvantages and mounting costs" of Blue Streak in particular, put at risk "our hopes of increasing the size of our conventional naval forces".[37] The Admiralty and War Office, as several writers have noted, mounted a sustained campaign against the whole idea of independent nuclear deterrence in the late 1950s for this very reason.[38]

The Treasury, through its BNDSG representative Bruce Fraser, maintained a consistent position of opposition to Blue Streak – and many other projects – on cost grounds. Fraser was an archetypal civil-service mandarin, serving in a number of home departments before retiring in the 1970s to produce a new edition of Sir Ernest

32 PRO, DCAS to Ward, 15 Dec 1959 and brief for Ward of 21 Dec 1959 in AIR 8/2256; BND(SG)(59)11th mtg of 30 Nov 1959 in DEFE 7/2301.

33 Richard Moore, *The Royal Navy and nuclear weapons* (Frank Cass 2001), esp. ch. [[check]].

34 PRO, Fraser (Treasury) to Powell, 16 Dec 1959 in DEFE 7/2301.

35 PRO, Mountbatten to Burke, 17 Feb 1959 and other papers Jan-Feb 1959 in ADM 205/202.

36 PRO, Lambe to Selkirk, 25 May 1959 in ADM 205/202.

37 PRO, Selkirk to Lambe, 1 Jun 1959 in ADM 205/202.

38 [[fn needed - check]]

Gowers's *Complete Plain Words*. As such he was innocent of any attachment to a particular deterrent system. The Treasury's own papers on the deliberations of the BNDSG have unfortunately been lost,[39] but it seems clear that Fraser sought initially to attack the plan to base Blue Streak underground, with a view to securing its overall cancellation later.[40]

Unfortunately, such costings as individual BNDSG members felt able to share with the wider group were always subject to disagreement, and it is abundantly clear that assumptions were varied on purpose to produce the desired answer. For example, the Air Ministry was extremely keen not to relax the agreed damage criterion of 40 Soviet cities, knowing that to achieve this level of attack using Polaris meant significant expenditure on additional submarines.[41] Although it seemed likely that Skybolt would be a relatively cheap option, in the sense that it made good use of existing investment in V-bombers and their bases, this argument does not leap out of the pages of the final BNDSG report. Indeed, a sound value-for-money decision on deterrent systems, based on a single set of agreed cost estimates, was impossible. This being the case, Guy Finch's description of the Treasury's influence over nuclear policy-making seems to be apt: "the position of the Treasury vis-à-vis the deterrent may be likened to that of a shark circling a raft. The shark is not strong enough to overturn the raft itself and must thus wait for a dispute on board to result in the casting of a victim into the water".[42]

The MoA, newly created in October 1959 for Duncan Sandys, replaced at MoD by Harold Watkinson after another general election victory for Macmillan's Conservative Party, took over many of the functions of the Ministry of Supply, including its seat on the BNDSG. Here it was represented by its most senior civil servant, Sir William Strath, famous for his 1955 report on the fall-out implications of an H-bomb attack on the UK. David Edgerton paints a vivid picture of the MoA as a huge and far-reaching empire, directing an economically significant part of Britain's industrial and research capacity.[43] Other accounts criticise the MoA for its inaction, its labyrinthine committee structures, its distance from the end customers of its project work, and its protection of particular industrial and technological interests. The Ministry of Supply created and oversaw the Blue Streak programme and for reasons of industrial policy it opposed, in particular, any American alternative. The MoA inherited these interests, strengthened further by Sandys's own personal support for Blue Streak. Nevertheless the available documents give the impression that the MoA played its hand weakly in the Blue Streak debates, failing in particular, perhaps due to wishful thinking, to realise the gravity of the threat to its cherished programme until very late in the day. So for example we find Sir Steuart Mitchell complaining to Strath on 25 January 1960 – by which time, as we shall see, it was almost too late – of his lack of opportunity thus far to influence the debate.[44]

The BNDSG report and after: into the realm of politics

39 They should be in two PRO files, T 225/885 and 886, listed in the catalogue as retained but in fact missing: James Underwood, Treasury Information Rights Unit, pers. comm. 15 Nov 2010.

40 PRO, brief for VCAS 16 or 17 Nov 1959 in AIR 2/13708.

41 See *e.g.* PRO, VCAS note of 1 Feb 1962 in AIR 19/999.

42 Finch, 'Replacing the V-bombers', p.16.

43 See David Edgerton, *Warfare state: Britain 1920-70* (Cambridge UP 2006).

44 PRO, Mitchell to Strath 25 Jan 1960 in AVIA 65/910. Copious February 1960 papers from Sandys's private office in AVIA 66/1 give a similar impression that the MoA was late presenting its key arguments on Blue Streak.

On 31 December 1959, his last day in office at the MoD before moving to the Board of Trade, Powell presented the BNDSG's report to Watkinson.[45] The report concentrated on questions of technical vulnerability: "in view of our terms of reference we have excluded from our considerations the political purposes for which British nuclear forces are required. Our main object has been to examine the technical and operational factors and the broad costs involved". Where Blue Streak was concerned, the BNDSG concluded that: "If we assume that the Soviet attack would be made with ballistic missiles of an accuracy equal to that which we expect to achieve ourselves ... and that a warhead of at least 3Mt could be available, 95 per cent of the underground Blue Streak sites could be destroyed by between 300-400 Soviet missiles ... we have no doubt that the Soviet stockpile by 1967 would be sufficient to provide these warheads for attack on the United Kingdom".

The BNDSG did not, however, specifically propose the cancellation of Blue Streak. Instead it made a series of conditional recommendations. *If* a "fire-first" weapon were acceptable, then the development of Blue Streak should continue. Meanwhile ministers would have to decide whether they wished to be seen to depend upon the United States for a delivery system for the strategic deterrent. *If* such dependence were acceptable, and *if* a satisfactory deal could be struck with the Americans to obtain either Skybolt or Polaris, *then* Blue Streak could be cancelled. On the other hand, if these conditions could not be met, then either Blue Streak should be completed and deployed, or a gap in credible strategic deterrence would have to be accepted for a time while resources were found to develop and introduce an all-British mobile system.

Powell, in his covering note to Watkinson, was even more cautious about cancellation. In a rare flash of partiality, he offered his "personal view ... that despite the cost involved we should continue with the development and some deployment of Blue Streak, unless we are prepared to accept an entirely new concept of ... 'British operation' of part of an American deterrent force [rather than] the independent British contribution to a joint Anglo-American effort".[46] It may seem odd that one of the MoD's most senior officials was unclear as to whether this or that measure of independence would be acceptable to ministers. However, whilst the BNDSG had been steered away from consideration of the political context of deterrence, a whole parallel controversy had been raging on precisely this question.

The key forum for this debate was a Future Policy Committee (FPC), set up by Macmillan in June 1959 under the chairmanship of his closest and most senior official advisor, the Cabinet Secretary Sir Norman Brook. The remit of the FPC was exceptionally far-reaching, covering Britain's whole place in the world and the resources needed to sustain it.[47] Powell, Mountbatten and the Chiefs of Staff, with counterparts from the Treasury and Foreign Office, all sat on the FPC, which for some time avoided the specific question of nuclear deterrence. Eventually, in the autumn, a relatively neutral Foreign Office paper was circulated on the pros and cons of maintaining a wholly independent British capability to create "unacceptable damage" to the USSR, as against unilateral disarmament, or independent control of a contribution to the western deterrent.[48] On 4 December 1959, the FPC met to discuss the paper. Most delegates stressed the difficulty and cost of maintaining a fully independent deterrent and the desirability of acting in concert with Britain's

45 PRO, BND(SG)(59)19(Final) of 31 Dec 1959 in DEFE 7/1328.
46 PRO, Powell to Watkinson, 31 Dec 1959 in DEFE 7/2216.
47 See Peter Hennessy, *Having it so good: Britain in the fifties* (Allen Lane 2006), ch.13.
48 PRO, FP(A)(59)8 of 30 Nov 1959 in CAB 134/1930.

allies. Mountbatten, Lambe and the Chief of the Imperial General Staff, General Sir Francis Festing, all mentioned, in addition, the need for spending on conventional forces. Boyle took the personal risk of disagreeing at length:

> he felt that our influence in the world would be greater if we maintained an independent nuclear deterrent, capable throughout the next ten years of inflicting unacceptable damage on Russia, than if we merely provided a contribution to the western deterrent. In any event it was essential that we should have complete positive control and not merely a right of veto over the use of our nuclear forces. He did not accept that the independent deterrent need cost more than a contribution ... On the question of priorities between the services there was no reason to suppose that conventional forces above the present planned levels could offer any significant additional advantages in meeting our world-wide commitments. Our influence very much depended on the existence of our strategic nuclear forces which in general supported all our other military efforts.[49]

Boyle again protested when Brook, attempting to sum up at the end of the meeting, asserted "unanimous agreement" that Britain could never take on the Soviet Union alone, and his minority conclusion – "the view of one of those associated with this study" – was reflected in the FPC's final report to the full cabinet in February.[50] Many years later, Peter Ramsbottom, a Foreign Office official present at the December FPC meeting, recalled Boyle's performance vividly: the southern Irishman had been "wrapped up in the Union Jack".[51]

Having made his point, Boyle left office at the end of 1959 and, as Powell's uncertain words to Watkinson in his covering note to the BNDSG report suggested, the implications for Blue Streak were still unclear. On 12 January 1960, Watkinson turned to the Chiefs of Staff for advice, and three days later Powell's replacement as MoD Permanent Secretary, Sir Edward Playfair, held a meeting on the options, at which there was "general agreement that cancellation would be a mistake ... Blue Streak, in the timescale envisaged, is the 'devil we know' against two devils we don't know very well" [*i.e.*, Skybolt and Polaris]. Sandys, either sensing no great danger or at least affecting lack of concern, meanwhile wrote to the Chancellor of the Exchequer, Derick Heathcoat-Amory, to seek authorisation for some necessary spend on Blue Streak test facilities in Australia.[52]

On 22 January, however, at a further meeting in MoD to prepare a submission to Watkinson, ahead of the Chiefs' meeting on 26 January at which the BNDSG conclusions were to be discussed, cancellation seems suddenly to have become a clear possibility. Watkinson had apparently made clear that he was now unwilling to rely on Blue Streak alone, and wished to diversify the deterrent; this and the FPC's conclusions had encouraged thoughts of greater reliance on the US. There had also been "more reassuring information about the availability of WS138A, in the light of which the Chiefs of Staff are likely to conclude that, on military grounds alone, there

49 PRO, FP(A)(59)7th mtg, 4 Dec 1959 in CAB 134/1930. See also briefs provided to Boyle ahead of FPC meetings, preserved in AIR 8/1961.

50 PRO, C(60)35 of 29 Feb 1960 in CAB 129/100, p.29.

51 Quoted in Hennessy, *Having it so good*, p.585.

52 Date of Watkinson's request to Chiefs recorded retrospectively in PRO, COS(60)28 of 5 Feb 1960 in AVIA 66/1; Chilver to Playfair 14 Jan 1960 and Nicholson to DCDS 15 Jan 1960 in DEFE 25/13.

is no justification for continuing with the development of Blue Streak".[53] It is interesting that Skybolt was mentioned specifically as the proximate cause of this conclusion. At a meeting in the Air Ministry just the previous day, the Secretary of State, George Ward, had reported back enthusiastically on a recent visit to the United States. His view was that "we should now press the Minister of Defence most strongly" for Skybolt, indeed that "he had already covered this ground briefly with the minister ... who had suggested that Sir Solly Zuckerman should visit the USA to examine the project".[54] RAF representatives had been present at hearings of the Fletcher Committee, an internal Pentagon body set up specifically to scrutinise the Skybolt project, in Washington on 14-15 January, and Defense Secretary Thomas Gates was sufficiently impressed by the outcome of these hearings to approve continued development under tight management control. This optimism about Skybolt seems to have been extremely significant, coming as it did at precisely the wrong moment for Blue Streak.

On 26 January, Mountbatten chaired the Chiefs' sixth regular meeting of the new year. Powell attended in person, despite having moved to his new job, along with Lambe, Festing and two newcomers to our story: Marshal of the RAF Sir Thomas Pike, now CAS in succession to Boyle, and Zuckerman, the new MoD Chief Scientific Advisor. Unfortunately the minutes of this particular discussion appear not to have survived,[55] but it seems most likely that this was the point at which the Chiefs first stated their definite opposition to Blue Streak. Certainly by 2 February Pike agreed with the other Chiefs that "Blue Streak as a weapon had no validity", and on 5 February the Chiefs issued a note recommending "the cancellation of its further development as a military weapon ... [and] the cancellation of the planned deployment ... We attach no military value to Blue Streak as a weapon". The words "as a weapon" were chosen carefully, and the Chiefs expressed concern about any setback to British missile and space research, therefore also recommending that some defence money should be spent on continuing the project for research purposes only. Finally, in the light of the recent encouraging news about Skybolt, the Chiefs recommended an immediate approach to the US for this weapon, rather than Polaris.[56]

Making the decision stick

The Chiefs' unanimity in opposing Blue Streak was certainly important, as many commentators have argued, but it was not the end of the matter. Sandys was conveniently out of the country on a tour of South America to promote British civil aviation between 25 January, when he described the cancellation of Blue Streak as "inconceivable",[57] and 7 February when he cannot have been so confident.

53 PRO, Chilver to Watkinson 22 Jan 1960 in DEFE 25/13; see also, in the same file, the brief of the same date to Mountbatten for the forthcoming Chiefs' meeting.

54 PRO, note of meeting in SofSAir's room, 21 Jan 1960 in AIR 20/10697.

55 The minutes of COS(60)6th mtg of 26 Jan 1960, in PRO DEFE 4/124, record that item 6 referred to a note in the Secretary's Standard File, where more sensitive items were usually held; but in this file, now DEFE 32/6, a manuscript note says this particular item was further removed to a separate annex because of its Atomic classification; here the trail goes cold.

56 PRO, COS(60)8th mtg of 2 Feb 1960, confidential annex in DEFE 25/13; COS(60)28 of 5 Feb 1960 in AVIA 66/1.

57 PRO, Sandys to Heathcoat Amory, 25 Jan 1960 in AIR 8/2057. This note was apparently drafted on the way to the airport ((see Clark p.180, Hill p.104 or Wynn p.393 – check)). For

Nevertheless he told Watkinson, on his return, of his intention "to fight for Blue Streak against WS138A to the bitter end".[58] Sandys was not alone in supporting Blue Streak: Lord Hailsham, the Minister for Science, feared "serious losses to British science and technology,"[59] and Lord Home, the Commonwealth Secretary, stressed the likely impact of cancellation on relations with Australia.[60] No less than seven ministerial meetings, all chaired personally by the Prime Minister, plus face-to-face talks between the Macmillan and US President Eisenhower, were required before a recommendation could be taken to the full Cabinet. Blue Streak was certainly not cancelled on a whim.

After some initial skirmishing on paper,[61] battle-lines were drawn at a regular meeting of the ministerial Defence Committee on 24 February. Macmillan, back in the country after his "winds of change" tour of Africa, introduced a paper no doubt drafted by Brook, and already discussed by a smaller group of ministers, which summarised the FPC conclusions on deterrent policy before endorsing the Chiefs' views on Blue Streak and suggesting urgent discussions with the United States.[62] In discussion, Watkinson and Heathcoat-Amory offered their support. Sandys stated his disagreement, claiming that "it was very doubtful whether the cancellation of Blue Streak would save money in the long term" and, less controversially, that "the effectiveness of Skybolt had not yet been proved". Revealingly, he also said that "he would not, however, dissent from the recommendation to abandon Blue Streak as a weapon on the understanding that development work on it continued as part of a United Kingdom programme on research into outer space".[63] Thus a political compromise – certainly discussed by officials as early as 14 January[64] – was explicitly offered. Other points were raised at the meeting, some predictable and others not. There were two mentions, for example, of basing Blue Streak in the west country, including from Macmillan himself: "the deployment of static missiles on fixed sites had an adverse effect on public opinion and there would be particular problems in siting Blue Streak missiles in the west country".[65] Exactly what lay behind this newly expressed concern is unclear. There had been incidents with protesters at Thor missile sites in East Anglia, and Macmillan may have been worried that new underground Blue Streak sites, needing to be further west for geological reasons, would attract similar attention and be otherwise unpopular with landowners and voters in the Tory shires. Although "fire-first" was mentioned, ministers were quite clearly some way from being concerned exclusively by nuclear strategy.

Sandys chose to pursue a number of other arguments at subsequent meetings, for example challenging Skybolt on the grounds that V-bomber aircraft carrying the missile would be just as vulnerable to Soviet pre-emptive attack as Blue Streak. This argument, guaranteed to infuriate the RAF and Air Ministry, was still

Sandys's trip, see Alastair Pugh, 'South American rentrée', *Flight* 8 Jan 1960, pp.37-9; *Flight*, 29 Jan 1960, p.159.

58 PRO, ms note from Mountbatten, 12 Feb 1960 in DEFE 25/13.

59 PRO, D(60)5 of 22 Feb 1960 in CAB 131/23.

60 PRO, Home to Heathcoat Amory, 11 Feb 1960 in AIR 8/2256.

61 PRO, Sandys paper for 20 Feb 1960 mtg in AIR 8/2256; draft of Waktinson paper (?19) Feb 1960 in DEFE 25/13; D(60)5 of 22 Feb 1960 from Hailsham in CAB 131/23.

62 PRO, D(60)2 of 24 Feb 1960; also D(60)8 of 23 Feb 1960, both in CAB 131/23.

63 PRO, D(60)1st mtg, 24 Feb 1960 in CAB 131/23.

64 PRO, Chilver to Playfair, 14 Jan 1960 in DEFE 25/13; also e.g. Strath to Sandys, 23 Feb 1960 in AVIA 66/1 and Ward to Watkinson, 23 Feb 1960 in AIR 8/2256.

65 PRO, D(60)1st mtg, 24 Feb 1960 in CAB 131/23.

being pressed as late as 6 April.[66] Ministers also commissioned and discussed a report from officials on the possible continuation of the Blue Streak project for space research, concluding that the compromise offered by Sandys on 24 February was indeed a good idea.[67] MoA officials including Strath, who had protested that "if we stop the development of Blue Streak there is no way of avoiding a situation that in terms of industry is little short of disastrous", were somewhat mollified.[68] Thus Blue Streak, latterly under the auspices of a European Launcher Development Organisation, enjoyed for a time a successful afterlife as the first stage of a possible space launcher.[69] The attitude of the Australian government, which hosted so many of the facilities for Blue Streak testing, had also to be gauged. Although Home was concerned not to "arouse further doubts in Mr [Robert] Menzies's mind about our frankness with him",[70] the Australian Prime Minister seem to have had a canny idea what was going on. The Australian forces' senior representative in London, Air Vice-Marshal Alister Murdoch, had briefed Canberra about rumours of cancellation on 21 January, and the High Commissioner, Sir Eric Harrison, had spoken to Sandys. Menzies took the eventual news, explained to him face-to-face by the visiting Charles Lambe and sweetened by the decision to continue space research, well.[71]

The remaining obstacle to cancellation was the small matter of securing American agreement to Britain's obtaining Skybolt "without strings", *i.e.* with no US or other veto over its possible use. When the British ambassador in Washington, Sir Harold Caccia, first raised the question with the US Secretary of State Christian Herter and his deputy for disarmament, Livingston Merchant, the signs were not promising. State Department officials were willing to supply Skybolt or Polaris to Britain only in the context of a wider agreement on NATO nuclear sharing. On 22 March, Macmillan told Watkinson he did not "like the look of Washington telegrams" on the subject, but at this stage he appears to have been content to leave the running to his ministers.[72] On 25 March, however, he was briefed that the subject might come up in the margins of his own imminent arms-control talks with Eisenhower at Camp David.[73] A few days later, the deal was done, apparently with little fuss on the American side. Britain now had Skybolt, although ambiguity over the precise deal struck between the President and Prime Minister was to cause considerable later confusion.[74] A further meeting of the Defence Committee on 6 April, and a discussion at the full cabinet on 13 April, ratified the decision to cancel Blue Streak as a weapon.[75]

Weak strategic arguments

66 PRO, Sandys to Macmillan, 25 Feb 1960 and other correspondence in DEFE 13/195; Ward to Macmillan, 1 Mar 1960, brief to CAS and SofSAir of 6 Apr 1960 and other correspondence in AIR 8/2256; D(60)11 of 18 Mar 1960 and D(60)16 of 25 Mar 1960 in CAB 131/23.

67 PRO, D(60)17 of 1 Apr 1960 in CAB 131/23.

68 PRO, Strath to Playfair, 10 Feb 1960 in DEFE 7/2247.

69 Hill, *A vertical empire*, ch. ((check)); Martin, *De Havilland Blue Streak*.

70 PRO, Home to Heathcoat-Amory, 11 Feb 1960 in AIR 8/2256.

71 National Archives of Australia, Canberra (hereafter NAA), Murdoch to Edwin Hicks (Secretary, Dept of Defence), 21 Jan 1960 and Harrison to Menzies (by signal) 24 Feb 1960 in A1945, 128/1/8; Menzies to Macmillan, 23 March 1960 in A6706, 76.

72 PRO, Macmillan to Watkinson, 22 Mar 1960 in AIR 20/10697. See also the diplomatic telegrams in question between 19 and 22 March in AIR 2/15603.

73 PRO, de Zulueta to Macmillan, 25 Mar 1960 in PREM 11/2994.

74 See e.g. Clark, *Nuclear diplomacy*, pp.182-4, 270 *et seq.*; Moore, *Nuclear illusion, nuclear reality*, pp.64-8.

75 PRO, D(60)3rd mtg, 6 Apr 1960 in CAB 131/23; CC(60)26, 13 Apr 60 in CAB 128/34.

The documentary record of the decision to cancel certainly, as we have seen, stresses the "fire-first" vulnerability of Blue Streak and its resultant military inutility. Ian Clark, for example, has argued on this basis that the decision was driven by strategic logic: "by the end, there was a powerful consensus at both the political and military level that the strategic case against the missile was all but unanswerable".[76] The account in Harold Watkinson's memoirs also majors on strategy.[77]

However, close reading of the arguments presented in writing and, in particular, close observation of the obvious jockeying for position between ministers and officials, from the very creation of the BNDSG to the final defeat of Sandys and his less than gracious acceptance of Blue Streak's future in space research, cannot fail to suggest that somewhat more complex motivations were in play than pure strategic logic. Moreover, many of the participants in the debate on Blue Streak at the time acknowledged, more or less openly, that there were serious weaknesses in the strategic argument against the weapon.

Deterrence is a political as well as a technical construct, and although the BNDSG's terms of reference focused its attention quite deliberately on technical issues, it became impossible wholly to ignore politics. At the BNDSG's meetings on 13 and 19 November 1959, for example, officials began to speculate that Blue Streak's vulnerability to pre-emption was illusory. How could the Russians be sure that a first strike on the United Kingdom with 400 three-megaton warheads would not invite American retaliation? How could they be sure the fall-out over the USSR from such an attack would not be ruinous? With British understatement, one member of the group commented that "it was important not to underestimate the caution which the Soviet leaders would be bound to exercise in determining whether to launch a nuclear attack on this country".[78]

Zuckerman was made aware of some of the relevant arguments and papers by Powell in the weeks before taking up his new appointment on 1 January 1960, and also rebelled against some of the curious assumptions made about Russian behaviour. Vulnerability should only matter, he thought, if the Russians shared the assumption that they might one day make a nuclear first strike of their own against the UK, and were prepared to make a cold calculation of the risks to themselves inherent in such a course of action. Zuckerman did not believe in the scenario: "if the Russian attitude is what it is now supposed to be, there is every reason to press on with the development of an effective Blue Streak system".[79] He later complained to Watkinson that his attempts to question political assumptions in this way had been "set aside as something that falls into some field of 'religious' discussion".[80]

Within the Air Ministry, Permanent Secretary Sir Maurice Dean also believed that "these calculations are probably done differently in Moscow",[81] and another senior official, Ronald Kent, noting the Soviet leader's well known fascination with rocketry, pointed out that "Mr K[hrushchev] is more likely to be impressed by a ballistic rocket or at least by a mixed deterrent than by a V-force".[82] When Powell

76 Clark, *Nuclear diplomacy and the special relationship*, p.185.

77 Harold Watkinson, *Turning points: a record of our times* (Salisbury, Michael Russell 1986), pp.122-5.

78 PRO, BND(SG)(59)8th mtg, 13 Nov 1959 and 9th mtg, 19 Nov 1959, both in DEFE 7/2301.

79 PRO, Zuckerman commentary dated 30 Nov 1959 on BND(SG)(59)17, in DEFE 19/11 and DEFE 7/2301.

80 PRO, Zuckerman to Watkinson, 19 Feb 1960 in DEFE 7/2247.

81 PRO, (unsent) memo Dean to Pike, 1 Feb 1960 in T 325/88.

82 PRO, Kent (AUS(A)) to VCAS, 2 Nov 1959 in AIR 2/17371.

himself passed the BNDSG's interim report to Watkinson on 31 December 1959, his covering note stressed that Blue Streak's "only defect" was its "technical vulnerability to a Soviet pre-emptive attack ... the importance to be attached to this defect turns on the political assessment of the likelihood that the Soviet Union would make such an attack on this country alone when deterrent bases in the United States could not similarly be neutralised". Although intelligence suggested the Russians might, by the late 1960s, have sufficient weapons with the range to mount such an attack on the United Kingdom, they would have no such capability against the United States for many years to come. As we have seen, Powell offered a rare glimpse of his own thinking, adding: "my personal view is that, despite the cost involved, we should continue with the development and some deployment of Blue Streak".[83]

Brundrett, now retired, was so concerned by the possibility of cancellation that on 16 March he took the opportunity of a lecture at the Royal United Services Institution in London to mount a public defence of the MRBM:

> From the military point of view, Blue Streak gives us the only timely means of ensuring that we satisfy the government policy of keeping our independent contribution to the Western deterrent continuously in being ... my last word on the subject of rockets, satellites, and military thinking is that we in this country cannot possibly afford to stop the development of Blue Streak; we simply must press ahead with it as rapidly as possible.[84]

We should recognise, as most senior officials did at the time, that the military and strategic arguments against Blue Streak were in fact extremely weak. Zuckerman, for one, certainly noted that the Soviet pre-emptive attack against Blue Streak's underground bases, envisaged by the BNDSG, and which supposedly made the missile a "fire-first" weapon, involved expending 1.2 *billion* tons of TNT equivalent over southern England, *in a war against the United Kingdom alone*.[85] This was far-fetched indeed, coming as it did when the FPC had just confirmed that the purpose of Britain's strategic nuclear deterrent was to make a contribution to the defence of the western alliance as a whole. Macmillan's memoirs indicate surprise and satisfaction that the warring service Chiefs had, most unusually, agreed on a point of policy: "it was hard to resist the objections raised by the Chiefs of Staff, now presented with a unanimity and force which had hitherto not been achieved".[86] Watkinson too noted that "even Winston in the war years had rarely overthrown the advice of the Chiefs of Staff".[87] But we must look beyond strategy for the real reason the Chiefs – and in particular Boyle and Pike, for we have already touched on the views of their counterparts – had turned against Blue Streak.

Manned bombers

The Defence White Paper of 1957 had announced an end to peacetime conscription and emphasised nuclear deterrence of a major war between East and West. In drafting and championing the paper personally, with barely a pretence of

83 PRO, Powell to Watkinson, 31 Dec 1959 in DEFE 7/2216.

84 Sir Frederick Brundrett, 'Rockets, satellites and military thinking', *Journal of the Royal United Services Institution* 105/619 (1960), p.340.

85 PRO, undated file note at the start of Zuckerman's own file DEFE 19/11.

86 Macmillan, *Pointing the way*, p.251.

87 Watkinson, *Turning points*, p.110.

consultation, Duncan Sandys won no friends in the MoD. Each of the services found something particular to dislike in Sandys's policy – a grudge to bear for some time to come. The Royal Navy's role in major war, for example, was dismissed as "somewhat uncertain".[88] For the RAF, the paper's comments on future manned bomber and fighter aircraft were the particular goad:

> the evolution of rocket weapons of all kinds, both offensive and defensive, has been proceeding apace ... the government have decided not to go on with the development of a supersonic manned bomber ... Work will proceed on the development of a ground-to-air missile defence system, which will in due course replace the manned aircraft of Fighter Command.[89]

Dermot Boyle, the professional head of the RAF, "represented that 'cavalry school' of air officer most attached to the traditional appearance of an air force",[90] and took particular exception to these remarks. As he noted in his memoirs:

> By far the most important and alas far reaching event for the Air Force during my time as CAS was the 1957 Defence White Paper in which the Minister of Defence, Duncan Sandys, insisted that in future there would be virtually no more manned aircraft and that everything would be done by missile. He rewrote the Defence White Paper overnight to this effect and refused to listen to advice to the contrary. I fought him in every legitimate way I could with very little effect.[91]

The shock caused to the RAF by Sandys and his views on manned aircraft is hard to overestimate. RAF officers were, almost by definition, pilots by profession; bombers in particular were the very conceptual essence of the independent air force created by Lord Trenchard after the First World War. For Sandys to suggest there should be no more such aircraft was beyond heresy. Although the supersonic reconnaissance bomber requirement OR.330, and the Avro 730 aircraft intended to meet it, were abandoned in early 1957 in line with the new policy, a body of opinion within the Air Ministry set out almost at once to undermine Sandys's conclusions.

As Guy Finch has pointed out, a supersonic bomber as conceived in the 1950s would have, almost by definition, a number of specific operational disadvantages compared to an equivalent subsonic aircraft. It would have a large radar cross-section and lack manoeuvrability, both key factors in avoiding fighter or missile interception.[92] In addition, at supersonic speed, it would be almost impossible to drop a free-fall weapon from an internal bomb bay: it would make far more sense to fire a missile carried externally, in which case the missile and not the bomber might as well meet any requirement for high-speed penetration.[93] Many within the Air Ministry accepted that a high-altitude supersonic bomber would be

88 *Defence: outline of future policy* (Cmnd.124), April 1957, p.4.
89 *ibid.*, pp.1, 9.
90 Laurence Martin, 'The market for strategic ideas in Britain: the "Sandys era"', *American Political Science Review* 56/1 (Mar 1962), p.28.
91 RAF Museum, Boyle papers: *My life: an autobiography by Marshal of the RAF Sir Dermot Boyle* (privately published, 1989), pp. 108-9.
92 Finch, 'Replacing the V-bombers', ch.2.
93 Chris Gibson, *Vulcan's hammer: V-force projects and weapons since 1945* (Manchester, Hikoki 2011), pp.36-7.

costly, and vulnerable to a nuclear-tipped surface-to-air guided weapon.[94] But in a country which until December 1957still held the world air-speed record, and in which the *Boy's Own Paper* was still read avidly, such arguments were difficult to accept. The long story of Concorde shows, if nothing else, Britain's continuing love affair with the aeroplane, and the totemic power of the word "supersonic". Significantly for our story, studies of a new manned bomber continued, and were given a specific boost in the months immediately before the Blue Streak cancellation.

Boyle, for one, certainly never gave up hope of reinstating a requirement for a high-performance V-bomber replacement. Little more than a month after the publication of the notorious White Paper, Boyle already felt able to write to his Deputy Chief of the Air Staff (DCAS), Air Marshal Sir Geoffrey Tuttle, responsible to him for all matters relating to future equipment, to ask about "the possibility of a supersonic bomber carrying a powered guided bomb."[95] The idea resurfaced periodically thereafter. In May 1958, for example, at the Prospect conference, held at the Royal Empire Society in front of an invited audience including press representatives and the Duke of Edinburgh, Boyle and other senior RAF officers claimed no intention to "cling to the idea that we need a bigger and better bomber". They then proceeded clearly to advocate a further generation of manned aircraft, both bombers and fighters.[96] Sandys was furious at Boyle's challenge to stated government policy.[97] Spotting the difference of opinion, opposition MPs took delight in asking a series of awkward questions about supersonic bombers in the Commons, where Ward explained somewhat lamely that the conversations at Prospect had been in general terms and related to a more distant future than the five years specifically foreseen by Sandys in 1957.[98]

In December 1958, Ward himself wrote to Sandys outlining an Air Ministry proposal for "a manned vehicle to continue the deterrent" after about 1970, replacing both the V-bombers and Blue Streak. Ward felt the need to reassure Sandys that the aircraft "need not have an exceptional performance in terms of speed ... what we have in mind in no way returns to OR.330, which we agreed to cancel". He noted instead that a new bomber would require long endurance, in order to "remain airborne and poised for attack under positive control, without becoming irrevocably committed" – a specific advantage, it should be noted, over a ballistic missile such as Blue Streak. Indeed, Ward specifically suggested that the aircraft's development could be paid for by cutting the proposed deployment of Blue Streak.[99] By April 1959, Boyle had been sent a draft requirement for "a successor manned vehicle, not dependent on large bases".[100] The following month this draft, or another very similar, was sent for consideration to the Air Ministry's Strategic Scientific Policy Committee (SSPC), set up by Boyle personally to look into significant issues of air policy and chaired by Zuckerman. "The Air Staff", explained the draft, "have always considered the manned aircraft with a powered bomb to have an extended life as a complementary weapon to the ballistic missile". The rather fantastical aircraft they

94 The Assistant Chief of the Air Staff for Operational Requirements, Air Vice-Marshal H J (Jimmy) Kirkpatrick, is quoted to this effect in April 1957 in Tony Buttler, *British secret projects: jet bombers since 1949* (Midland Publishing 2003), p.86.

95 PRO, Boyle to DCAS, 20 May 1957 in AIR 8/2057.

96 'Conference Prospect', *Flight*, 16 May 1958, p.88.

97 Boyle, *My life*, pp.108-9.

98 House of Commons Debates, vol.588, 14 May 1958, cols.398-402.

99 PRO, Ward to Sandys, 16 Dec 1958 in AVIA 65/1653 and ADM 205/202.

100 A minute on the subject to CAS from DCAS of 17 Apr 1959 is referenced in a later brief dated 2 Jun 1959 in PRO, AIR 8/1961.

now described might have vertical take-off (VTO) capability, to free it from dependence on large airfields; carry a new variable-trajectory cruise missile; have up to 15 hours' endurance but also supersonic and/or low-altitude capability to penetrate enemy airspace; and might take advantage of boundary-layer laminar flow control, variable geometry or even nuclear propulsion to improve performance.[101] The SSPC's discussion of the draft requirement was brief, but at the Air Council a month later Boyle stated confidently that "the assumption that a manned vehicle would be required as a successor to the V-bombers was clearly right".[102]

In November 1959, Boyle made a long tour of air force and industrial facilities in the United States. Ahead of the visit, he was briefed again on ideas for a new manned bomber, differing little from the description circulated in the spring except that supersonic speed was no longer mentioned. He was also briefed separately, and at some length, on possibilities for nuclear aircraft propulsion, which was being studied actively in the US. "This is important", he was told, "as, although we are not yet in a position to state an operational need, a likely application of nuclear power would be to a long-endurance manned weapon carrier with long-range weapons for the maintenance of the deterrent after the V-bomber/Blue Streak era". Whilst in California, he witnessed a test launch of the Thor ballistic missile, somewhat similar to Blue Streak and in the course of deployment, under dual-key UK/US control, to RAF bases in eastern England. But he was also shown newer work by Douglas, the Thor contractor, on WS138A. British interest in this project had begun almost a year earlier, and the weapon's original requirement specifically mentioned carriage on V-bombers as well as US Air Force aircraft. As we have seen, the BNDSG was already considering its adoption, although Boyle's brief before the visit was relatively downbeat, highlighting delays to the project and the possibility that "new factors may well result in the development of a weapon which is no longer compatible with the V-force".[103] We may surmise that senior managers at Douglas subsequently took pains to dispel any such impression in the mind of their VIP visitor.

More specific bomber ideas

While Boyle was away, a further draft of the new manned bomber requirement, now known by the number OR.347, was circulated within the Air Ministry and outline costings were discussed with the Ministry of Aviation (MoA).[104] At just the moment of Blue Streak's maximum political danger, therefore, and at just the moment its most senior Air Ministry customer was involved in the crucial FPC debates on deterrent policy, Boyle and others were showing more and more interest in alternatives. On 9 December 1959, a draft from within the Air Ministry's operational requirements branch for onward submission to Air Marshal Sir Charles Elworthy, newly appointed as DCAS, considered the question of a "manned element of the deterrent force" in detail. Anticipating a response soon from the MoA on costings, the author noted the likely vulnerability of the V-bombers in years to come and their

101 Draft Air Staff Target sent 22 May 1959 in PRO, AIR 2/15003 and also (with Zuckerman's own manuscript annotations) in Zuckerman Archive, University of East Anglia, Norwich, SZ/AMSSP/3.

102 PRO, AMSSPC(59)7th mtg of 25 May 1959 in AIR 2/15003; AC(59)15th mtg of 25 Jun 1959 in AIR 6/112. Other Air Council papers around the same time, here and in AIR 6/117, record the same assumption.

103 PRO, briefs and papers relating to Boyle's visit in AIR 8/2324 (manned bomber and nuclear aircraft propulsion) and AIR 8/2326 (WS138A).

104 PRO, notes in front cover of AIR 2/13382 and correspondence in AVIA 65/1653.

lack of range to loiter while political decisions on the use of the deterrent could be made. Mentioning long endurance, VTO and the possibility of WS138A or a variable cruise weapon to arm the new bomber, he also sought guidance: "I would appreciate your reaction to this proposal which would of course have an effect on the requirement for Blue Streak".[105] When the MoA responded with comments on the various technical trade-offs likely to be faced in designing the new aircraft, they too emphasised that "the draft [requirement] makes it quite clear that provision of an alternative deterrent to the ground launched ballistic missile is the primary requirement of the system".[106]

In January 1960, Elworthy, Pike and the Vice-Chief of the Air Staff (VCAS), Air Marshal Sir Edmund Hudleston, met to discuss ideas for the V-bomber successor in more detail. To deter the USSR, they accepted that a very long-endurance subsonic aircraft, able to take off rapidly from runways in the UK and attack targets in European Russia using a long-range missile, without penetrating Soviet airspace, would be acceptable. By 1970 or 1980, however, they felt the aircraft might need a role against China or in limited war elsewhere, in which case supersonic and/or low-level performance was back on the agenda.[107]

Conversations with the MoA, however, were beginning to force the Air Ministry to consider their requirements more realistically. The need for long endurance, in particular, was essentially incompatible with both VTO and supersonic performance. MoA officials were looking at between 40 and 48 lift engines for VTO, adding considerable weight to any new bomber design; this and supersonic speed would also consume too much fuel for the aircraft to be able loiter for between 18 and 30 hours, as contemplated by the Air Ministry. Variable geometry possibly offered a way of squaring some of the conflicting requirements, but the MoA felt that even a small demonstrator variable-geometry aircraft would not fly until around 1970, meaning the technology could not be incorporated into a large new bomber until several years later. On 27 January, officials from the Air Ministry were told flatly by the MoA's Deputy Controller of Aircraft for Research and Development that "all the requirements were incompatible in one aircraft". Significantly, Pike was now "said to hold the view that a system based on the VC10 transport would largely fill the requirement".[108] The Vickers VC10 was a proposed airliner and military transport, which used none of the exotic new technologies so far discussed with such excitement within the Air Ministry. It would be available, however, before 1970 and with modifications it could meet various other key requirements including payload, endurance, rapid take-off and the launch speed and altitude (Mach 0.8 at 40,000ft) necessary to achieve maximum range for Skybolt. Other work at Vickers, by Barnes Wallis and his team, was also discussed: the maverick designer offered the Air Ministry his Mach 4.5 "venetian blind aeroplane", known as Cascade.[109] But by mid-February, Hudleston was describing the more practical VC10 as an "eminently suitable" V-bomber replacement, and Pike was minuting that "the time has come for us to tell the Ministry of Aviation that we have serious ideas of introducing the VC10

105 PRO, DDOR.1 to ACAS(OR) with draft for DCAS, 9 Dec 1959 in AIR 2/13382.
106 PRO, DGSR(A) (MoA) to ACAS(OR), 23 Dec 1959 in AIR 2/13382.
107 PRO, DCAS to Controller Aircraft (MoA), 15 Jan 1960 in AIR 2/13382.
108 PRO, notes of AM/MoA meeting in DCA(R&D)'s office, 27 Jan 1960 and other correspondence in AIR 2/13382.
109 Wallis met Zuckerman on 28 Jan 1960: see PRO, papers in AIR 20/10571.

as a follow on to the Comet [transport] and also as a carrier for Skybolt".[110] Thoughts began to turn to specific operational concepts for a VC10/Skybolt force, and in particular the possibility of mounting a permanent airborne alert, side-stepping the problem of vulnerability on the ground to pre-emptive attack. Many in the Air Ministry hoped, through the standing airborne patrol, to distance their preferred manned bomber decisively from the "fire-first" strategic logic used against Blue Streak. Unfortunately the numbers of aircraft needed to maintain an airborne alert made this a costly option: 60 VC10s might be needed, with 240 Skybolts.[111]

Even within the Air Ministry, there was nervousness and disagreement about the VC10 in the deterrent role. Kent cautioned against promoting the idea of an airborne-alert force, fearing that the vulnerability argument could be used against the existing V-bombers.[112] Elsewhere, there was concern that drawing too much attention to the idea of *any* successor aircraft would be dangerous: "Skybolt's chief attraction is that it is a relatively inexpensive way of extending the life of the V-bombers into the late sixties – no new aircraft will be needed, and this, politically, is very acceptable. Any suggestion, therefore, at this stage, of another aircraft from which to launch Skybolt, even if it is a transport VC10 is, I think, bad tactics. All sorts of sinister motives will be suggested and as a result we may lose the goodwill which currently surrounds the idea of Skybolt in the V-bombers".[113] Finally air lobbyists were concerned not to jeopardise the prospects of the TSR-2, which might itself have a deterrent role to play. For a time in the summer of 1960 Watkinson became keenly interested in this idea, which was also discussed when the BNDSG reconvened in the autumn.[114]

Towards the end of 1960, as several aircraft companies began to show interest in the possibility of a V-bomber replacement, competing ideas again began to surface. Whilst Vickers pressed the merits of the VC10, Handley Page offered a developed version of the existing Victor, or else the HP117, an advanced flying-wing design with boundary-layer control, and Avro suggested a new version of the Vulcan. The wholly irrational desire for a supersonic bomber, now also requiring a variable-contour cruise missile, again resurfaced.[115] In May 1961 the Secretary of State for Air, now Julian Amery, chaired a meeting to explore replacing "all elements of our strategic force, after 1970, with variants of a variable geometry supersonic aircraft".[116] By 1962 a further new requirement for a "three-in-one" strategic transport, maritime patrol and deterrent missile carrier aircraft had been drafted, and discussed at ministerial level.[117]

The cancellation of Skybolt by the US administration, in December 1962, brought discussions of a new deterrent aircraft sharply to an end. The V-bombers lost their deterrent role to Polaris, although they remained in service for many more

110 PRO, VCAS note of 15 Feb 1960 in AIR 2/13708; Pike to DCAS, 19 Feb 1960 in AIR 8/2256 (Elworthy replied that he had been telling the MoA this "for weeks").

111 PRO, correspondence in AIR 2/13708, AIR 20/10925. The name "Poffler" was briefly used to describe the mooted VC10 airborne-alert aircraft.

112 PRO, Kent paper of 7 Mar 1960 in AIR 2/13708.

113 PRO, DRPS(Air) to DCAS, 10 Mar 1960 in AIR 2/13719.

114 See e.g. Wynn, *RAF strategic nuclear deterrent forces*, pp.520-3.

115 PRO, ACAS(OR) paper of 19 Jan 1961 and other correspondence in AIR 2/13382.

116 PRO, note of meeting in SofSAir's office, 10 May 1961 in AIR 2/14556.

117 PRO, draft air staff target of 29 May 1962 and Kent to VCAS, 31 Jul 1962 in AIR 2/14556.

years, and certainly as late as 1972 the MoD was still doing paper studies of a supersonic bomber, now based on the American SR-71.[118]

Existing accounts of the Blue Streak cancellation seriously neglect the importance of the idea of a new bomber, and the ferment it created within the Air Ministry. It seems clear that both Boyle and Pike were enthusiasts, that this enthusiasm undermined their support for Blue Streak when the moment of truth came, and that this is what enabled the unanimous agreement of the Chiefs in January 1960.

Conclusions

The Blue Streak cancellation was a complex and highly political affair, and simple explanations relating to cost or strategic obsolescence fail to do justice to this complexity. The motivations of decision-makers differed, and not just according to organisational allegiance: we have seen, for example, that unanimity was hard to find even within the Admiralty or Air Ministry. To account fully for the cancellation, it seems, we must look to explain a shifting advocacy coalition, not a clear-cut victory for one bureaucratic interest or another. It is surely significant, for example, that of the two strongest political supporters of Blue Streak, Sandys moved jobs in October 1959 and Brundrett retired at the end of the year; neither now found himself able to influence events as strongly as he might have wished. Powell too, as soon as he had expressed even mild support for Blue Streak, was gone. Sandys, overseas when the Chiefs first reached their verdict, chose thereafter to mount a fruitless attack on the V-bombers, and was bought off with the promise of investment in space research. Macmillan skilfully out-manoeuvred American opponents of a bilateral Skybolt deal by talking directly to Eisenhower. Such accidents of timing and tactics clearly made cancellation politically easier.

Different key factors in the decision were emphasised later by the various participants. The Prime Minister, having chaired the many ministerial meetings, certainly had his hands deep in the blood of cancellation, and his memoirs, for example, do highlight cost considerations; indeed, his own headline estimate goes up by £100 millions in the space of two pages, to an exaggerated figure not strictly supported by contemporary documents.[119] Watkinson, on the other hand, as we have seen, preferred to emphasise "fire-first" strategy. All participants meanwhile noted the importance of the Chiefs' advice, without which the opponents of Blue Streak might have lacked sufficient ammunition for their fight. Here, the personal role of Boyle and Pike was also clear. Sir Maurice Dean recalled with regret that "Tom Pike had just become CAS and was convinced by these arguments and decided to go along with the [Chiefs of Staff] committee in a recommendation to cancel Blue Streak. I did everything in my power to stop this".[120]

Somewhat ambiguously, Watkinson told Sandys, in connection with the Chiefs' advice, that "I am afraid Dermot sold the pass here to begin with".[121] It

118 PRO, ACAS(Pol) to CSA, 12 Apr 1972 and other papers on air-delivered strategic weapons systems in AIR 2/19184.

119 Macmillan, *Pointing the way*, pp.251/3 (£500m to £600m). Macmillan's diary entries on 7, 16, 20 and 24 Feb 1960 also point to an greater than usual level of concern about the economy generally and the cost of Blue Streak in particular: Peter Catterall, ed., *The Macmillan diaries vol.2: Prime Minister and after 1957-66* (Macmillan 2011), pp.269-74.

120 PRO, T 325/88, undated (retrospective) note by Dean on 'The Skybolt story'.

121 PRO, Watkinson to Sandys, 9 Feb 1960 in AVIA 66/1.

seems odd to single out Boyle in this way, when Pike had attended the meetings. On the other hand Boyle had made a memorable contribution to the FPC, and it seems inconceivable the two men differed in their view that Skybolt – capable of maintaining the RAF's very essence, the strategic bomber force, for at least the next several years – was preferable to Blue Streak. Certainly, according to one of the RAF's official historians, Pike was "single-mindedly enthusiastic about Skybolt".[122] To another, the RAF had been arguing all along "the case for a weapon, Blue Streak, about which there were misgivings even within the Air Ministry".[123] Ward, their Secretary of State, appears to have been equally keen on Skybolt following his January trip to the US.

I have argued at length above that the prospect, in addition, of a whole new generation of bombers was a powerful argument, in the eyes of the Air Ministry, in favour of Skybolt. The manned bomber seems to have had as damaging an effect on the MRBM as the Lightning supersonic fighter had on its own unmanned equivalents, the surface-to-air guided weapons Bloodhound and Thunderbird.[124] Thinking within the Air Ministry paralleled that within the US Air Force, whose bombers and ballistic missiles vied very publicly for attention and funding.[125] The senior Australian forces officer in London certainly felt this was an important factor, reporting that "the Air Ministry in particular is against the continuation of Blue Streak, this view ... being related to the question of policy on manned aircraft".[126] Brundrett also, interestingly, spotted this aspect of the pro-Skybolt arguments, expressing, for a life-long government defence scientist, a surprising cynicism:

> the development must take several years and this means that its adoption would in due course necessitate the development of yet another aircraft. In this connection, it is my considered view that the desire to keep going an excessively large aircraft industry in this country has for far too long bedevilled military planning.[127]

The industrial aspects of the Blue Streak cancellation are, so far, little understood. The MoA certainly sought to preserve – throught military, and later space research – Britain's ability to produce large liquid-fuelled rockets, although payload and other practical considerations made it less enthusiastic about using newer solid fuels at similar scale.[128] This protection of industrial interests will seem familiar to a twenty-first century audience. It does not seem, however, that politicians, officials and industrialists in the 1950s 'warfare state' were cosily engaged in a cynical, let alone corrupt, protection of profits and jobs. Indeed the available evidence, and much of the literature, refutes any perception of a 'military-industrial complex'. Industry chafed constantly against government bureaucracy, whilst the MoD specifically complained in 1958 that De Havilland's "managerial resources were not equal to the load" of Blue Streak and other projects.[129] The attitudes to the Blue Streak programme of De Havilland, Rolls Royce and other firms

122 Wynn, *RAF strategic nuclear deterrent forces*, p.408.
123 T C G (Cecil) James, *Defence policy and the RAF 1956-63*, PRO, AIR 41/86, p.237.
124 Richard Moore, 'Surface-to-air guided weapons for UK air defence in the 1950s', *Prospero* 2 (Spring 2005), pp. 193-212.
125 See *e.g.* Michael E Brown, *Flying blind: the politics of the US strategic bomber programme* (Cornell UP 1992).
126 NAA, Murdoch to Hicks, 21 Jan 1960 in A1945, 128/1/8.
127 Brundrett, 'Rockets, satellites and military thinking', p.339.
128 See *e.g.* PRO, DRP/P(59)17 and 19, both of 18 Feb 1959 in DEFE 10/356.
129 PRO, CWP/M(58)2 of 23 Apr 1958 in DEFE 13/193.

involved in guided and ballistic missile research are, in fact, far from clear in the documentary evidence so far uncovered. It is not obvious, in particular, that there was a great deal of money to be made from missiles. Investment in new technologies and new capital facilities was required, key skills were in short supply and the payback, over what were likely to be short production runs, was uncertain. Industry, just as much as the Air Ministry, was comfortable with the manned aeroplane. In this sense, it may well be that Sandys made the right tactical judgement in travelling to South America when he did; De Havilland and Rolls Royce stood to gain significantly from a sales drive for British civil aviation in general, and the Comet IV in particular. An emphasis on civil, rather than military, technological research is commonly associated with the 'white heat' of the Wilson government after 1964, but perhaps Sandys's trip foreshadowed this change.

Whether the Blue Streak story teaches us anything of relevance to modern defence procurement and, in particular, the problem of whether and how to cancel a large defence equipment programme, is debatable. Political and industrial conditions have changed dramatically over fifty years. The British defence industry has far closer links now with America and Europe; the MoA no longer exists as a separate department of state reporting to a separate cabinet minister, and has morphed over time into the Defence Equipment and Support arm of the MoD; Rolls Royce has passed into and out of public ownership and the De Havilland site at Hatfield, headquarters of the Blue Streak programme, was sold by BAE Systems in the 1990s after the collapse of the Nimrod airborne early-warning aircraft programme.

To observe that the whole-hearted support of a project's major customer is essential to its success, and that priorities change over time as other technological possibilities arise, seems trite, and yet these factors seem to have been key to several other controversial postwar defence cancellations. The RAF seems in the end to have lost faith in the affordability and/or achievability of TSR.2 and the early-warning Nimrod, for example, opting for American alternatives; and the Royal Navy was at times deeply ambivalent about the Chevaline programme to update and harden Polaris. The makers of unmanned drone aircraft are no doubt aware today that their creations involve as great a threat to the organisational essence of the RAF – crudely, fit young men flying the fastest aeroplanes they can – as the guided weapons of the 1950s and 1960s.

And yet there is no rule that only the customer can kill off a large defence programme, for there is a notable counter-example: the Navy's planned CVA-01 aircraft carrier was crucial to its world-view, and naval officers never wavered in their support for it. The First Sea Lord, Admiral Sir David Luce, and his minister Christopher Mayhew both resigned when it was cancelled in 1966. Each of these other programmes also posed different technical and cost problems – arguably greater than those of Blue Streak – and rose and fell at different points in the economic cycle. It is hard to generalise about success and failure on the basis of such a small sample. All that is clear is that Macmillan's observation to Zuckerman remains valid: "'Kill them when they are no bigger than sprats', Harold Macmillan had advised me. Defence R&D projects become almost impossible to get rid of when they reach the size of a herring".[130]

130 Solly Zuckerman, *Monkeys, men and missiles: an autobiography 1946-88* (Collins 1988), pp.398-9.