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"Replacing the V-Bombers: RAF Strategic Nuclear Systems Procurement and the Bureaucratic Politics of Threat"

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Table of Contents

Introduction

Chapter One – Low Altitude Bomber

Chapter Two – Avro 730

Chapter Three – Blue Steel

Chapter Four – Blue Streak

Chapter Five – TSR2

Chapter Six – Skybolt

Conclusion

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Introduction

In 1952, some two years before the first V-Bombers entered service, the Air Staff began its quest to find a second generation deterrent system to replace the jet bombers. In institutional terms, this would be a project of the highest importance, possession of the deterrent role being central to the Royal Air Force's own strategic rationale whilst, nationally, maintaining the viability of Britain's indigenous nuclear capability was the cornerstone of the country's defence and foreign policy. Eleven years and five major project failures later, the RAF lost its responsibility for the next generation strategic system to the Royal Navy, and Britain was forced to accept dependence on American weapons for its supposedly 'independent' deterrent.

The reasons for this apparent policy failure have been heavily debated for the last 40 years by historians and political analysts alike. The debate, however, has been limited in scope to high policy decision making and an analysis of only three of the five major and two minor projects. As a result, significant inconsistencies and omissions have arisen in the historical narrative regarding British nuclear procurement. To address these inconsistencies and omissions, it is necessary to consider alternative locations of power within the procurement hierarchy and examine all the projects involved.

This thesis will assess the role of bureaucratic politics in the procurement of Royal Air Force strategic deterrent systems between 1952 and 1963. It will examine the way in which threat assessments were manipulated to provide a legitimating language for bureaucratic politics agendas. The type of threat under examination will not be the grand strategic threat that informs high policy but the military/technological threat that informs operational planning. The study will argue that significant decision making took place within the procurement hierarchy at a far lower level than has previously been recognised and in furtherance of a variegate set of agendas that were not those of the policy elite. In this, it will differ from preceding interpretations, which have stressed the significance of either economic or strategic considerations at high policy level as the determinants of this dramatic policy failure. These preceding historiographical interpretations will now be briefly outlined before the study's methodology and scope are described.

Historiography

The Orthodox Perspective

The early writers on British nuclear history, such as Margaret Gowing and GM Dillon, concentrated on the political utility of the deterrent, largely ignoring other possible rationales for Britain's nuclear policy, particularly that of strategy. In this respect, their writing reflects the assumption of many writers in the Cold War era that British defence policy existed in a state of 'strategic poverty' caused by 'decline' and was governed purely by economics. These early writers on post-war British defence policy generally told a tale of economic determinism concerning defence policy and political foot-dragging with regard to recognising Britain's reduced status in the world. Bartlett's *The Long Retreat* is perhaps the archetypal work of this genre.[1] The picture it paints is of military overstretch caused by a political establishment unwilling to either relinquish the symbols of its former grandeur or react quickly and decisively to the problems that resulted from this . These problems were an inevitable succession of crises due to a shrinking economy, which was characterised by the low productivity of a poorly educated workforce, chronic under-investment and bad economic planning. This perspective remained compelling into the early 1980s and, although its individual components have all been challenged with varying degrees of success over the years, it still has a certain resonance for some. However, of the works specifically dealing with British nuclear policy, perhaps the most notable was Gowing's *Independence and Deterrence*, which was written from official documents and was published

[1] Bartlett, C., (1972) *The Long Retreat: a Short History of British Defence Policy 1945-70*, London: Macmillan.

in two volumes.[2] Still definitive within its specific subject, it is in some respects unfortunate that such an authoritative and seemingly unchallengeable work appeared so early in the development of the historiography of British nuclear policy. This is because the book's Whitehall/Aldermaston axis is not perhaps as all-illuminating as might be imagined; a fact that the monumental and detailed nature of the work tends to obscure. Gowing's work describes the political decision making that led to the instigation of the nuclear programme and the work of Sir William Penney and his scientists to implement it. The intense political interest in happenings at Aldermaston, the influence of Penney in high policy circles and the political significance attached to the Bomb Test are particularly emphasised by this perspective. The development and demonstration of the bombs themselves is seen as the key focus of political interest and providing most of the political utility of the deterrent. Military/Strategic issues do not manifest themselves strongly in what is largely a story of politicians, civil servants and scientists. Military figures appear largely pre-occupied by inter-service rivalry.

Strategic issues could only really come into view with regard to the development of the delivery systems, which were largely outside the scope of Gowing's work. With regard to the political policy making regarding the bomb, and the development of the atomic bomb itself Gowing's work remains largely unsurpassed. However the extensive and detailed use made by Gowing of the official archives made the scope of the books seem wider than it was and in some respects led to an assumption that there was little more of value to be extracted from the archives. This, and the prominence given to the political perspective by Gowing's work, was very probably a strong contributory factor to the neglect of several other important issues regarding the subject for many years afterwards.

[2] Gowing, M. (1974) *Independence and Deterrence: Britain and Atomic Energy 1945-1952*, London: Macmillan (two volumes).

The Revisionist Perspective

In contrast to the political/economic determinist perspective of the orthodox writers, the major theme of the succeeding revisionists has been the emphasising of the importance of strategic considerations in the formulation of British nuclear policy. Early writers such as Gowing paid very little attention to strategy formulation. A further wave of writers emerged in the late 1960s and early 70s. Rosecrance's *Defence of the Realm* was published in 1968,[3] followed Andrew Pierre's Nuclear Politics in 1972,[4] and Groom's *British Thinking about Nuclear Weapons* in 1974.[5] These writers saw the 1950s as a time of wide-ranging and extremely innovative strategic discussion in Britain, the Strategy Papers of 1950 and 52 all being evidence of a lively and original strategic debate that in some respects, for instance in advocating the substitution of nuclear for conventional forces, was in advance of American thought.[6] Andrew Pierre believed that Britain was:

> ...the first nation to base its national security planning almost entirely upon a declaritory policy of nuclear deterrence.[7]

However, the full drafts of the Global Strategy Papers had not been released at the time, and none of the new works could be based upon the type of extensive official documentation that would have enabled a convincing challenge to be made to what has been described as the 'rather dismissive attitude' of Gowing regarding the significance of strategy in British nuclear planning.[8]

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[3] Rosecrance, R.N., (1968) *Defense of the Realm: British Strategy in the Nuclear Epoch*, New York: Columbia University Press.
[4] Pierre, A., (1972) *Nuclear Politics: The British Experience with an Independent Strategic Force 1939-70* Oxford: Oxford University Press.
[5] Groom, A.J.R., (1974) *British Thinking about Nuclear Weapons*, London: Frances Pinter.
[6] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 149.
[7] Pierre, A., (1972) *Nuclear Politics: The British Experience with an Independent Strategic Force 1939-70* Oxford: Oxford University Press, p. 87.
[8] Clark, I. and Wheeler, N.J., (1989) *The British Origins of Nuclear Strategy 1945-55*, Oxford: Clarendon, p. 6.

This remained the situation until the late 1980s, when the documents of the Chiefs of Staff Committee, the Cabinet Defence Committee and the Joint Planning Staff, covering the period from the late 1940s to the early 1960s, became available. This led to the publication of Clark and Wheeler's *British Origins of Nuclear Strategy*[9] and Navias' *Nuclear Weapons and British Strategic Planning.*[10] These works did not so much supersede the orthodox economic/political perspective as add a further dimension to it. They also qualified the claims made earlier by Pierre and Rosencrance regarding the originality of British strategic thought in the 1950s. The new writing showed that although it was not the era of strategic poverty that orthodox authors seemed to infer, there was also a strong continuum with earlier British strategy making, rather than pure innovation. This new revisionist perspective could, however, now conclusively challenge the orthodox 'dismissal' of strategy as an influence on British nuclear policy.

However, one problem remained. It is seldom easy to find a direct link between strategic thought and policy action. Too many grandiose strategic conceptions become lost as political reality forces policy makers to perpetually react to events. The revisionists, however, believed they had found a major policy decision that seemed to be firmly grounded in a strategic rationale. This was the cancellation of Blue Streak, the significance of which will now be examined.

The Importance of Blue Streak

Explaining the cancellation of the Blue Streak intermediate-range ballistic missile (IRBM) is perhaps the acid test of any interpretation of post-war British defence policy. All the different strands of policy – economic,

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[9] Clark, I. and Wheeler, N.J., (1989) *The British Origins of Nuclear Strategy 1945-55*, Oxford: Clarendon.
[10] Navias, M.S., (1991) *Nuclear Weapons and British Strategic Planning 1955-58*, Oxford: Clarendon.

strategic, political and technological – come together in this decision. Any inconsistencies between these strands becomes glaringly obvious and the monumental nature of the decision, universally thought to herald the end of Britain's independent deterrent, means that inconsistencies cannot be ignored or hidden.

Early writers on British post-war defence policy, such as Pierre, Barnett and Nailor,[11] certainly regarded the Blue Streak saga as the end of Britain's pretensions towards maintaining a truly independent deterrent. These writers adhere to the view that Blue Streak was obsolete before it was deployed and hence synonymous with the problems of economic, strategic and technological overstretch that bedevilled Britain in the years following the Second World War.

The cancellation of Blue Streak, due to cost and obsolescence had, for almost three decades, underscored Britain's inability – economically and technically – to maintain unaided the most vaunted bulwark of its defence policy and the ultimate underwriter of foreign policy. The role of the Treasury and the constraints caused by Britain's economic decline were particularly emphasised by this perspective. As such, it can be seen as a complete vindication of the orthodox 'economic policy as defence policy' view and, indeed, the entire perspective that regards British post-war history as a study in 'declineology'.

This orthodox view, however, was challenged in the early 1990s by the emerging revisionists. Examination of the relevant high policy documents revealed that Blue Streak was apparently scrapped due to the unanimous verdict of the Chiefs of Staff that it had become vulnerable to pre-emptive strike. This meant that it could only be used as a first strike weapon,

[11] Pierre, A., (1972) *Nuclear Politics: The British Experience with an Independent Strategic Force 1939-70* Oxford: Oxford University Press; Bartlett, C., (1972) *The Long Retreat: a Short History of British Defence Policy 1945-70*, London: Macmillan; Nailor, P., (1980) *The Future of Britain's Deterrent Force*, London: International Institute for Strategic Studies.

something that was not in accord with Britain's accepted nuclear strategy. This can be seen as a complete vindication of the revisionist perspective and has been heralded as such by Clark and Wheeler.[12] It is clear that the orthodox and revisionist perspectives have between themselves explored the political, economic and strategic strands of defence policy and have reached contradictory conclusions with regard to Blue Streak.

Despite neither perspective specifically addressing the technological issues at stake, the one thing they do agree upon is that the missile was technologically obsolete in terms of a specific strategy. However, recent research by Dommett, Wright, Hill and others involved in the British Rocketry Oral History Project, has reached quite the opposite conclusion.[13] Blue Streak, in terms of its silo, re-entry vehicle and engine control system, was probably the most advanced land-based strategic system under development at the time and its technology subsequently became the basis for all future Western research into penetration aids and silo design. Attempts to reconcile this with either the orthodox or revisionist perspective is impossible unless some intermediary factor can be identified as being at work. Revisionism has identified and addressed the obvious gaps in the orthodox account, therefore the answer to this conundrum must lurk behind a blind spot in the revisionist perspective.

Weaknesses of the Revisionist Perspective

Whilst it can be seen that the revisionist writers have put forwards a strong case regarding the significance of strategic considerations, there is some disagreement between them regarding the quality of British strategic thought. Whilst Clark and Wheeler and Navias tend to emphasise pragmatism and

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[12] Clark, I. and Wheeler, N.J., (1989) *The British Origins of Nuclear Strategy 1945-55*, Oxford: Clarendon, p. 157.

[13] For example, Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press; Dommett, R., (1999) *A Brief Account of the Development of Blue Streak and Black Knight Re-entry Heads*, Farnborough: Royal Aircraft Establishment.

innovation in British strategy-making,[14] Baylis' study of ambiguity underlines incoherence as its main characteristic and force-of-circumstances as its principal drive.[15] Although Navias, for example, draws attention to the significance of Duncan Sandys in changing the direction of policy,[16] Baylis repeatedly emphasises a lack of political guidance in policy making that considerably widened the field for inter-service rivalry and bureaucratic politics.[17] Therefore, it can be seen that although revisionism is synonymous with the promotion of strategic considerations as a determinant of British foreign and defence policy, its conception as to how strategy is made is far less clear.

The point must also be raised as to exactly what the relevance of this entire 'British Nuclear Strategy Debate' was, given that the RAF had neither enough operational aircraft nor nuclear weapons to implement anything that resembled a strategy until virtually the end of the 1950s, if not later. There seems to be a general agreement amongst revisionist writers that British nuclear strategy making was in decline by the mid-1950s, although explanations as to why this was so vary. Nonetheless, it can be legitimately questioned as to whether this entire debate ever played an active role in the targeting of a single British nuclear weapon. The very limited resources of Bomber Command in the mid to late-1950s make it seem far more likely that Britain's nuclear strategy was devised 'on the hoof' at a far lower command level than the Chiefs of Staff Committee, whatever Bomber Command's command directive might otherwise state. This discrepancy between Britain's strategic aspirations and its actual nuclear capability would suggest that a great deal of high-level decision-making could have been rendered unworkable or irrelevant, giving far greater scope for lower echelons to improvise alternative policies. This, in turn, would have opened a perfect

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[14] Clark, I. and Wheeler, N.J., (1989) *The British Origins of Nuclear Strategy 1945-55*, Oxford: Clarendon; Navias, M.S., (1991) *Nuclear Weapons and British Strategic Planning 1955-58*, Oxford: Clarendon.
[15] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press,
[16] Navias, M.S., (1991) *Nuclear Weapons and British Strategic Planning 1955-58*, Oxford: Clarendon.
[17] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press,

arena for bureaucratic political agendas. This study will argue that the identification of these agendas is the key to understanding the failure of the V-Bomber replacement projects.

Whilst bureaucratic politics might be the key to understanding the cancellation of Blue Streak, the key to understanding the bureaucratic politics of Blue Streak lies in locating the continuities of the agendas at work amongst both past and succeeding projects. It is only by observing the affect that they had on other projects that their nature and origin can be deduced with any hope of accuracy.

Both revisionists and orthodox writers have treated Blue Streak as an isolated project, with all decision-making regarding the project being confined to the years 1957-1960 during which time the project ran as Britain's follow-on deterrent system. A major finding of this thesis is that although treating Blue Streak in isolation is understandable from the high policy perspective, it ignores the extent to which policy options at the high policy level are constrained by decisions already made at the research and development level. Blue Streak was, in fact, the third of seven projects that were put forward in succession as replacements for the V-Bomber force – many of the bureaucratic politics agendas at work in the project have histories which precede and survive Blue Streak itself. The significance and indeed the very existence of these agendas only becomes apparent if Blue Streak is placed in context with these other 'V-Bomber replacement projects'.

Some of these projects, most notably Skybolt but also Blue Steel Marks 1 and 2 and 'strategic' TSR2, have received varying degrees of attention from academic writers, although this is almost entirely in the context of high policy decision-making. The first two projects to be considered in this thesis, the Low Altitude Bomber and the Avro 730, have been entirely ignored although, due to the focus of the existing historiography, this is hardly surprising. Though each project ran for two years in succession as Britain's second generation deterrent system, there was little or no high policy involvement in the decision-making regarding their instigation, development or cancellation. Indeed, in the case of the Low Altitude Bomber, the Secretary of State for Air was only informed of its existence when his signature was required to confirm its cancellation.[18]

This example is illustrative not only of a significant blind spot in the existing narrative but it also underlines the extent and significance of decision-making in the policy implementation strata. The Low Altitude Bomber and Avro 730 projects are examined and described for the first time in this study, revealing the origins of bureaucratic politics agendas that were to have a powerful effect on Blue Streak and its successors. However, the study of bureaucratic politics raises many challenges for the historian. These will now be discussed and the methodology used to address them described.

Methodology

Bureaucratic Politics

Bureaucratic politics has long been recognised by writers of both orthodox and revisionist perspectives as having a detrimental affect on British defence policy. Inter-service rivalry, as is manifested frequently in the Chiefs of Staff Committee Meetings, is regarded as the most characteristic form of this. The three services jostled in rivalry for most of the period in order to gain supremacy for their individual brands of strategy. This, however, provides only a limited insight into an understanding of the complexities of the Blue Streak cancellation. In almost unprecedented accord, the Chiefs of Staff were unanimous in their decision to discontinue the project. Therefore determining the bureaucratic politics of Blue Streak is a far more demanding

[18] AVIA54/749 CA to Minister of Supply, 4 October 1954

enterprise that raises several problems for existing bureaucratic politics analyses.

The Problems of Contemporary Bureaucratic Politics Theory

Ian Clark has described the Blue Streak project as a 'fascinating example of bureaucratic politics as regards new weapons acquisitions.'[19] This is only too true. It also provides a variety of excellent examples that illustrate virtually all the different theoretical models, their derivatives and critiques, not just of Bureaucratic politics theory but of several other organisational theory models.

Bureaucratic politics theory largely derives from the work of Graham Allison.[20] John Baylis has described the heart of Graham Allison's bureaucratic politics model as being that "where you stand depends on where you sit."[21] The attitude of Treasury officials towards Blue Streak can be seen to have been almost entirely motivated by economic considerations, there seemingly being little attempt to consider wider issues. However, there are also prominent examples of officials ignoring their departmental objectives as will be seen with regard to Sir William Strath and the Ministry of Supply, for example. This raises questions regarding the utility of the basic Allison model.

An answer to this might be found in the Belief Systems approach advocated by Alexander George, Steve Smith and others.[22] This suggests that due to the complexity of the decisions that decision makers are frequently called

[19] Clark, I. and Wheeler, N.J., (1989) *The British Origins of Nuclear Strategy 1945-55*, Oxford: Clarendon, p. 164.
[20] Allison, G.T., (1971) *Essence of Decision: Explaining the Cuban Missile Crises*, Boston: Little Brown: Allison, G.T. and Halprin, M., 'Bureaucratic Politics; A Paradigm and Some Policy Implications' in Tanter, R. and Ullman, R.H. (eds.) (1972) *Theory and Policy in International Relations and Foreign Policy,* Princeton: Princeton University Press.
[21] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 10.
[22] George, A., 'The Causal Nexus between Cognitive Beliefs and Decision-making: The "Operational Code" Belief System' in Falkowski, L., (ed.) (1979) *Psychological Models in International Politics,* Boulder: Westview Press; Smith, S. and Hollis, M. 'Roles and Reasons

upon to address, individuals will often resort to relying on their own personal 'core beliefs', their unquestioned basic assumptions about life and the world, in order to simplify matters. This can be seen at work in the Air Staff's attitude towards supersonic bombers for instance, as will be seen when the Avro 730 is examined. However, as actors can also be seen making decisions that can be explained entirely rationally and that go against the 'belief system', such as the Chief of the Air Staff's recommendation to the Government to cancel TSR2, can it be determined when a belief system actually 'kicks in'?

A similar criticism can be made of Paul Sabatier's extrapolation of the belief system, the 'Advocacy Coalition'.[23] This is theoretically made up of individuals with similar core beliefs who form coalitions across institutional boundaries. However, with regard to this study, although coalition groups are manifest, they rarely have all or indeed any of the necessary attributes of an Advocacy Coalition. For instance, they are rarely coalitions of individuals. Almost all the trans-institutional coalitions encountered are confederations of intra-institutional 'interest groups'. Secondly, they are usually extremely unstable in their composition, whereas anything based upon a core belief should be extremely stable, according to Sabatier.[24]

A further organisational theory model is Jack Snyder's concept of 'Strategic Culture',[25] which examines the cultural roots of national strategy making. Whilst this is potentially extremely useful, the nature of British strategic culture is heavily contested, as John Baylis has noted.[26] Different historiographical interpretations give three different definitions. Firstly, there is Hart's emphasis on a maritime strategy, and then what Baylis refers to as Howard

in Foreign Policy Decision Making', *British Journal of Political Science* (1986) vol. 16, pp. 269-286.
[23] Sabatier, P.A. 'An Advocacy Coalition Framework of Policy Change and the Role of Policy-oriented Learning Therein' Policy Sciences, (1988) vol. 21, pp. 129-168.
[24] *Ibid.*
[25] Snyder, J., (1977) *The Soviet Strategic Culture: Implications for Limited Nuclear Operations*, Santa Monica: RAND.
[26] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 27.

and Graham's 'mixed strategy' and French's 'pragmatic strategy'.[27] Therefore, as far as Blue Streak is concerned, the concept of Strategic Culture might provide a fascinating debate to contribute to but it has severe limitations as a methodological tool.

It can be seen, therefore, that Blue Streak, amongst many other things, is a sound example of the problems of contemporary bureaucratic politics and organisational theory. It would make an excellent case study for anyone trying to evolve a unifying theory in this field. However, that is not the aim of this thesis, and in the absence of such a unifying theory, use will only be made of the vocabulary of this discipline to provide a loose classification of phenomena. The challenge, therefore, is to evolve an alternative methodology to uncover and interpret bureaucratic politics agendas.

Evolving a Methodology

The principal problem in investigating bureaucratic politics is that by its very nature it does not leave a very explicit 'paper trail' thus not endearing itself to historians as a subject for study. The lack of direct documentary evidence

[27] Hart, B.H.L., (1932) *The British Way In Warfare,* London: Faber & Faber; Howard, M., 'The British Way In Warfare: A Reappraisal' in Howard, M., (1984) *The Causes of War*, London: Allen & Unwin; Graham, C.S., (1972) *Tide of Empire: Discursions on the Expansion of Britain Overseas*, London: McGill-Queen's University Press; French, D., (1990) *The British Way in Warfare 1688-2000*, London: Unwin Hyman.

requires a search for some alternative indicator. Given that what is sought is evidence to confirm that alternative and illegitimate agendas have diverted policy away from the intentions of its rightful instigators, what is therefore required are indicators that will denote whether policy is following a course that is consistent with its original high policy objectives. Finding such indicators would be extremely difficult if the project were a conventional non-nuclear one. All kinds of different departmental policies – financial, industrial and technical as well as political – could legitimately interpose into the procurement system. Establishing a hierarchy of policy priorities by which to judge the progress of conventional low priority systems is therefore extremely problematic. However, Blue Streak was a strategic deterrent system and the deterrent was the cornerstone of Britain's defence and foreign policy. Ensuring that its constituent systems were reliable, had the performance necessary to carry out Britain's strategic needs and were entering service on time, theoretically overruled all other considerations. The nuclear deterrent was officially designated Britain's number one defence priority for all but two years of the 1950s, and even then it was second only to the guided weapons programme. Due to this, in theory there were no other procurement priorities or any other policies at all that had primacy over that of ensuring the deterrent's operational effectiveness, as far as those charged with its establishment and maintenance should have been concerned. This being so, there are far fewer problems in establishing a useable hierarchy of priorities to assess institutional behaviour than might normally be the case.

Once a hierarchy of high policy priorities has been established, this can then be compared to the actual hierarchy of priorities that prevailed within the procurement process regarding the project. Any variation between the two provides evidence of some form of alternative agenda. Essentially, this is an 'establish what the rules should be and see how closely they are played by' approach.

As in this case, operational effectiveness was actually the primary high policy requirement, followed closely by the need for an indigenous source of the technology, the challenge becomes to determine the degree to which everything within the procurement process was optimised towards achieving this end. Operational effectiveness is a very loose term and, for the purposes of this research, it was taken as meaning the extent to which ensuring the maximum survivability with regard to the threats outlined by the relevant threat analyses was a priority, combined with providing the necessary performance to undertake the missions demanded by the prevailing operational strategy. The consistency of these concepts of threat and strategic utility, both in form and application between the projects, will provide an indicator of whether they are being used as a legitimating language for bureaucratic politics agendas. This is only possible if Blue Streak is considered in the context of the other V-Bomber replacement projects, which underlines the significance of this aspect of the study. The form of any divergence in the prioritisation will also provide an indication of its source, although most of the work in linking the bureaucratic actors and their agendas will be done using the standard inductive historical methodologies.

Actors

In terms of bureaucratic actors, this study will focus primarily on the Air Staff, the Ministry of Supply, its constituent research institutes, and the aircraft industry. This is largely dictated by the methodology used to locate bureaucratic politics agendas. The methodology works backward from the target of that agenda to its source, highlighting those organisations whose agendas were active and effective and ignoring those whose agendas were either ineffectual or non-existent. The above actors are the source of the bulk of the bureaucratic politicking discovered. The Admiralty had effective agendas only with regard to Blue Streak and Skybolt whilst the Ministry of Defence is either remarkably inactive or ineffectual in this area. The influence of other bodies, such as the Home Office and the political parties will be discussed where appropriate. Notable absentees from major discussion in this study will be the Foreign Office, the Treasury and, to a large extent, the

Cabinet and most of its defence-related committees. In all previous studies, these organs of government have provided the core focus but, as this thesis intends to examine the influence of the policy implementation strata, they largely fall outside its scope.

Whilst the Cabinet, the Foreign Office and to an extent the embryonic Ministry of Defence are all clearly parts of the high policy decision-making strata, it could be argued that the Treasury had a key role not only in policy-making but also in policy implementation through its financial supervision of the projects. Whilst this is certainly true and the extent to which the Treasury's shadow loomed over all British defence projects during this period can scarcely be exaggerated, it is true to say that, with regard to the deterrent, the Treasury's influence was ultimately circumscribed. Despite severe crises, at no time since the end of the Second World War has Britain's economic situation been so bleak as to give the Treasury the power to have the deterrent scrapped.

It would be a mistake to characterise the Treasury as anti-defence or totally anti-deterrent but, by the latter years of the 1950s, some of the most notable sceptics of the deterrent in the Conservative Party had gravitated to ministerial positions there and its attitude had hardened considerably. However, the centrality of the deterrent to both Britain's foreign policy and defence statures was such that once a project had been adopted as the future deterrent system, it could not be cancelled by the machinations of the Treasury, as long as the project retained the confidence and support of its sponsors. In many respects, 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. Virtually all the Treasury's levers of power over the project were highly visible and its agendas were well-known and legitimate, so with the exception of a few acts of 'gamesmanship' that will be examined, the Treasury does not really qualify as a bureaucratic politics 'actor', although its circling menace should not be overlooked.

This study will largely concern itself with the policy implementation strata of the procurement hierarchy, examining the middle echelons of the ministerial administrative staff down to the project managers in the aircraft industry. In terms of the Air Staff, with its dual policy formulation/implementation role with regard to the deterrent during the period under study, this is essentially from the various assistant Chiefs of Staff down, as the CAS, VCAS and DCAS can be seen as part of the policy elite. The situation with regard to the Ministry of Supply is somewhat different as, with regard to specific defence projects, its role was almost purely policy implementation, although, of course, it had a significant high policy role with regard to broader questions of industrial strategy. Therefore, the entire hierarchy of the Ministry of Supply falls within the policy implementation strata for the purposes of this study. Within this spectrum the power and influence of institutions, individuals and various intermediate groupings such as interest groups and advocacy coalitions will all be assessed.

Each major project will now be examined separately and in a chronological order, as far as is possible. Very fortunately, in each of the projects one of the major themes manifests itself in a stronger fashion than elsewhere, making it possible to largely maintain both a chronological and a thematic review

The Low Altitude Bomber

1.1 Introduction

This chapter will examine aspects of the instigation and demise of the Low Altitude Bomber Project. This, the first attempt by the Air Staff to find a replacement for the V-Force, is by far the least known. Academic literature has utterly ignored it, yet it is a key to understanding the cancellation of the Blue Streak missile, one of the most significant and well discussed episodes in the history of British post-war defence policy. The Low Altitude Bomber was the first in a series of five failed projects that attempted to provide a follow on to Britain's first nuclear deterrent system, the V-Bomber force. In attempting to account for the rise and fall of the Low Altitude Bomber, this chapter will examine both the roles of both the Air Staff and the Ministry of Supply in the decision-making regarding the project. In doing so, it will also take the opportunity to outline some of the principal issues that dominated the approach of these two major actors to all the V-Bomber replacement projects.

In order to understand the magnitude of the procurement failure that the Air Staff's V- Bomber replacement projects represented, it is necessary to first examine the situation that this failure left the RAF in by the mid-1960s. This also underlines both the soundness of the Air Staff's original assessment of what was required to replace the V-force, a specialised low altitude bomber, and the full extent and implication of the events arising from the subsequent deviation from this policy.

1.2 Replacing the V-Force: The Challenge

On 6 August 1964, a Vickers Valiant of 232 Operational Conversion Unit suffered a mid-air emergency on a training flight from RAF Gaydon. A large bang was heard, followed by severe vibration. The aircraft made an emergency landing, after which it was discovered that there were serious cracks in the rear spar of the starboard wing. A precautionary check was made of a sample of other aircraft of the Valiant force, and it rapidly became apparent that the majority of the aircraft were similarly afflicted. It was initially thought that a repair scheme would be feasible, but further inspection revealed by December that even more serious problems were manifesting themselves in the front spar. On 18 January 1965, the Vice Chief of the Air Staff told the Air Force Board Standing Committee that he believed the Valiant should be withdrawn from service, and this was announced by the Ministry of Defence on 26 December.[1] The aircraft were immediately scrapped, many where they stood. It was rumoured that this was because some were so unsound it would be unsafe to attempt even to tow them across the airfield.

The demise of what constituted the United Kingdom's most powerful contribution to NATO's nuclear forces can be directly linked to the changes in tactics that the force had been driven to undertake some 18 months earlier. The adoption of low-level penetration tactics in the face of an effective Soviet high altitude surface-to-air missile threat had greatly exacerbated the Valiant's structural problems due to the extra buffeting and stresses of low altitude flight. Therefore, in the space of just over two years, the RAF had suffered the major disaster of losing, for the future, its prized deterrent role to the Royal Navy and also had its ability to maintain its current nuclear commitments thrown completely into doubt.

However, the missile threat, the need for low level tactics to combat them, and the consequences of using V-bombers at low altitude had all been thoroughly appreciated 10 years earlier. What is even more surprising is that this threat analysis had not been superseded or forgotten, merely continually

[1] Wynn, H., (1994) *RAF Nuclear Deterrent Forces:: their Origins, Roles and Deployment 1946-69* London: HMSO, pp. 465-7.

ignored due to the inconvenient nature of its findings. Moreover, the destruction of Francis Gary Power's Lockheed U2 at 70,000 feet over the Soviet Union by a surface-to-air missile on 1 May 1960 'spelt the end of the high altitude bomber'[2] in a very public manner. To maintain public confidence in the deterrent, some semblance of a switch to alternative tactics had to be undertaken.

The desperate nature of the RAF's decision to commit the V-Force to low level operations is underlined by the awareness of the negative consequences of such a policy amongst senior officers. When asked to conduct trials of the necessary tactics, Bomber Command's Director of Operations wrote to the VCAS in September 1960 outlining his reservations at the proposed change:

> We were, of course, very much aware of the severe drawbacks outlined in paragraph 2 of the C-in-C's letter in applying the low level concept; in particular we were very worried about the fatigue life penalty. The fatigue life of the Valiant using the flight profile to be used in the proposed trial is only 144hrs, so that eight sorties of about 4-41/2 hours each would absorb a very significant proportion of the aircraft's remaining life. Moreover, the profile suggested is very typical of an operational sortie and is one which would require considerable training if combat efficiency is to be achieved and maintained. It seems to us therefore, that this would be quite impossible to maintain with such a short aircraft life. I would like to mention here that the Victor and Vulcan fatigue lives on a similar profile are of the same order as that as the Valiant.[3]

The problems were not merely limited to the fatigue life of the aircraft, as the Director of Operations further pointed out:

> Since a large proportion of any operational sortie using the suggested technique would have to be spent at very low altitudes, the range penalty would be almost prohibitive. Only about 20% of the targets in the target complexes likely to be attacked by Bomber Command could be covered by V-Bombers operating at low level.[4]

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[2] Thompason, S. L. and Boyman, W.J., (1987) *The Wild Blue*, London: Century, p. 135.
[3] AIR20/11404 DO (BR) to VCAS, 22 September 1960.
[4] *Ibid.*

This restriction, the Director of Operations (BR) thought, made the use of low level tactics untenable as a general operational policy but he thought the trials should go ahead, as:

> ...the points raised in paragraph 4 of the C in C's letter show clearly that some useful information would be obtained which could be put to good use should we ever be forced in an emergency to resort to the low level role.[5]

The use of the phrase 'forced in an emergency' underlines the utter unsuitability of Bomber Command's equipment for the task it was to be asked to undertake, even under peace-time conditions. This is further underlined by his final caution:

> The C-in-C's proposals regarding publicity on low level operations are obviously well worth while, but we must be careful how this is done. If we advertise a full low-level capability in Bomber Command, the Americans are bound to know about it and we may well be embarrassed by invitations from the USAF to participate in the SAC Bombing Competition and have to refuse.[6]

As has already been stated, however, this entire situation had been anticipated some ten years earlier. An investigation at the time as to whether the then-new V-Bombers could be used in the low level role in place of a specialised aircraft not only noted the range considerations but also a lack of adequate air speed:

> If we use the Valiant, since it has the highest wing loading, its optimum speed for range at sea level or thereabouts is 300 knots (.45m) - the range being about 1300 miles. This miserable performance is useless and contrary to the low-level conception – a bomber has its maximum performance at the design height, hence the miserable Valiant performance low down.[7]

These considerations had led to an Air Staff Requirement for a specialised low-level aircraft to succeed the V-Force by the early 1960s. Establishing why this did not, in fact, reach fruition represents the major task of this thesis. Before undertaking this it is necessary to outline the strategic rationale of the

[5] AIR20/11404 DO (BR) to VCAS, 22 September 1960.
[6] *Ibid.*

force that was to be replaced, in order to provide reference point for both the strategic debate that was emerge during this process and the manner in which concepts of threat were manipulated

1.2.1 The Strategic Rationale of the V-Force

The 'V-Force' of strategic medium bombers was the visible manifestation of Britain's nuclear deterrent between 1956 and 1969. In terms of strategy, technology, tactics and organisation it appeared to be a new departure for the RAF and has usually been portrayed as such in the existing literature. However, only the technology was really new; both the tactics and organisational structure were heavily based on wartime developments and the strategic concept owed its origins to the very beginning of air strategy. In terms of technology, the V-Force integrated two new developments. These were the jet engine and the atomic bomb. The advent of the Atomic Age with the obliteration of Hiroshima in August 1945 is almost invariably regarded as the starting point for the creation of the V-Bomber fleet. However, it can be argued that the invention of the jet engine had a far more formative influence on the creation of the V-Force than has been credited, and, indeed, one whose significance possibly overshadows that of the atomic bomb whose carriage has previously been regarded as its *raison d'être*. The origins of the V-bomber force show that its development was in fact an attempt to address the problems of creating a jet-powered strategic force rather than a nuclear-armed strategic force. The carriage of nuclear weapons was not initially regarded as the prime purpose of the V-Force, but only as one solution to the problems posed by the introduction of gas turbine propulsion to strategic bomber aircraft.

The Air Staff first began to consider the problems of jet strategic bomber design in the winter of 1944. In February 1945, they appointed the rather

[7] AVIA 54/1935 WJT to SO (T), 24 June 1953.

under-employed design staff of Short Brothers to the task of undertaking a design study of a long-range jet bomber.[8] The design, the SA4, was large, extremely complex and had a number of implications for the Air Staff to consider, ones that were amplified by work being done at the RAE Farnborough regarding bomber interception.[9] These implications were essentially threefold. Firstly, the aircraft would be very expensive, and therefore a large force would be out of the question. Secondly, the aircraft would not be suitable for mass production, so that wartime attrition would be difficult to replace. Finally, its sophistication would render it extremely difficult to maintain, therefore a high sortie rate would not be possible. Although the V-bomber's 20,000lb weapon load was a definite improvement on the 8-12,000lb capacity of their wartime predecessors, the anticipated force would be a fraction of the size, with a much lower sortie rate.

The force would simply not be able to move enough high explosives in the time required to level a well-built European city. Therefore the relentless bombardment of the enemy by thousands of aircraft using conventional high explosives in a long drawn-out campaign as in the Second World War was no longer a tenable proposition. Instead, a small number of aircraft flying a small number of sorties in a relatively brief time span would have to achieve the same results. This had two implications. Either conventional bombs would have to be delivered with far greater accuracy than previously, as there would be no margin for wastage or error, or weapons of mass destruction would have to be used to compensate for the small size of the striking force. Initially this left biological weapons as the only choice, but by the summer of 1945 a new possibility appeared, the atomic bomb. Biological weapons continued to be specified as an alternative war load for the V-Force until at least 1949, when the decision to 'postpone' the construction of a plant for the bulk production of pathogens was taken, effectively signalling the end of active

[8] Buttler, T., "Origins of Britain's V-Bomber Force" *Air Enthusiast* (1999) no. 79, p. 28.
[9] Nahum, A., "The Royal Aircraft Establishment from 1945 to Concorde" in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press, p. 35.

consideration of offensive biological warfare in Britain.[10] However, the fortuitous development of atomic weapons effectively solved the Air Staff's problem. One problem remained, however, and that was persuading the Government to invest in the enormously expensive infrastructure needed to produce these weapons.

In the immediate post-war years, little account had been taken of the public, and indeed, international, perception of the atomic bomb. To the RAF, weapons of mass destruction just represented an economy of effort. Producing mass destruction had been their 'way of warfare' for the previous four years and nuclear or biological weapons were merely an alternative method of doing the same. No concrete idea of deterrence theory had yet formed with regard to atomic weapons, apart from that implicit in the strategic bombing theories of Douhet and Trenchard, and this had been obscured by five years of war fighting. Therefore the new technology did not immediately alter existing strategy. Fortunately for the Air Staff, even without a clear idea of what strategic purpose it would serve, the political significance of the bomb as a symbol of power was already apparent in high policy circles as Bevan's famous 'naked into the conference room' comment was to illustrate.[11] It might therefore be argued that from the beginning Britain's nuclear strategy emerged as a dressing for pre-existing technological and political contingencies.

Why then did the Air Staff did not come to the opposite conclusion in the spring of 1945, that jet engines made strategic bombing an obsolete concept, and start to devise alternative strategies for the employment of air power? The likelihood of this was remote due to the centrality of the strategic bombing concept to the RAF's strategic culture. Indeed, the V-bomber concept expressly conformed to the Trenchardian concept that the strategic bomber would be the primary weapon even in very limited conflicts. Achieving this was the principal reason why the Air Staff abandoned its

[10] Carter, G. and Balme, B., "Chemical and Biological Warfare and Defence" in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam, Harwood Academic Press, p. 315.

original OR230 requirement for an extremely large 'heavy' bomber with a 5000 mile range, in favour of a 'medium' bomber half the size that could use existing facilities anywhere in the world.[12] The OR230 aircraft would have been an ideal deterrent aircraft, its huge range providing for great flexibility in targeting from bases in the United Kingdom. However, the smaller fleet size and dependence on specially built runways would have precluded its use in limited war. To satisfy the limited war role a smaller aircraft, available in greater numbers that could easily be deployed to far-flung trouble spots was required. This was what the V-Bomber specifications attempted to provide.

The emphasis given to limited war operations in the V-Bomber requirement is perhaps best illustrated by the variety of war loads for which the aircraft was optimised. In addition to an atomic bomb or biological weaponry, the aircraft was required to be able to carry alternative conventional loads that comprised either of 2x10,000lb concrete piercing bombs, 2x10,000lb HC bombs, 4x 5,000lb HC bombs, 20x1,000lb MC bombs, or 20x1,000lb incendiary clusters.[13] Whereas the 10,000lb concrete piercing weapons were for use against military and infrastructure targets such as submarine pens, port facilities, bridges and tunnels, the HC bombs and incendiaries were exclusively for 'anti-city' use. The MC bombs were a general-purpose weapon, but were particularly useful for cratering airfields.

This illustrates the wide variety of missions envisaged, also the varying levels of conflict in which the aircraft was to engage. The continued presence of conventional 'city busting' weapons should be noted. This was not for general war use, as the Tizard report makes it plain that biological weapons would be used to cover any shortage of atomic weapons in this role. Also, as has been mentioned, the small size of the force compared to the that of the wartime Bomber Command was unlikely to be large enough to destroy substantially built European cities on anything like the scale necessary with conventional weapons. This points to the use of strategic bombing against

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[11] Speech at Labour Party conference, 3rd October 1957.
[12] Buttler, T., "Origins of Britain's V-Bomber" *Air Enthusiast* (1999) no. 79, p. 28.
[13] *Ibid.* p. 31.

smaller, less substantial targets outside the European theatre. This is certainly in line with pre- war RAF 'colonial policing' policy in Mesopotamia, which always emphasised the deterrent effect of levelling of towns and villages, rather than futile attempts to ambush guerrillas. This is indicative of the Air Staff's continued retention of the concept of strategic bombing as being a tactic suitable for use in all levels of conflict until at least the late 1940s. Their belief that the strategic bomber had a utility in limited war situations lasted even longer. Although not undertaking classical 'strategic bombing' attacks, the use of V-Bombers in the Falklands, at Suez and their deployment during the Indonesian Confrontation is in no way the aberration from their 'true' nuclear deterrent role that has sometimes been claimed. In many respects, these were exactly the type of operations for which the aircraft had been primarily designed. Regarding the V-force as purely a nuclear deterrent system disregards much of the thinking that informed its origins. It also emphasises the reluctance of the RAF to commit itself to a purely nuclear force, something that was to count heavily against the Low Altitude Bomber.

1.3 The Low Altitude Bomber

The case of the British Low Altitude Bomber project of 1951-55 is an interesting example of the problems of policy implementation with regard to advanced technology. At face value, its instigation could be described as a model of far-sighted and effective defence procurement. Totally integrated with a coherent national defence strategy, having an operational profile based on a highly prescient threat analysis, technologically viable, backed by an experienced and successful governmental management system and a large and capable aircraft industry, the Low Altitude Bomber should have had everything going for it. In fact, the truth was quite the opposite. The Low Altitude Bomber project fell foul of a procurement ministry whose institutional agendas it threatened and whose organisational weaknesses it exposed, and a service ministry whose perception of technology and concept of nuclear strategy did not match those of its Government.

At the heart of the low altitude bomber concept was this categorical statement, which, though frequently ignored, was never refuted in the ten years it took before its accuracy became manifestly self-evident.

> With the development of ground launched missiles, aircraft flying at high altitude may become extremely vulnerable. This vulnerability does not decrease with greater height, nor, within certain limits, much higher speeds.[14]

British appreciation of the significance of the surface to air guided missile was enshrined within the Tizard Report as early as September 1945:

> The most promising form of defence so far conceived is the Guided Anti-aircraft Projectile; and the importance and urgency of its development cannot be over emphasised.[15]

By 1950, such weapons had been accorded superior development priority to the V-Force and equal priority to the nuclear energy program. It was anticipated that surface to air weapons would start to enter service with the British armed forces from 1957 onwards.[16] Due to the 'mirror imaging' in which Soviet technological capability was assessed by Western intelligence agencies, this implicitly meant that the USSR would also be expected to achieve the same capability at the same time.

During the 1950s, Western estimates of Soviet technological capability tended to assume equality with the west. British estimates were usually slightly more conservative than those of the United States but generally 'mirror imaging' was the order of the day. This perception had its origins in 1949 with the explosion of the first Soviet atomic weapon, some eight years

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[14] AVIA54/ 749 Operational Requirement 314, 6 January 1951.
[15] Revised Tizard Report quoted in Wynn, H., (1994) *The RAF Strategic Nuclear Deterrent Forces, their Origins, Roles and Deployment 1946-69* London: HMSO, appendix 1, p. 556.
[16] Twigge, S.R., (1993) *The Early Development of Guided Weapons in the United Kingdom 1940-1960*, Chur: Harwood Academic Press, p. 73.

before Anglo-American analysts had anticipated such a capability.[17] This challenged perceptions of western technological supremacy, and the new-found respect for Soviet technology was reinforced by the appearance of the MIG 15 swept wing fighter over Korea in 1951. The 'Sputnik panic' of 1957 further reinforced this impression but also widened the gap between United Kingdom and United States estimates of Soviet capability, the Americans assuming Soviet superiority in some fields, particularly strategic rocketry. In general, however, parity was assumed throughout the 1950s.[18] In terms of basic technological capabilities, such as jet and rocket propulsion and airframe design, this proved to be fairly accurate. However, in terms of production capacity, United States estimates did prove to be extremely inaccurate. Britain and the United States could not agree on the size of the Soviet nuclear stockpile until the early 1960s and the United States overestimation of Soviet production capacity led to the 'bomber gap' and subsequent 'missile gap' debates in the United States.[19] With regard to the Soviet introduction of technologies such as supersonic fighters and guided missiles, however, the estimates, which were largely based on anticipated western progress, proved to be largely correct.

Given the emphasis on the development of guided weapons and the anticipation that they would be in service by the end of the decade, it was regarded as virtually certain that the high altitude bomber, no matter how superior its performance, would rapidly become obsolete by the beginning of the 1960s. The Low Altitude Bomber was specifically conceived to deal with this threat. However, the Low Altitude Bomber concept was not merely innovative in the manner in which it evaded enemy defences but was also a new departure for the RAF in terms of its offensive capabilities.

The Low Altitude Bomber was a new concept in that it was both solely nuclear armed and specifically designed to attack counter-force targets. Although the files of OR16, the Air Ministry organ concerned with the operational research

[17] Scott, L. and Twigge, S.R., (1999) *Planning Armageddon: Britain, the United States and the Command of Western Nuclear Forces*, Amsterdam: Harwood Academic Press, p. 239.
[18] *Ibid.* p. 243.

behind the operational requirements, are still closed, it is possible to deduce something of the strategic concept that informed the operational requirement for the Low Altitude Bomber from the characteristics required by the specification. The most revealing of these is the requirement for the aircraft to be able to fire its missile at the target using an offset aiming point. The necessity for this was that 'it may also allow a more readily recognised landmark to be used.'[20] This emphasises that the expected targets for this system were not primarily cities, easily recognisable even to the primitive H2s radar, but far less distinct military targets such as airfields. In many respects the Low Altitude Bomber can be seen as the technological embodiment of the 1950 Global Strategy Paper and the counterforce strategy it advocated.[21] This new targeting strategy was largely inspired by Sir John Slessor, who sought a radical change in RAF policy on becoming Chief of the Air Staff. As Baylis puts it:

> Slessor's ideas were not only based on an attempt to deal with the problem of vulnerability and improve deterrence. They were also designed to reinforce the central role of the Air Force in the struggle with the two other services over resources, Slessor, as Simon Ball has argued was 'the business of constructing a role for the bomber which would be politically attractive'. A damage-limitation role through attacks on Soviet forces...fulfilled this criterion.[22]

This is highly notable, as it will become apparent that direct linkage between High Policy strategic considerations and lower echelon procurement decisions was not always so evident.

As well as being specifically a counter-force weapon, the Low Altitude Bomber was also novel in being specifically a nuclear system. In this it departed from the V-Bomber concept, which had always had a dual nuclear/conventional role. The Air Staff, however, were not at all happy with this development with regard to the Low Altitude Bomber, and their resistance

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[19] *Ibid.* p. 242.
[20] AVIA 54/1935 LAB WP 1st Report.
[21] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford Clarendon Press, pp. 103-10.
[22] *Ibid.* p. 110.

to the concept of a dedicated nuclear deterrence system surfaces repeatedly in the long drawn out process of finding a replacement for the V-Force. With regard to the Low Altitude Bomber, their acquiescence to a nuclear only system rapidly changed once the OR had been issued. In June 1951, Group Captain Vielle at the RAE wrote to the Air Ministry:

> Since our high level policy was adopted....We are not so blinded by suggestions of 'Atomic Bombs Only'.[23]

It was becoming apparent to many in the Air Staff that, despite finding its origins in the Air Staff's traditional concept of 'bomber strategy', the new concept of 'nuclear deterrence' was not entirely in accord with its progenitor in several important respects. This could have severe repercussions for the RAF's 'institutional essence', as will be discussed. Furthermore, there was already a disquiet about the possible effectiveness of counterforce strike. The need for such a strategy was largely based on a widely held view that Britain was uniquely vulnerable to atomic attack and would collapse more quickly and more totally to it than virtually any other nation.[24] Therefore, the paramount need seemed to be to destroy the enemy's means of launching such an attack before it could develop. This would need the most advanced and effective nuclear systems available.

However, the reverse argument could also be made. Due to Britain's unique vulnerability, if this strategy and the tactics and systems that supported it were not 100 *per cent* effective, the country would still rapidly succumb beyond recovery. The Second World War had graphically illustrated to air power analysts the degree to which it was reasonable that untried strategy, tactics and technology could be expected to succeed and the prognosis was not favourable.

The duality of the old bomber strategy whereby, if deterrence failed, it was always possible instead to fight to victory no longer applied. It was deterrence or total destruction. This was the concept that later informed the Mutually

[23] AIR20/10952 IAP to DOR, 15 June 1953.

Assured Destruction of the thermonuclear era but it was regarded as a reality for Britain nearly a decade before anywhere else. Though speaking in the mid-1960s, Peter Thorneycroft perhaps best summed up this sense of vulnerability when he said in Parliament:

> I have been a little doubtful whether the idea of options in nuclear war, at least for this country, was a very realistic conception ... As far as this small island is concerned, nuclear war is nuclear war.[25]

John Baylis has described this dilemma as one of the 'key issues to emerge in the literature on British strategy' and, indeed, it forms the starting point for revisionist claims with regard to the influence of a distinctive nuclear strategy on British defence policy.[26] However, from the point of view of this study there is a further significance to the emergence of this attitude and that is its pervasiveness. As will be illustrated, rigid compartmentalisation of the defence establishment generally left the middle echelons ignorant of developments in the high policy strategic debate. This should have acted to preserve the 'purity' of high policy strategy making at the implementation level. Unfortunately the reverse happened. This was mainly due to the fact

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[24] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford Clarendon Press, p. 87.
[25] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 303.
[26] *Ibid.* p. 87.

that the sense of 'unique vulnerability' was so ubiquitously perceived. In September 1947, the defence correspondent of *The Times* commented, regarding nuclear weapons, 'few uses are likely to be more effective than dropping them on this country.'[27]

As the middle echelons of the defence establishment were 'out of the loop' with regard to official strategic debate, the widespread acceptance of this perception triggered parallel strategic debates, which, although they frequently mirrored those occurring at the high policy level, began from very different organisational perspectives and often had a markedly different character. Amongst the procurement staff the nagging question was whether the needs of deterrence and nuclear 'war-fighting' were one and the same. It was a question that was to persist for the next decade, as this study will demonstrate.

A year after the release of the Operational Requirement, the Air Staff were still pursuing the idea of a multi-purpose weapon system, as the Ministry of Supply noted:

> They cannot accept a single-purpose aircraft held to one weapon, and consideration must therefore be given to the carriage of and release of conventional weapons in the 1000, 5,000 and 10,000lb classes.[28]

However, the Air Staff finally retracted its opposition in the autumn and winter of 1952-53, possibly due to the influence of the Global Strategy Paper, but more likely due to a temporary technological contingency. The concept of the low level 'lay down' retarded nuclear bomb was not considered feasible at this time. Fusing difficulties and the fragile nature of contemporary nuclear weapons precluded it, though this was all to change fairly rapidly. At that moment it seemed that the only way of ensuring the bomber's survival against the radiation and blast of its own weapon was to use a winged, rocket propelled, 'stand-off' bomb. The carriage of such a weapon was thought to

[27] Scott, L. and Twigge, S.R., (1999) *Planning Armageddon: Britain, the United States and the Command of Western Nuclear Forces*, Amsterdam: Harwood Academic Press, p. 22.
[28] AVIA 54/762 Draft Memo LAB Armament Aspects, 21 July 1952.

require a specialised 'launch-rail' and other ancillary equipment that would preclude the fitting of a conventional bomb-bay. Indeed, the proposal from the Bristol Aeroplane Company envisaged that at such low altitudes the missile could not be 'dropped', but would have to be fired from a 'piggy-back' position with the weapons bay actually on top of the aircraft.[29]

The significance of bomber survivability should be noted here. At this stage Britain's nuclear strategy envisaged a relatively prolonged counterforce campaign with kiloton yield weapons.[30] This required that the bomber force be capable of repeated sorties over a period of weeks, hence the need to ensure aircraft survivability. The concept of the 'one way ride' with a thermonuclear weapon, as adopted by the French Force de Frappe, was a product of the 'Mutually Assured Destruction' era then very much in the future. However, despite the Air Staff's acceptance of the Low Altitude Bomber's purely nuclear role, important factions within it were to continue to press for a dual role system, and were to continue to argue for this capability with regard to strategic systems for the next ten years. As this study will illustrate, lack of a limited war capability was a factor that would weigh heavily against those systems that did not possess it.

1.3.1 Further Air Staff Objections

Apart from the inability of the Low Altitude Bomber to undertake conventional warfare operations, other aspects of the Low Altitude Bomber project did not find full favour with the Air Staff for two reasons. Firstly, a long-standing RAF distaste for low-level operations and secondly, the influence of totemic factors in technology selection. In what might be described as an example of 'tactical culture', antipathy towards low altitude operations had a long pedigree within the RAF and had been reinforced by the experiences of each generation of serving officer. In the First World War, the desperate use of RFC fighter

[29] Barnes, C.H.G.B., (1970) *Bristol Aircraft Since 1920*, London: Putnam, p. 385.

squadrons on low-level ground attack missions, to stem the German spring offensive of 1918, had led to heavy losses and a widespread dread amongst aircrew of low level operations.[31] In the inter-war period low-level operations were synonymous with the type of Army and Naval support operations from which the RAF was desperately trying to escape. In the eyes of the Air Force, the unfettered use of air power would occur as far above the land and sea as possible. Equally, operational research promoted high altitude operations, which led, for instance to an the RAF high altitude flight capturing the world altitude record at over 50,000ft in 1933.[32]

During the Second World War, low level operations had drawn opposition on two different counts. Firstly, low altitude attacks had suffered enormous casualties when undertaken during the war. Indicative of this was the fact that the bulk of the Victoria Crosses awarded to RAF personnel during the war were for such low level bombing missions, such as the Ruhr dams raid, the attack on the Knapsack power station, the attack on the MAN diesel works and the Amiens prison raid.[33] Secondly, and rather conversely, such raids were also unpopular because the units that undertook them were invariably withdrawn from operations for long periods of specialised training, and were allocated the most skilled and experienced crews. This put increased strain on squadrons facing the nightly slog of the bomber offensive.

There was also a certain amount of resentment from these squadrons at what they considered to be the undue publicity and recognition given to low-level

[30] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 111.
[31] Yeats, V W, (1934)*Winged Victory*, London:Jonathon Cape, p.44.
[32] *Encyclopaedia of Aircraft* (1981) vol. 4, p. 934.
[33] Terraine, J., (1985) *The Right of the Line: The RAF in the European War*, London: Hodder & Stoughton, p. 538.

'special' missions and the units that undertook them. One unit in particular, 617 Squadron, famous for its part in the Ruhr dams raid, was the focus for much hostility. This was exacerbated by its subsequent use as a low-level target marking unit for No5 Group by Air Vice Marshall, Ralph Cochrane, which led to acrimony between Cochrane and Air Vice Marshall, Donald Bennet, head of the Pathfinder Force. Bennett was committed to high altitude target marking, the effectiveness of which he had fought hard to prove, thus he resented Cochrane undermining his efforts.[34] Although Bennett left the RAF shortly after the war, many ex-Pathfinders reached prominent positions in the post-war RAF and wartime feuds were not forgotten. By the 1950s, therefore, a strongly entrenched institutional distaste existed within the RAF for low-level operations that was to count heavily against the Low Altitude Bomber.

Combined with this was the fact that the Low Altitude Bomber project transgressed what had been, until then, the fundamental law of technological development in aviation – 'bigger, faster, higher'. It was probably the first time that a 'smaller, slower, lower' solution had been proposed to any aeronautical development problem. As such, it cut against the 'natural order' and was almost certainly viewed with distaste and suspicion, as the rather irrational enthusiasm aroused for the succeeding high altitude supersonic Avro 730 seems to illustrate. Despite these objections, though, the threat analysis made it quite clear that there was no other option for the Air Staff if it wished to retain the deterrent than to persist with the Low Altitude Bomber. This the RAF did for the next three years.

It might be expected, if the work done on the other projects in this study is used as a guide, that considerable progress would have been made by the project in this time. The Valiant had made it to prototype stage in just over 3 years, for instance.[35] This, however, was not the case with the Low Altitude Bomber, despite considerable Air Staff pressure. In fact, so little had been

[34] Terraine, J., (1985) *The Right of the Line: The RAF in the European War*, London: Hodder & Stoughton p. 502.

done that the Air Staff had nothing to lose by cancelling the Low Altitude Bomber and swapping to a project that fulfilled all its requirements with regard to limited war capability, service politics and even aesthetics, although, intriguingly, not with regard to being able to perform strategic nuclear strikes. This was the Avro 730 supersonic bomber The reason given for this change of policy was that the Low Altitude Bomber had proven to be too technologically demanding. As the Low Altitude Bomber was promptly replaced by a project which posed even greater technological challenges, subsequently failing due to them, the validity of this is open to question and this strongly suggests that alternative agendas were at work.

Before an attempt is made to identify these, though, the question of the project's technological viability must be addressed. The Low Altitude Bomber most certainly presented formidable challenges, but to what extent where these insurmountable?

1.3.2 The Technological Challenge

There were three interlocking technological challenges facing the project. Firstly, the problem of ensuring the aircraft had adequate range for the mission. Jet engines work with increasing efficiency the higher the altitude. The jet engines of this period were notoriously fuel thirsty, and at sea level fuel consumption was excessive. The aircraft would therefore be required to carry an exceptionally heavy fuel load. This caused great difficulties for the design staff when combined with the second problem, which was the extremely dense and turbulent nature of the air at low level. This creates intense buffeting which is not only highly detrimental to the crew's ability to perform their tasks but also places immense strain on the airframe. The only effective method of dealing with this at the time was thought to be drastically reducing the wing area to increase the wing loading, which would dampen-out

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[35] Wynn, H., (1994) *The RAF Strategic Nuclear Deterrent Forces, their Origins, Roles and*

the buffeting. Unfortunately, this combination of very high all up weight and a small wing area rendered it almost impossible for the aircraft to lift itself from a typical RAF bomber airfield.

The final major problem was solving the navigation/attack problem. An integrated system would have to be provided that could solve three separate problems. Firstly, it would have to be able to navigate the aircraft to the target area. Secondly, it would have to provide a terrain following radar capability to enable the aircraft to fly at low altitude at night and in bad weather. Finally, this would also have to locate the target and aim and fire the missile as well, in the absence of totally accurate intelligence. A lack of capability in any of these fields would invalidate the whole system. This was true of all the other problems with regard to the engine and airframe. All had to be solved or the project would fail.

The solution to the range problem should have been linked to that of ensuring adequate take-off performance, the obvious option being an engine with both a sufficiently low specific fuel consumption and enough power to get the aircraft off the ground. That this was not the path chosen, despite the existence of such an engine, provides early evidence of an issue that is seldom acknowledged, but which plays a very significant role in the V-Bomber replacement saga. This is the question of the role of aesthetics in technology selection. The concept that, apart from politics, anything other than cost and functional efficiency plays a part in the selection of advanced military technology is generally not recognised. However, on several occasions, promising technological solutions were rejected on purely aesthetic or totemic grounds. Totemism, whereby great significance is accorded to features or qualities that is not reflected in their practical worth, is a variant of aesthetics associated more with function than appearance and is, perhaps, virtually endemic in the cultural attitudes of industrial societies towards technology. Both pure aesthetics and totemism can be seen at work with regard to the selection of the Low Altitude Bomber's engines.

Deployment 1946-69 London: HMSO, p. 55.

In the autumn of 1951, the Ministry of Supply commissioned Rolls-Royce to report on the most suitable type of powerplant for the Low Altitude Bomber. Their conclusions were as follows:

> Conclusions: The turboprop engine driving a supersonic airscrew is the best type of powerplant for this duty. Its advantages over other types of turbine powerplant are:
>
> 1) Much greater takeoff thrust which should be sufficient to permit takeoff at full laden weight, thus avoiding the necessity for fuelling in flight immediately after takeoff.
>
> 2) Appreciable increase in range if the cruise speed is restricted to about 400knots (a still air range of approaching 5,000 miles should be possible at this flight speed)
>
> 3) At a cruising speed of approximately 0.9 mach number (590 knots) the range should be at least as good and possibly slightly better than with turbo jets.[36]

However, despite the clear advantages of the turboprop, particularly its ability to get the aircraft off the ground at full laden weight, it was never considered by the Low Altitude Bomber working party or by any of the firms placing tenders. Due to its findings the Rolls Royce report was simply ignored. This was because it was realised by both the Ministry of Supply and the aircraft manufacturers that the RAF would never accept a propeller driven aircraft, no matter how good its performance, as a replacement for their jet powered V-bombers. The incorporation of such an anachronism, no matter how effectively it would have solved a particular technological problem, would have greatly devalued the aircraft in the eyes to the RAF. Such aesthetic and totemic considerations emerge repeatedly with regard to the projects examined by this study, and can be regarded as a significant influence in diverting policy implementation away from the intentions of the high policy makers.

In the case of the Low Altitude Bomber, totemic considerations led to a compromise solution that very much complicated the already difficult

[36] AVIA 54/762 Rolls Royce Report, 25 January 1952.

technological problems facing the project. Instead of a 'turboprop' a 'turbofan' would be used. The turbo fan shared many features with the concept of the turbo-prop, yet crucially still looked like a 'jet'. Unfortunately, such engines were insufficiently developed at the time to be able to meet both the fuel consumption and take-off power requirements. Therefore the problem of getting the aircraft off the ground had to be solved by other means.

The most favoured means of solving the take-off problem certainly added another layer of complexity to the project. However, it was not sufficiently great as to make the Low Altitude Bomber an impractical proposition. It was proposed that the aircraft should take off without its full fuel load, and immediately fill its tanks from an accompanying tanker. This was a totally novel concept in 1953, and a report of the time outlined the problems. These were that the minimum airspeed of the Low Altitude Bomber would be 350 knots, whilst the tankers maximum airspeed would be 375 knots, causing a great disparity in manoeuvrability between the two aircraft. The whole process would be spread out over 100 miles and as it would have to be undertaken at below 10,000ft it would probably have to take place in bad weather.[37] However, not only was an even more extreme variant of this concept adopted for the Mirage IV's of the French Force De Frappe during the same operational time frame that was anticipated for the Low Altitude Bomber, but it has subsequently become accepted practice, since the Vietnam War, not to launch aircraft at their maximum all up weight where possible, but instead to top-up their tanks in mid air.

The RAF were alive to the possibilities of in-flight refuelling during the early 1950s, with widespread trials under way. Equipment had previously been procured to enable the use of Lancaster tankers over the Pacific if the Second World War had continued.[38] Although presenting problems, in-flight refuelling was regarded as a eminently practical solution to the problems of take-off with a high all-up weight and, despite the added complications caused by the refusal to adopt a turboprop power-plant, it was not precluded

[37] AVIA 54/1935 WST to SO (T), 24 June 1953.

as an option for the Low Altitude Bomber. Indeed, at the time, it was not regarded as the major problem facing the project. That was almost universally regarded as the development of the Navigation/Attack system.

Of all the technological challenges of the project, it was those relating to the electronics and particularly the Navigation/Attack system that were most contentious and caused the greatest concern. A major problem soon emerged:

> Investigations by RRE have shown that forward looking radar for this project is not now the practical proposition which was at first thought and it is now proposed that a sideways array only should be used.[39]

However, subsequent research concluded that:

> At low heights, it is suggested by RAE, that a visual fixing system for bomb release is worth serious consideration. In daylight the technical problems were relatively easy and a simple solution should be possible to the heading reference at release problem. At night, the development of a line-scanning visual (or possibly infra-red) system offers the possibility of fix accuracies of tens of yards in the vicinity of the target and a fairly simple solution to the heading reference problem.[40]

The research led directly to the extremely sophisticated navigation and attack system for TSR 2, and in general technology of this type had been perfected by the early 1960s. Indeed, the instigation of the OR339 project which matured into the TSR 2 took place only a few months after the cancellation of the Low Altitude Bomber, and took over the work being done for the Low Altitude Bomber. OR339 required an even more ambitious low-level navigation/attack system, and was intended to enter service within almost the same time frame for which the Low Altitude Bomber had been originally intended. This would seem to confirm that at the time of the Low Altitude Bomber's cancellation, the Air Staff and Ministry of Supply had no doubt that

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[38] *Encyclopaedia of Aircraft* (1982) vol. 7, p. 1543.
[39] AVIA 54/749 E I Campbell to DMARD (RAF), 5 January 1954.
[40] AVIA 54/749 Report 'A Missile For 0R314'

such a system, the most technologically challenging part of the requirement, was completely viable.

One further anticipated problem is revealed in a Ministry of Supply note to firms considering tendering for the contract:

> Any ideas you may have on providing for the safety of the bomber from the effects of its bombs exploding would be welcomed.[41]

This confirms that the concept of a 'lay down' nuclear weapon was considered impractical at the time, and that ensuring the safety of the aircraft was a driving consideration in selecting technology for delivering the nuclear weapon onto the target. The problem of ensuring the survival of the aircraft after releasing its nuclear war load at low level nuclear was intended to be solved by the development of the Red Cat 'stand off bomb'. The stand-off bomb concept envisaged a propelled, inertially guided weapon that would be released over a prominent off-set aim point and fly a pre-determined course to the target, some 5-20 miles away, whilst the bomber turned away and escaped.[42] As the Ministry of Supply and industry had no previous experience of constructing a large, air-launched, powered, guided weapon, many fundamental problems had to be addressed. These ranged from choice of power-plant, size and performance of the weapon, how to launch the weapon successfully from the aircraft and, most importantly, how to guide it. Whilst these all presented difficulties at one stage or another, they were certainly not insurmountable, and did not preclude the development of the technologically very similar Blue Steel stand off bomb, work on which had already started before the Low Altitude Bomber was cancelled.

It can be seen that the Low Altitude Bomber presented some major technological problems to the Ministry of Supply and the Air Staff. However, by 1953, the working party was able to report:

[41] AVIA 54/762 Cambell to DMARD (RAF) Instructions to firms regarding LAB, 30 July 1952.
[42] AVIA 54/749 Report 'A Missile For 0R314'

> In fact, in this period we have gone from not knowing whether the project was at all viable to having something close to a basic design worked out, not only for the airframe but also for some of the special equipment.[43]

The cancellation of the Low Altitude Bomber on the grounds of a lack of technological viability does not hold water. Not only did all the technology required by the project subsequently emerge in the required time span but there is also good evidence to suggest that these technologies were regarded as perfectly viable when the aircraft was cancelled. The fact that the Ministry of Supply and the Air Staff then embarked on a replacement project that was manifestly even less technologically viable, and in fact failed disastrously due to this, shows that they were not at all adverse to taking large technological risks on certain occasions.

Why, then, was the Low Altitude Bomber project really cancelled? This seems to be a conjunction of two factors. Its lack of conformity to deep-seated RAF concepts of deterrence has already been commented on, but although this seems to be a recurring contributing factor with several blighted projects, for the first three years of the project there was absolutely no other alternative to the Low Altitude Bomber and the Air Staff regarded it as a project of great significance. What enabled them to drop it as suddenly and completely as they did once an alternative became viable was the fact that the Ministry of Supply had done virtually no substantive work on it during all that time. This is in contrast to other projects, particularly Blue Streak and the Avro 730, on which a great deal of design work and infrastructure development was undertaken in a similar time-span. This fact kept the Low Altitude Bomber out of the political spotlight and allowed the Air Staff to cancel it at will. The very first the Ministers for both Air and Supply heard of the Low Altitude Bomber was the note sent to them by their subordinates explaining why it had been cancelled.[44] The lack of progress on the project also highlights what was, technological considerations aside, the greatest single problem facing the Low Altitude Bomber project. This was the hostility

[43]AVIA 54/1935 Minutes of LAB Working Party, 13 July 1953
[44] AVIA54/749 CA to Minister of Supply, 4 October 1954.

of the Ministry of Supply towards the project, and this was recognised both inside and outside the Ministry from the very beginning. The Ministry of Supply Director General, Technical Development, saw the problems facing the Low Altitude Bomber as being:

> Firstly there is the question of the difficulty and magnitude of the project. This has been emphasised in Annex A and B but there is the additional factor that the project may not be very appealing either to Ministry of Supply staff or to firms.[45]

Whilst the lack of appeal of the project to the aircraft industry is somewhat open to question, its lack of appeal to the Ministry of Supply is not.

1.3.3 The Internal Problems of the Ministry of Supply

The Ministry of Supply was a ministry under threat by the early 1950s. Its major origins were in the wartime Ministry of Aircraft Production and, although its role in the winning of the Battle of Britain and maintaining allied air supremacy throughout the rest of the war had been widely lauded at the time, by the early 1950s it was under fire from several directions. As Sir Frank Cooper stated:

> There was no doubt that relations with the Ministry of Supply and the Air Staff went from bad to worse...The breach itself was of long-standing. The basic cause was lack of trust...nothing seemed to arrive at the right time and at the right price, let alone with the desired performance.[46]

Later referred to by Macmillan as 'half baked',[47] and generally regarded as highly inefficient, the Ministry of Supply was especially unpopular with the armed service ministries due to the Ministry of Supply's usurpation of some of their most prized procurement functions. The Ministry looked set to suffer in

[45] AVIA 65/20 DGTD (A) to CA, 8 March 1954.
[46] Cooper, F., "TSR 2 and Whitehall" in Hunter, A.F.C., (eds.) (1998) *TSR 2 with Hindsight*, London: Royal Air Force Historical Society, p. 34.

any re-organisation of the defence establishment, calls for which were becoming ever more strident. It has to be recognised that the workload put upon the Ministry was very high, due to the needs of the Korean War re-equipment program, the nuclear program, the guided weapons program and all the other advanced projects emerging at this time. However, there were widespread complaints regarding various aspects of the Ministry's activities. Firstly, it was believed that its methods were too bureaucratic, leading to long delays in the completion of projects. Secondly, its committees had too much power due to the Ministry's remit to issue all contracts for both civil and military aircraft, which particularly on the civil side led to a certain detachment from market forces. Finally, its research establishments were accused of dictating the pace and direction of national aeronautical research in a manner that was not always conducive to the needs of its potential customers, civil or military. The Ministry of Supply's sensitivity to such criticism, and wariness of any attempt to encroach on Ministry of Supply prerogatives is readily apparent in its files. This criticism of the Air Staff's Operational Requirement for the Low Altitude Bomber is both illustrative of its attitude in general and towards the Low Altitude Bomber in particular:

> Requirement approaches technical specification whereas it should give broad operational requirements, leaving the method of accomplishment to MoS.[48]

The fact was that by the early 1950s, it was becoming increasingly difficult to keep these two functions separate. This was extremely alarming for the Ministry of Supply. The horror that the Ministry felt at the possibility of other agencies becoming aware of its increasingly apparent shortcomings in project management, are revealed in this report on the Vickers Valiant:

> The purpose of this minute is to draw your attention to the somewhat novel communications system now in vogue on the Valiant, viz
>
> (a) Bomber Command liaison officer flies in aircraft, discusses with firms representatives and reports direct to Bomber Command
>
> (b) Bomber Command pass report to the Air Staff
>
> (c) DOR(A) picks up points in report and asks for our comments.

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[47] Broadbent, E., (1988) *The Military and the Government: From Macmillan to Heseltine*, Basingstoke: Macmillan, p. viii.
[48]AVIA 65/20 MoS comment on OR 324, 20 October 1953.

> I have no criticism of the substance of the liaison officers reports, which actually reach CS(A) from Bomber Command very soon after issue, but I am not sure that it is entirely a good thing for Bomber Command to know about all the teething troubles which arise during contractors trials, and which even the Aircraft and Armament Experimental Establishment are shielded from in the normal course of things.[49]

Extremely sensitive to possible criticism, the Ministry of Supply was at pains to both emphasise the importance of its role and hide any evidence of inadequacy. It went to various lengths to achieve this. Some were innocuous, such as its insistence to exhibitors at the 1953 Farnborough air show 'The placards used in the static display denoting the description of the aircraft are to state, in a prominent position, BUILT UNDER MINISTRY OF SUPPLY CONTRACT.'[50] Others, as will be described, were more drastic, particularly with regard to the Low Altitude Bomber. At the root of this paranoia were the serious problems that the Ministry was encountering in simultaneously maintaining a balanced industrial strategy and ensuring that high priority projects were successfully brought to fruition at the right time. As will be described, these two aims were, in fact, mutually exclusive and it seemed increasingly likely that what the Ministry believed to be its *raison d'etre*, its prized industrial strategy making function, would have to be abandoned in order to bring to fruition priority projects such as the nuclear programme. Why this was so will now be examined.

1.3.3.1 The Primacy of Industrial Strategy

A recurring theme within this study will be the extent to which officially stated high policy clashed with the unstated policies of the bureaucratic actors. However, it is also true that there were frequent clashes between different strands of official high policy, both stated and implicit within the structure of government, which suggest that John Baylis' 'ambiguity' hypothesis is part of a wider problem not merely limited to nuclear strategy.

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[49] AVIA 54/617 AD/RDL2 to DMARD (RAF).
[50] AVIA 54/617 Instructions to exhibitors at the SBAC Show 1953

The fundamental problem with regard to the Ministry of Supply and the deterrent was the clash of priorities between the needs of the deterrent and the Ministry's industrial planning function. The deterrent was part of a prioritised defence procurement plan and for almost all of the period under consideration it was at the very top of that prioritisation. The establishment of clear priorities might be thought to entirely in accord with the smooth running of the Ministry's industrial strategy, but in fact the opposite was true. The nuclear programme was extremely dependent upon small concentrations of specialist knowledge and production capability. Whilst this could be planned for fairly reliably with regard to the nuclear weapons side, the situation with regard to delivery systems was quite different. The rapid evolution of delivery system technology meant that quite sudden switches from one area of specialism to another frequently occurred. This demanded great industrial flexibility, something that was extremely difficult due to the multiple commitments of the necessary industrial base.

The aircraft industry was regarded as a key component of important civil and conventional military policies as well as the deterrent. It was one of Britain's principal earners of foreign capital. This might seem to be the ultimate justification for a powerful centralised planning organisation, but unfortunately the inherent structure and mind-set of the Ministry of Supply worked against the effective assumption of this role. The Ministry was essentially a product of the First and Second World War; it was geared to sustaining the large-scale manufacture of a range of fairly simple equipment over a long period of conventional warfare. The need in the Cold War to rapidly reorganise in order to manufacture small numbers of sophisticated systems, at the expense of long term sustained mass production, was entirely at odds with the Ministry's ethos and structure. What was true with regard to the needs of the Low Altitude Bomber at a micro management level was also true at a macro level in terms of the deterrent as a whole. Indeed, the essential change necessary for the Ministry of Supply to adapt to the post-war world was the abandonment of the macro management of industry and instead a move to perfecting the micro management of individual projects.

By the early 1950s British foreign and defence policy no longer depended upon the maintenance of a broad industrial base capable of sustaining prolonged conventional war. Foreign and defence policy now rested largely upon the deterrent, which in turn relied upon a small number of very specific and sophisticated pieces of technology. Making sure that these pieces of technology worked and were available on time was the priority the Ministry should have been addressing, and it was to be achieved by successfully managing individual projects, not entire industries. Indeed, good project management often ran at cross-purposes to good industrial strategy, and vice-versa. This created a clash of interests. Either putting the deterrent first would totally derail the Ministry's industrial strategy, or the deterrent would have to fit in with it and suffer delay. Unfortunately, the Ministry of Supply's original *raison d'être* was the management of industrial strategy and, unsurprisingly, it was upon this that the focus remained. This resulted in a situation where although the nuclear deterrent theoretically had priority over all other defence projects, in reality it had to take its place in the queue behind the priorities of the Ministry of Supply industrial strategy.

Evidence of the continued subordination of good project management to industrial strategy is quite apparent with regard to the Low Altitude Bomber. A major source of delay with regard to the project was the Ministry of Supply's reluctance to nominate a contractor. Whilst this can be seen as part of its general procrastination with regard to weapon system management, it was also heavily linked to questions of industrial strategy. The Ministry's production policy was based upon the maintenance of ten competent design groups and sufficient production volume to ensure the mass production of essential types. This may well have been necessary during the Second World War but it was of little relevance to Cold War requirements. The RAF's concept of a 'short war' totally negated the need for 'war production' and even the naval concept of 'broken-backed war' only required the maintenance of large stockpiles, not the ability to produce fresh stocks.[51]

This perceived necessity by the Ministry to retain production volume had a negative effect on the placing of contracts for the deterrent. Firms were not given contracts primarily due to their ability, but due to the need to maintain the level of their order books and preserve the Ministry's desired industrial base. As maintaining production volume was one of the prime considerations, there was a tendency to pay insufficient attention to prioritising which projects the firms were allowed to undertake. This was left largely to the firm's discretion, despite the fact that even prototypes of civil aircraft were built under Ministry of Supply contract. The net result of this was frequently that the firms best suited to a particularly large or complex project were unavailable due to their concentration on a wide number of minor ones. The Low Altitude Bomber project suffered directly because of this. An example is the position of the Bristol Aeroplane Company, which was highly favoured by some in the Air Staff as the obvious choice for the Low Altitude Bomber contract. PDRD(A) decided that they would have to be discounted as possible contractors as:

> ...in view of their commitments on Britannia developments, 171 and 173 helicopters and their variants, and the large helicopter I think it would be unwise to let them have this bomber. This is disappointing since Bristol had some original thoughts on the subject, but I am convinced that if they take on these projects as well as the M=2 aircraft, both would be seriously delayed.[52]

The Ministry of Supply seems to have been well aware that surrendering even part of its authority on the management of individual projects would have a 'knock-on' effect on its overall control of the equipment development and production. A good example of this was the Ministry of Supply's opposition to the Air Ministry's desire to save time by only issuing the Low Altitude Bomber requirement to a single company, rather than issue it to several companies

[51] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 144.
[52] AVIA 54/749 PDRD (A) to CS (A), 13 October 1954.

and to wait whilst the relative merits of their proposals were compared. This was a common problem that the Ministry would rapidly need to address. Before the war, aircraft had been cheap and simple enough for the Air Ministry to merely put out multiple tenders for prototypes which could then be comparatively tested. Some requirements, such as the F7/30 interceptor requirement, brought forth as many as seven different prototypes.[53] By 1950, however, merely calculating the performance figures of different designs, let alone ordering prototypes, threatened to overwhelm the Ministry of Supply's resources. This was something of which the Low Altitude Bomber committee was extremely conscious:

> PDRD(A/C) mentioned that 11 designs had been required from seven firms for a Mach 2 research aircraft and that using the usual procedure some months would have to be spent working out the performance of aircraft that might be ruled out on other grounds.

Inviting a single tender only seemed to be the best solution to the problem. The Ministry ruled this out though, despite the delay this would incur, because of the danger of 'upsetting the integrity of our relations with the industry.'[54] This may seem like mere scrupulousness, but the relationship between the aircraft industry and the Ministry was largely consensual. The Ministry's determination not to damage this, losing its influence over the industry as a whole, is illustrated by the extent it was prepared to sacrifice the efficient running of individual projects to accommodate its relations with industry. This assumed even greater significance in the mind of the Ministry as the necessity for contraction within the aircraft industry was ever looming. The Ministry of Supply's Under Secretary for Air Procurement impressed these factors upon the Low Altitude Bomber committee:

> US Air emphasised that the financial situation was at present very difficult and that a cast iron case would have to be made if normal tender action was not to be taken. In the next year or two it might prove necessary to squeeze two or three firms out of the industry. For example, Handley Page might possibly lose the contract for the Victor

[53] Mason, T., (1993) *British Flight Testing: Martlesham Heath 1920-39*, London: Conway Maritime Press, p. 100.
[54] AVIA 65/20 E I Campbell to DMARD (RAF) (undated).

and might then be forced to seek fields other than aircraft. If this occurred and the MOS had arbitrarily chosen one firm it might well damage the Ministry's standing with the industry.[55]

The Ministry's doggedness at maintaining its 'standing with industry' was to continue to confound High Policy attempts to prioritise strategic nuclear systems until the end of the 1950s at least.

The conflict between Second World War industrial strategy and Cold War 'special projects' management was not a problem unique to Britain. The way it was resolved abroad, though, only highlighted the uniquely British circumstances that would have to be overcome in order to address the problem. In the United States, the clash of interests between industrial strategy and individual project management was also to lead to the demise of a project. What differed, however, was the USAF's response to this. In the United States, the Air Force still retained responsibility for its own procurement strategy. During the early fifties, it had two separate organisations for the development of combat aircraft and their production, Air Research and Development Command and Air Material Command respectively.

The Republic Aircraft Corporation was building a highly advanced, all-titanium Mach-3 interceptor for the ARDC, the XF103. Due to the nature of the material being used, the prototype aircraft could not be built using the type of temporary 'soft' jigs and formers usually used for the construction of prototype aircraft. Instead, the titanium airframe would have to be built on 'hard' production type jigs. This ignited a conflict between ARDC and AMC. Air Material Command claimed that by building the aircraft on production jigs, Air Research and Development Command would effectively be making decisions about production technology and industrial strategy that were not within its remit, and as far as possible blocked its development. This dispute remained

[55]AVIA 65/20 Minutes of LAB Working Party, 13 July 1953.

unresolved until the aircraft was cancelled, very largely due to the delay caused.[56]

Fortunately for the United States' aircraft industry, once the implications of this had been digested, the USAF acted quickly and instigated what was known as the 'Cook-Craigie Plan',[57] which installed procedures that dealt effectively with the problem. This was possible because both organisations were part of a rigidly hierarchical military organisation that was able to make sudden and sweeping changes in a direct and unchallengeable manner. However, in Britain the Ministry of Supply was part of the Civil Service, not the military, and the Civil Service was a collegiate entity not a hierarchical one. Little change would be prompted from within, and swift executive action was most unlikely against the Ministry of Supply, unless there was a major political will to do this. This brought little comfort to the Ministry, though, because as already discussed it was acutely aware of its unpopularity. The consequences of that unpopularity could be dire for the Ministry should the long threatened changes in the structure of the defence establishment ever materialise. It was into this atmosphere that the Low Altitude Bomber emerged, bringing with it a further and even more worrying twist to the Ministry of Supply's dilemma.

Whilst the prospect of losing its treasured industrial strategy function was bad enough for the Ministry of Supply, the challenges presented by the Low Altitude Bomber's technology might potentially lead to it losing its project management functions as well, bringing extinction upon the Ministry. The reason for this lay in the rapid development of aviation technology since the end of the war and the radically different management strategies needed to accommodate this.

Between 1940 and 1945, the Ministry of Supply had successfully evolved a structure best suited to its wartime role organising the manufacture of vast numbers of relatively simple piston-engined aircraft. As it was comparatively

[56] Meiss, R., "Republic XF103" *Air Enthusiast*, no. 7, p. 212.

easy to match different engines and equipment to different airframes, each of these components could be independently evolved, and development could take place at the highest possible speed with minimal risk of either causing, or suffering, delays by the pace of development in other fields. The most advanced airframes, engines, and equipment available at any one time could easily be mated to provide the best possible aircraft for the war effort at that time. This enabled rapid incremental development to take place.

When, for instance, the appearance of the Focke Wulf 190 threatened to establish a German air superiority over the Channel, it was a relatively simple matter to take the experimental two-stage supercharged Merlin 60 engine and shoe-horn it into the existing Spitfire Mk V, creating the Spitfire Mk IX and averting a perilous situation.[58] Thus over 22,000 Spitfires and its naval variant, the Seafire, were produced in variants from Mk1 to Mk47 in under ten years.[59] The only similarity between the prototype Spitfire and the last Seafire FR 47 was the underside of the rear fuselage. However, by the early 1950's, the Ministry of Supply, was being faced with the task of producing small numbers of highly advanced aircraft. Whilst the existing machinery could just about manage this many cases, the Low Altitude Bomber uniquely threatened to expose its inherent anachronisms.

1.3.3.2 The Threat of Weapons System Management

The Low Altitude Bomber concept was dependent on the combined success of several new technologies in each of the equipment, airframes and engines fields. At a meeting regarding the manner in which the Low Altitude Bomber project should be handled, the Director of Military Aircraft Research and

[57] Air 20/8573 The Weapon System Concept (OR16 Report) November 1955.
[58] *Encyclopaedia of Aircraft* (1981) vol. 1, p. 72
[59] *Encyclopaedia of Aircraft* (1981) vol. 1, p. 73.

Development for the RAF 'wished to stress from the outset that if any aspect of the project were to fail, the whole concept would be a failure.'[60]

This meant that developments in the hitherto fairly discrete fields of systems, engines and airframes would have to be synchronised and integrated if the project were to succeed. The problems this would cause are highlighted by the management arrangements needed to run the Red Rapier project, an extremely simple flying bomb suitable for rapid wartime mass production along the lines of the German V1. Despite only involving two contractors, unlike the situation that would exist with the Low Altitude Bomber, the management structure was thus:[61]

	Director	**Contractor**
Airframe	DMARD(RAF)	Vickers
Power Units	D.Eng.RD	Soar engines on E.L.
Auto Pilots	Vickers	Vickers, EL/C ctte ,RAE
Bombs	D.Arm.RD	Vickers, separate contract
Airborn Guidance System DCRDA(A)	Vickers/ Ferranti	

On this far less demanding project, there were no less than five different directing agencies. The Low Altitude Bomber would require more if it were developed by the existing system, with far more sub-contractors, some working under more than one directorate. This would lead to disputes over the prioritisation of work and the integrated nature of the systems would blur the demarcation between the different directorates, leading to disputes over design authority. The unwillingness of the directorates to be subordinated to one another would complicate matters further. It was strikingly obvious to all

[60] AVIA 65/20 Meeting regarding manner in which LAB project should be handled, 11February 1954.
[61] AVIA 65/20 Phythian to Bullock, 3 May 1954.

concerned that the Low Altitude Bomber project would require both the total restructuring of the Ministry of Supply's aviation research and development organisation, and the instigation of management methods that would render the Ministry itself largely redundant.

The management method that the Ministry feared would bring about its demise was the 'Weapon System' concept. Evolved in the United States, it entailed putting all project co-ordination and management into the hands of a single airframe contractor, who then sub-contracted work on systems and engines to specialist companies in those fields, but maintained overall responsibility for the project. Glowing reports as to its success were continually arriving from the United States. Group Captain Perkins of the British Joint Services Mission sent this report, which pertinently regarded a American project for a low altitude bomber, MX 2092:

> It is of interest to note that the firm attribute the quick development of this design to its present stage of feasibility, to the Weapon System concept now adopted by the USAF for all its future aircraft and missiles. To this end, the firm have already made initial managerial changes and have instructed its intended subcontractors to plan likewise. This will allow the weapon system idea to operate without friction from top control at WADC through the main firm down to all subcontractors.[62]

The friction caused by the weapon system management concept, even if it were employed, was another cause of concern to the Ministry of Supply. Senior officials did, in fact, recognise and accept that some kind of drastic restructuring was necessary. However, carrying this out against the opposition of many of the constituent components of the Ministry of Supply aviation research, development and production organisation would be difficult. The problem of retaining skilled staff, ever-present in any administrative, research or manufacturing enterprise in Britain in the 1950's further complicated matters. The Controller (Air), writing to the Controller Guided Weapons and Electronics in April 1954, emphasised all of these factors:

[62] AVIA 54/1933 Report on MX2092, 30 April 1953.

> I agree in general with all your views but I am doubtful whether it is appropriate, quite at this stage, to ventilate them to your staff. What was said by my principal directors when the working party's report was being studied was obviously 'ad referendum' and I have so far kept the discussions to my top-level staff while our thinking is largely formative. In particular, until we know whether the Air Staff is going on with this project it would be a pity to link these ideas initially to the low-level bomber. As you say, they set a pattern which we might well follow for all new aircraft and I think the guidance we give should be timed accordingly. Your Item 1 should not go on the record at all for the moment. We shall have to go into the policy of competitive tendering very fully before we can ventilate this aspect of the problem more widely.[63]

The main opposition to the reorganisation came from the various research institutions that formed the backbone of the Ministry of Supply aviation research effort. Principal amongst these were the Royal Aircraft Establishment at Farnborough and the Royal Radar Establishment at

[63] AVIA 65/20 CA to CGWL, 14 April 1954.

Malvern. The weapon system concept was expected to draw the strongest opposition from those at Malvern. The Principal Director of Research and Development (Aircraft) revealed at an early management meeting that 'there might be opposition to this scheme on the part of the RRE, though the RAE, with its aircraft background, would readily accept.'[64] This difference in attitude can be attributed to the influence over the electronics contractors that would be wielded by the aviation firms, and through them the RAE. The RRE worried that it would be totally sidelined from major development decisions and reduced to doing odd jobs for the RAE and the private contractors. These views rapidly surfaced as the organisational problems of the Low Altitude Bomber project began to be addressed. Atherton of the RRE was particularly outspoken:

> Mr Atherton said he was strongly opposed to the proposal. He argued that with the normal machinery at present being used aircraft firms had every opportunity to collaborate in the design of electronic equipment for their aircraft. As equipment often had to fit several types of aircraft this had in some cases put a limit to the influence of any one firm. He did not agree that an aircraft contractor would be any more successful in producing developmental equipment from electronics firms than MoS had been and, in fact, thought the results might well be very much worse. He thought the project should be dealt with in the normal way.[65]

Atherton's views may have contained a grain of truth but the manifest difficulties being experienced by British project managers on projects across the board, particularly when compared to the relatively glowing successes of their American counterparts being reported by Ministry observers, gave the prospect of dealing with the project 'in the normal way' little credibility and renders suspect the RRE's motives in opposing change. The RRE was very alive to the possibility that the aircraft companies would rapidly exploit the situation, dictate research agendas, and promptly take the credit for any achievements. As Atherton put it '... if an aircraft firm were given a contract

[64] AVIA 65/20 LAB WP 6th Meeting, 12 November 1953.
[65] AVIA 65/20 LAB WP 6th Meeting, 12 November 1953.

at this stage it would only mean that they would get paid whilst the RRE did the work.'[66]

It can be seen that the Ministry of Supply were desperately in need of a management system that would heal the rifts caused by the prospect of Weapons System Management. Fortunately, the Ministry had a working prototype for a new structure for managing advanced weapons programs, the Guided Weapons Programme Management System. It was this that the Ministry were depending upon for their ultimate salvation by being able to simultaneously deliver the results required by the Air Staff, justify their own continued existence and maintain the influence of the research establishments. This system had managed to come into being due to two factors. Firstly, it had been possible to create the GWPMS primarily due to the extreme priority given to guided weapons development, which by 1952, was ranked first above all defence projects, even the nuclear program. Secondly, the fact that the nature of the technology, particularly in the electronics and propulsion fields, was so novel that it required the establishment of totally new design teams, research establishments and even the involvement of new contractors. This enabled a new structure to be created largely outside that already existing for aircraft production. This helped to sidestep the delicate question of dealing with the interdepartmental rivalries between the various organs of the Ministry of Supply.

Nonetheless, the GWPMS was still initially unpopular with the research establishments. Why this unpopularity passed was seen to be the winning advantage of GWPMS. As was pointed out to the Low Altitude Bomber working party 'the scheme was unwelcome to Establishments for a time until it was realised that there was no intention whatsoever of reducing the contribution which might be made by an Establishment.'[67] However, this highlights the Achilles heel of the GWPMS. The solutions found to the management problem by the guided weapons program unfortunately included maintaining wherever possible those bureaucratic empires that had been

[66] AVIA 65/20 LAB WP 6th Meeting, 12 November 1953.

established within the Ministry. This structure evolved to do this was described by the chairman of the Low Altitude Bomber working party:

> [I]n no case had it been possible to place the overall contract with an aircraft firm, but in the majority of cases, the nearest approach to the ideal (the weapons system concept) had been the formation of technical partnerships by contractual methods. By this he meant the placing of a main contract on one firm and stipulating that the firm was responsible for technical co-ordination of the whole project. Separate contracts were placed by the Department for selected equipment, or possibly the equipment was designed in an Establishment, and the firm or Establishment concerned was instructed to work under the co-ordinating direction of the main firm. The firms then were obliged to co-operate and co-ordinate their activities day by day and this, in his view, was far more reliable than any system of meetings. By and large the method was working well in the Guided Weapons area.[68]

The essential difference between this and the weapons system approach was that although it had the appearance of the streamlined weapons system approach, by keeping the subcontracting in the hands of the Establishments, it interposed them between the main contractor and the subcontractors. This had the effect of maintaining not only the Establishment's influence over their traditional contractors, but also enabling them to control the type of development in which the firms were engaging. This was an extremely controversial matter, as the Air Staff regarded the RAE in particular as being far too prone to undertaking and promoting basic research into long term problems, rather than providing answers to the problems of the day. The RAE's propensity to 'place theory before practicality'[69] had previously led the Admiralty to recommend placing responsibility for guided weapons research elsewhere. A further blessing for the Ministry of Supply of the Guided Weapons management apparatus was that not only did this preserve the existing organisational structure but it also allowed it new scope for expansion. The chairman of the working party made no bones about this:

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[67] *Ibid.*
[68] AVIA 65/20 LAB WP 6th Meeting, 12 November 1953.
[69] Twigge, S.R., (1993) *The Early Development of Guided Weapons in the United Kingdom, 1940-1960*, Chur: Harwood Academic Press, p. 117.

> Of course...there had...to be a corresponding co-ordination in the department and they had delegated to the RAE (G.W. Dept.) responsibility for the technical co-ordination of weapon project work within MoS Establishments, and to discharge this RAE had set up a 'project' organisation. At headquarters there was an equivalent 'weapons' branch.[70]

It can be seen that instead of streamlining the organisational process, the structure developed for the Guided Weapon Project acted to preserve and even strengthen the existing structure whilst merely giving the appearance of change. However, whilst this had been possible to a certain degree in relation to guided weapons, it was unlikely to be sufficient to deal with the problems of the Low Altitude Bomber. When addressing this problem, the Director of Guided Weapons Research and Development stated that:

> ...although he did not think any other scheme was practicable, he thought it would be more difficult to operate this procedure on the aircraft side, particularly as there would have to be co-ordination between different MoS controllerates.[71]

The expedient of creating a totally new structure and grafting it on to the side of the old one would not work this time. The thorny problem of internal reorganisation would have to be addressed if the Low Altitude Bomber was to proceed.

Unfortunately, the Low Altitude Bomber Working Party was totally unable or unwilling to suggest a means of suitably reorganising the Ministry of Supply in order to address the problems of the Low Altitude Bomber. This did not change even when the organisational chaos created by attempts to deal with the situation using the old structure became painfully obvious, as in the working party's seventh meeting when 'the Chairman asked whether the missile was regarded as a bomb or an aeroplane.' Due to the departmental boundaries that were challenged by such a question, all that the committee would comment was that 'there was some doubt.'[72] Dealing with the

[70] AVIA 65/20 LAB WP 6th Meeting, 12 November 1953.
[71] *Ibid.*
[72] AVIA 65/20 LAB WP 7th Meeting, 21 December 1953.

organisational problems was so unpalatable, the committee eventually declared:

> At a working party meeting held on 21/12/53 it was agreed that item (E) of the terms of reference was not within the competence of the members to settle.

Item (E) reads 'to report on the developmental organisation necessary within the MoS to enable the project to be handled satisfactorily.' Although it was not stated into whose competence the resolution of item E would fall, rather unsurprisingly the Working Party did find it was in their competence to come to a related conclusion:

> Agreement was reached on one point, and that is that an MoS co-ordinating body in some form was necessary for the project.[73]

There was a strong suspicion in the Air Staff that the instigation of the working party had been a deliberate ploy to delay and sideline the project. The Assistant Chief of the Air Staff (Operational Requirements) had written at the very beginning of the program: 'I recommend that the target be issued to industry and the design studies results will therefore be dealt with through normal staff channels, not through a working party with no executive authority.'[74] 'Working parties' and 'study groups' were seen as traditional bureaucratic politics tools for promoting procrastination, and this suspicion surfaced again later in the V-Bomber replacement saga when the instigation of the Powell Committee was seen by many as a deliberate attempt at undermining Blue Streak.

Whilst the nature of such a committee's findings could not always be guaranteed (though careful selection of its membership could make them fairly predictable, as will be seen with the Powell Committee) their deliberations could always be counted on to cause delay. Also, their non-executive nature meant that anything positive they had to say about the project could be ignored, and yet anything negative could become

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[73] AVIA 65/20 DMARD (RAF) to PDRD, 7 January 1954
[74] AVIA 54/762 ACAS (OR) to DGTD (A), 30 January 1952.

'persuasive'. The Air Staff had worried from the beginning that the Ministry of Supply would try something along these lines and vigorously opposed the establishment of the working party. Even within the Ministry, senior officials were concerned that procrastination would be the response of many departments and individuals to a confrontation with the problems of the Low Altitude Bomber. The Director General's memo emphasised this:

> Although I have said in Minute 16 that we cannot inform the Air Staff as to whether we can undertake the low altitude bomber project until we have the final requirement for both the missile and the aircraft, I do not wish this to be interpreted as meaning we should stop work in the MoS.[75]

The resistance of both middle echelon management and the research establishments to the attempts at reform by the Ministry of Supply's senior officials were further assisted by structural factors. In particular, the overly bureaucratic nature of the Ministry of Supply and its administrative shortcomings conspired to interminably delay decisions on the project. This led to frustrations even for senior MoS staff:

> PDRD(A) queried the need to refer the working party report to the directors for their acceptance. They had all been represented on the working party and could surely be taken as subscribing to the report, but the chairman thought it necessary for a project of this importance, to obtain formally the concurrence of directors and principal directors.[76]

On another occasion, an important decision waited upon the inspection of a report from Farnborough and an impatient DMARD was forced to write:

> This investigation has been made by the RAE. I have been trying for the last 10 days to obtain a copy of this report from the RAE but so far without success.[77]

As the level of security required for a project of this nature caused hefty delays (as new personnel had to wait weeks for clearances for instance) it

[75] AVIA 54/749 DGTA (A) to PDRD (A), 4 November 1953.
[76] AVIA 65/20 Meeting regarding manner in which LAB project should be handled, 11 February 1954.
[77] AVIA 65/20 DMARD (RAF), 22 September 1953.

was even suggested by the Low Altitude Bomber working party that the 'project would be speeded up by downgrading it from top secret to secret.'[78]

However, whilst structural factors certainly caused problems, the degree of delay and the aversion manifested by some Ministry of Supply staff towards tackling the problems of the Low Altitude Bomber point to a deliberate resistance to the adoption of anything closely resembling Weapons System Management. A particularly circular argument became favourite for warding off any encroachment. This was that 'problems with the preferred 'weapon system' approach were that none of the aircraft firms had experience and knowledge enough to deal with the problems of Q band, navigation and inertial guidance systems.'[79] How the firms were ever expected to gain this experience was never suggested, however, nor did the fact that American firms started from exactly the same knowledge base and had achieved great success with Weapons System Management deflect this criticism.

By July 1953, the Air Staff's frustration with the lack of progress on the Low Altitude Bomber had begun to boil over. It was usual for RAF operational requirements to be subjected to a degree of constructive criticism by the Ministry of Supply in order ensure their technological viability. However, the Air Staff became convinced that the Ministry of Supply were being deliberately obstructive in the extent to which they queried the Low Altitude Bomber requirement. It is certainly notable that the Ministry of Supply raised few objections to the technologically disastrous, but far less organisationally challenging, OR330 when compared to the Low Altitude Bomber. On the 3rd, the Assistant Chief of the Air Staff (Operational Requirements) sent this somewhat exasperated note to the Director General, Technical Development, at the Ministry of Supply:

> It would be absurd if people started to tear the requirement to bits in detail. This could only cause more delay in getting the low-level bomber into the Royal Air Force. I shall be very glad if you will impress upon your staff the fact that there is no object at all in nitpicking the requirement. The main object is to have some hardware as soon as

[78] AVIA 65/20 Minutes of LAB Working Party, 13 July 1953.

possible...This leads me to my second point, which is that it has taken us nineteen months to get to the stage of issuing a draft OR. Practically the whole of 1952 was spent in getting design studies from four firms, and 1953 to date has been spent in having these design studies examined by a working party ... If we go this way about it I can see no reason to suppose that any work will start for well over a year.[80]

Unfortunately, this prompted a reply suggesting that further bureaucratic delay would, in fact, be beneficial:

> Normal tender action involves only one additional step, namely, the assessment of the tenders received, and adds the very valuable spur of competition. I am satisfied that this should not mean an increase in total time of more than six months and it might well be very much less.

The DGTD (A) went on to add, somewhat ironically it might seem, 'I share your anxiety that administrative procedure shall not be allowed to delay the project.'[81] However, ACAS (OR)'s note did cause a certain amount of pique within the Ministry of Supply. The Director of Military Aircraft Research and Development wrote this to the DGTD, after a protracted internal enquiry, to answer the ACAS's complaints:

> With reference to the minutes from ACAS(OR), I have attached a history sheet of this project. I hope you will agree that, having regard to the pressure of work in all branches concerned, action has not been unduly delayed. There are one or two places were we might have saved a little time, but we cannot treat every project as one of urgency with our present staff. We have had several enquiries of this kind lately, and they themselves take a great deal of time and delay other work.[82]

It is interesting to speculate as to exactly what project would have been 'one of urgency' if the follow-on nuclear deterrent system were not. The situation, though, did not improve despite Air Ministry pressure. The Ministry of Supply continued to achieve little with the project right up until September 1954, when the Air Staff finally tired of it and decided to pursue instead an alternative and far less plausible project, as will be discussed in the next

[79] AVIA 54/749 Minutes of LAB Working Party, 13 July 1953.
[80] AVIA 54/749 ACAS (OR) to DGTD (A), 3 July 1953.
[81] AVIA54/749 DGTD (A) to ACAS (OR), 7 July 1953.
[82] AVIA54/749 DMARD to DGTD, 4 September 1953.

chapter. The retirement of Sir John Slessor immediately prior to this was arguably also of great significance both to the fate of the Low Altitude Bomber and counterforce targeting in general. Although lack of 'technological viability' was blamed for the project's demise, it seems fairly clear that the total lack of progress made with the project was due to lack of 'organisational viability', at least as far as the existing structure of the Ministry of Supply was concerned. The Ministry's limitations were recognised in government circles and it was certainly under threat, as events later in the decade were to prove, but dealing with its deficiencies was politically sensitive and would take time. Until this happened, the continued retention of such a powerful industrial management organ as the Ministry within the procurement system ensured that industrial strategy would continue to have a very significant influence upon procurement, largely at the expense of high policy defence prioritisations. The implementation of these would also be further retarded by the ministry's attempts to maintain its grip upon project management.

1.4 Conclusion

With the cancellation of the Low Altitude Bomber project in September 1954, the Air Staff lost perhaps its most realistic chance of finding a workable successor to the V-Bombers. As the loss of the Valiant force was to subsequently prove, the Air Staff's resistance to the unanswerable logic of the Low Altitude Bomber's threat analysis cost them dear some ten years later when they were finally forced to adopt its recommendations. The official reason for the Low Altitude Bomber's abandonment, technological unfeasibility, is not only implausible due to the demonstrable contemporary progress with, and faith in, the technology required, but also due to the nature of the project that replaced it. This, the 0R330 supersonic bomber, was vastly more demanding technologically and had to be finally abandoned due to this.

The cancellation of the Low Altitude Bomber can instead be seen as being caused by two factors. Firstly, despite the soundness of its operational rationale with regard to nuclear strike, the concept of the Low Altitude Bomber did not appeal to the RAF in terms of service politics, aesthetics and most particularly its lack of conventional war capability, these factors coming increasingly to the fore following the retirement of the Low Altitude Bombers principal sponsor, Sir John Slessor. Secondly, the Ministry of Supply objected to the Low Altitude Bomber due to the way in which the project would uniquely highlight the flaws in that organisation and render it vulnerable to the designs of other bureaucratic politics actors. Neither of these factors had anything to do with stated high policy regarding nuclear deterrence, which the Low Altitude Bomber fitted perfectly. Given its place as Britain's premier defence priority, the needs of deterrent strategy should have been the decisive consideration in any procurement decision regarding a strategic nuclear system. This was not to be. The RAF only adopted the Low Altitude Bomber due to lack of any other option, and the Ministry procrastinated with the project long enough for a rival system to eventually emerge. As the next chapter will argue, the RAF adopted this despite its blatant inability to fulfil the strategic nuclear strike role, bringing into question the whole influence of high policy upon the procurement process.

The Avro 730

2.1 Introduction

The replacement of the Low Altitude Bomber Project by OR330, the Avro 730 high altitude supersonic bomber, is possibly the most difficult of all the procurement decisions connected with the V-Bomber replacement dilemma to explain. From the point of view of examining the role of threat in weapons procurement, it is probably the most interesting. In terms of operational effectiveness, the replacement of the Low Altitude Bomber by the 730 was an entirely retrograde step. The very best one of its strongest supporters could say of its abilities in the strategic strike role was:

> It would be very craven to assume that it is not worth while proceeding with 0R 330 merely because mathematical figures of possible kill rates paint a gloomy picture. When the next war comes it may well turn out to be only a little more frightening to attempt penetration in OR330 than sit at home awaiting delivery of the Russian weapons.[1]

However, it was not a case of a 'making-do' with what was available due to the failure of the Low Altitude Bomber. The supersonic bomber project had been gaining momentum for some time and was in itself a major contributing cause to the cancellation of the Low Altitude Bomber. When informing the Minister of Supply that the Low Altitude Bomber had been cancelled, the Controller (Air) noted:

> The amount of technical effort and resources needed could only be concentrated on this project at the expense of others of greater importance.[2]

As the Low Altitude Bomber was the replacement delivery system for Britain's nuclear deterrent it might reasonably be asked what possible project was of

[1] AIR20/8573 DOR (C) to DOR (A), 10 September 1956.
[2] AVIA54/749 CA to Minister, 4 October 1954.

'greater importance'? A note sent a year earlier by the Assistant Secretary, Air (2) to the Controller (Air), however, sheds some light on this:

> DCAS thought that the LAB development would follow the 'V'-bomber as expenditure on the latter ran down. It could provide a bridge between the 'V' bomber deterrent and the ultimate aim of having supersonic manned bombers[3]

This, in many ways, is a most puzzling statement. The Low Altitude Bomber had been specifically designed to operate in an operational environment in which high altitude, high speed penetration had been rendered obsolete by surface to air missiles, as has previously been described, and yet that is exactly the type of operation that was to be the forte of its putative successor. The sudden maturing of the necessary technology to create the supersonic bomber in 1953, enabling the fulfilment of the Air Staff's 'ultimate aim' is almost certainly what persuaded them to stop fighting the Ministry of Supply's intransigence regarding the Low Altitude Bomber, and opt instead for the OR330 supersonic bomber project. This was totally in defiance of its lack of any convincing operational effectiveness. Explaining why the supersonic bomber was the Air Staff's 'ultimate aim' is a complex matter that has very little to do with the nuclear strategies of high policy makers.

2. 2 Project Origins

The Avro 730 concept began life as the R156 reconnaissance aircraft. As such, it was intended to be in service by 1958, well before the Low Altitude Bomber. It was designed to partner the Blue Steel stand-off bomb equipped V-Bombers. The stand-off bomb concept envisaged a situation in that was expected to pertain from the late 1950's, for a period of about five years, where limited numbers of short range Soviet surface-to-air missiles and Mach 2 fighters would be operational, and tasked with the point defence of

[3] AVIA54/749 AS/Air 2 to CA, 6 August 1953.

important targets. In this situation, although the V-bombers would be vulnerable, a supersonic stand-off bomb launched out of missile range, or a Mach 2+ reconnaissance aircraft, would be able to penetrate the target area due to the limited reaction time available to the defences. A reconnaissance capability was still required at this time because the planners seemed to be assuming the continuation of a counterforce strategy, although this is not stated explicitly, as will be discussed. This would have required both the accurate location of enemy forces pre-strike and damage assessment post-strike. The V-Bombers, although still effective as missile carriers, would no longer be capable of providing this hence the need for a small force of supersonic reconnaissance aircraft. Once the Soviets were capable of deploying long-range missiles as a perimeter defence, backed up by other systems in depth, the stand-off bomb and Mach 2 reconnaissance aircraft combination would become operationally untenable, and the Low Altitude Bomber would take over the strike role.

The way in which the Low Altitude Bomber's predecessor became its successor is particularly difficult to understand from the perspective of threat. Indeed, it could be strongly argued that concepts of operational effectiveness played no part in the process of the selection of this system. What happened was that the supersonic bomber suddenly became a possibility and, this being so, the Air Staff dropped the low-level bomber in its favour. Despite knowledge of its operational vulnerability, the reason they had not adopted it before was, in fact, merely due to its technological impossibility. Creating a supersonic aircraft to carry the six-ton Blue Danube atomic bomb over the required range was an impossibility during the early 1950s. Even so, there was an unnumbered requirement for a supersonic bomber, later labelled OR336, which lay dormant through lack of feasibility. When the potential availability of powerful lightweight nuclear weapons became apparent in 1953, the supersonic bomber suddenly became practical. Rather than proceed with what became OR336, it was decided to expedite matters by reconfiguring the R156 reconnaissance aircraft to include a small bomb bay. This requirement was given the designation OR330. The OR336 was retained as a general requirement for a further generation of manned supersonic bombers. The reliance on a free-fall nuclear bomb by OR330 would also enable it to carry conventional weapons, unlike the Low Altitude Bomber. This multi-role capability, reconnaissance, strike and conventional bombing, would bring the aircraft in line with the V-Bomber concept, something from which the Low Altitude Bomber had long since departed.

2.3 Why the Supersonic Bomber?

Attempting to discern any convincing military rationale for the supersonic bomber is extremely difficult. Sustained supersonic flight is only viable at high altitude and, as the Air Staff had correctly identified in 1951, any aircraft operating in these regions by the early 1960s would be extremely vulnerable to surface to air missile attack. As the Low Altitude Bomber requirement recognised, these missile systems would become rapidly more effective and, by the middle of the decade, penetration at high altitude would be virtually impossible. Supersonic performance had some utility in complicating the interception problem for manned fighters, but it was always obvious that by the time a practical supersonic bomber was possible the surface to air missile would also be established in service. At best, a three to five year gap would exist after the earliest possible introduction of a supersonic bomber before such weapons could be deployed in sufficient depth to totally preclude any attempt at high altitude penetration. Whilst the Low Altitude Bomber Operational Requirement explains both the threat and the means of evading it, it is immediately noticeable that the Operational Requirement for 0R330 does not. This is unsurprising, as it is almost certainly true that from the beginning the Air Staff realised that the supersonic bomber would not be able to penetrate Soviet defences, and any attempt to provide a half-baked rationale by which it could would most likely only draw attention to the aircraft's inadequacies. However, in order to provide a yardstick by which the project can be assessed, the threat assessment which explained how the

Blue Steel high altitude stand-off bomb was intended to penetrate will be used.

2.3.1 The Problem of Supersonic Penetration

In order for high altitude supersonic penetration to work, three conditions must be fulfilled. The aircraft must have an extremely low radar cross section in order to escape detection until the last moment. Its speed must be great enough, and its altitude high enough so that once it was detected it could go 'over the top' of the missile radars' 'scan height' before the system could react. It must be added that effective electronic countermeasures would also greatly assist. However, if they were effective enough to suppress both enemy early warning and missile radars, the aircraft would not actually require its supersonic performance. It is apparent that the Air Staff did not believe that ECM would have a sufficient level of effectiveness beyond 1963. The speed required to evade Soviet missile radars was ideally around Mach 3, but Mach 2.5 could be regarded as a bare minimum. Altitude needed to be 70,000ft plus. Blue Steel would achieve all this by having a very short range, thereby being able to use a rocket motor. This not only gave it sufficient performance, but the ability to dispense with a jet engine's air intake, combined with the missile's small size, gave Blue Steel an extremely small radar cross section.

For the manned long-range bomber, the attainment of these raw performance figures was foreseeable, though the times-scale in which it could be done was open to question. What was far more difficult was sufficiently reducing the RCS or improving ECM. If this could not be done then the supersonic aircraft was in fact far more vulnerable to surface-to-air missile attack than the subsonic bomber, which generally had a surprising amount of manoeuvrability at altitude due to its vast wing areas and could conceivably evade missiles by using it. Whilst this was very much a tactic of last resort, it was totally unavailable to the supersonic aircraft, whose great speed precluded from any manoeuvring or deviation from a perfectly straight course, thereby making them a perfect missile target.

The chances of reducing RCS were slim. The worst offenders in terms of radar cross section on a conventional jet aircraft were undoubtedly the engine air intakes, and the situation worsens the wider and, particularly, the longer the air intake is. A large supersonic aircraft required such a vast amount of power that its air intakes would be enormous, and due to the need to slow the air down to subsonic speed before it entered the engines compressors the intakes would need to be exceptionally long. In short, the supersonic bomber was technologically a vicious circle that could not be effectively 'squared', and that was before the structural difficulties of the aircraft were taken into account. As can be seen, both from the technological and tactical point of view, the practicality of the supersonic bomber was obviously extremely thin. Why the RAF, and several other air forces tried to 'doublethink' their way past this will now be examined

2.3.2 Foreign Rationales for the Supersonic Bomber

Despite these technological and tactical difficulties, the RAF was not alone in wanting to procure supersonic bombers. In some respects, this can be seen as a reason in itself for wanting them: 'military fashion' has always been a powerful force and definite signs of its influence can be detected with regard to other projects examined in this study. However, the rationales for developing supersonic bombers evident in other air forces' procurement policies can also throw an interesting light on other factors that might have informed the RAF's attitude towards it.

By the mid-1950s, the United States was developing both the B58 supersonic medium bomber and the B70 supersonic heavy bomber. However, the B58 differed from the Avro 730 in that it was a lower performance Mach 2 aircraft, intended to enter service by 1960.[4] This was in order to exploit the three to five year gap in Soviet surface-to-air missile capability that would exist until the mid sixties. This was the same gap that the Air Staff had originally developed Blue Steel and the R156 reconnaissance aircraft to exploit. However, in replacing the Low Altitude Bomber, the R156/Avro 730 had now moved into the 1963 plus timeframe, when the Soviets could be expected to field a fully integrated perimeter and point defence missile system. This made it contemporary with the B70, which with a Mach 3 performance and a ceiling in excess of 70,000, had a much higher performance than the Avro730, though the B70 still shared the Avro 730's enormous radar cross section.[5] Unfortunately, both aircraft also shared another similarity. The USAF were also unable to come up with a convincing operational rationale for the B70, though they desperately required it for similar institutional reasons as the RAF required the 730, as will be described. The USAF eventually drifted into advocating a post-strike reconnaissance application, in which the bomber, redesignated RS70 would reconnoitre US missile strikes and bomb any targets that had been missed. As this was all too plainly clutching at strategic straws, the project was only continued as a technology demonstrator for future supersonic transport aircraft.[6] The B58 was switched to low altitude operations by the mid-sixties, and was withdrawn from service in 1968 after less than eight years in service.[7]

Soviet philosophy with regard to supersonic bombers was radically different and made perhaps the most practical operational use of the technology. Although operated in small numbers as strategic bombers, the Tu22 and 22M were principally regarded as missile armed anti-shipping aircraft, and their supersonic performance was of use in exactly the same way that it was to a supersonic interceptor. It enabled the aircraft to engage its target, in the

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[4] Brown, M., (1992) *Flying Blind, The Politics of the US Strategic Bomber Program* Ithaca, Cornell University Press, pp. 161-192.
[5] *Encyclopaedia of Aircraft* (1981) vol. 18, p. 4265.
[6] Brown, M., (1992) *Flying Blind, The Politics of the US Strategic Bomber Program* Ithaca, Cornell University Press, pp. 193-229.
[7] *Encyclopaedia of Aircraft* (1981) vol. 8, p. 1690.

bombers' case a US carrier battle group, before it got within range to launch a nuclear strike against the Soviet Union.[8]

In contrast, French use of the supersonic bomber exemplifies perhaps the maximum use of the totemic aspects of the technology, and the Armee de l'Air seems to have reached a similar conclusion to the Air Staff, in that nuclear deterrence is far more about symbolism than actual combat capability. In order to provide themselves with something that resembled a strategic nuclear delivery system, a scaled-up variant of the supersonic Mirage interceptor was ordered.

It is notable that this option was chosen, which optimised the totemic value of the system, rather than improving the range and low altitude capabilities of the existing Vatour subsonic tactical bomber, which might have increased the operational capability of the system. The enlarged Mirage IV met none of the necessary characteristics for high altitude penetration in the mid sixties when it entered service, being capable of only Mach 2.2 and having a service ceiling well below the necessary 70,000 ft, making it vulnerable to even a limited deployment of surface-to-air missiles. It also had only half the range necessary by normal calculations, although this was very pragmatically circumvented by making the aircraft, and its crew, 'expendable' by not allowing any fuel for a return journey.[9] In view of its performance, its operational effectiveness was very open to question and it was rapidly switched to low altitude operations like the rest of the world's bomber fleets. Its supersonic capabilities went almost totally unused despite the enormous cost in range, takeoff capability and sheer expense that they had caused. However, by cashing in on the totemism of the epithet 'supersonic bomber', which it only nominally was, the Mirage IV gave De Gaulle a perfectly adequate fig leaf to cover his conference nudity, France becoming an unquestioned member of the 'nuclear club'.

[8] *Encyclopaedia of Aircraft* (1981) vol. 8, p. 4207.
[9] Swanborough, F.G., (1981) *Military Aircraft of the World*, London: Ian Allen, p. 30.

Only one aircraft has consistently demonstrated a high altitude supersonic penetration capability, and that is the Lockheed SR71 reconnaissance aircraft. This successfully combined the three requisites for guaranteed success in this field. Firstly, and perhaps most importantly, it was the first production application of 'low observable' or 'stealth' technology. Although not to the same standard as was achieved by the much later F117 and B2, nonetheless the SR 71 had exceptionally low radar cross section for its day. Secondly, by using an extremely unconventional powerplant, it was able to achieve well in excess of Mach 3, which also gave it its final advantage, the ability to fly far above the necessary 70,000 ft.[10]

It is probably true to say that no aircraft has ever been so far in advance of the recognised 'state of the art' as the SR 71 was on its appearance in 1962. Its performance was vastly superior to any supersonic bomber project of the era, with the possible exception of the B70, which totally lacked the SR71's low radar cross section. The success of the SR71 has acted to conceal the flawed nature of the supersonic bomber concept whilst simultaneously adding to the lustre of its totemic significance, despite the performance of the SR71 being in a totally different league to that of almost all the bombers.

It can be seen, therefore, that although there was considerable activity elsewhere with regard to supersonic bomber projects, those that had a definite operational viability were either being built to a far earlier time-scale or for a very different role. The rest, like the Avro 730, were intended to fulfil totemic and institutional objectives that had little to do with what was usually meant by 'operational effectiveness'.

2.3.3 Other Possible Rationales

However, before totally discounting the influence of the traditional concept of operational effectiveness, it is necessary to examine one possible candidate

[10] Thompson, W., "Flight Testing the SR71 Blackbird" *Combat Aircraft* (1999) vol. 2, no. 3, p. 212.

for a threat-based rationale for the supersonic bomber project. There is a possibility that there was a mirror-imaging of the threat that the supersonic bomber posed to the United Kingdom with that which it posed to the Soviet Union.

The question of 'reaction time' is at the heart of this putative dilemma. For the early surface-to-air missile systems, it was not the physical flight performance of the missile itself that determined a system's effectiveness against a target such as a supersonic bomber. Even the earliest high altitude surface-to-air missiles had sufficient speed and altitude capability to catch such a target. The time the system took to detect the target, lock-on the guidance radar and provide a firing solution for the missile was of most significance. Against a high altitude supersonic aircraft, early missile systems were often left with less than a 5 second window of opportunity to engage.[11] It was this that created the 3 to 5 year gap between the first, limited, deployments of surface-to-air missiles and their total effectiveness against high altitude, high speed targets. This would occur once the systems were deployed in depth as part of a fully integrated air defence system. Against this there was little possibility of a supersonic aircraft surviving a deep penetration. The United Kingdom's inability, due to geographical factors, to provide such defence in depth caused the spectre of a Soviet supersonic bomber threat to be treated with enormous concern by the Air Staff in the mid fifties. Potential targets on a densely populated island such as Britain, either for a counter-value or a counter-force strike, were too close to the defensive perimeter to permit effective defence in depth. Problems with creating adequate reaction time were highlighted to the Air Staff by the crisis caused by the failure of the Rotor air defence system. This project, so massive that it had accounted for almost all of the GPO's cable laying activities during 1950-2, was an almost total failure largely due to slow handling of data.[12] Britain's air defence problems may well have created an over-appreciation in

[11] Thompson, W., "Flight Testing the SR71 Blackbird" *Combat Aircraft* (1999) vol. 2, no. 3, p. 212.

[12] Scott, L.V. and Twigge, S., (2000) *Planning Armageddon: Britain, the United States and the Command of Western Nuclear Forces 1945-1964*, Amsterdam: Harwood Academic Press, p. 265.

the minds of the Air Staff of the effectiveness of the supersonic bomber. The fact that the Soviet Union did not share Britain's geographical limitations when it came to defence in depth could well have been obscured by the panic that led to such measures as the rocket-powered fighter projects and the placing of surface-to-air missile development above that of the deterrent. There is, though, little direct evidence for this factor having any influence on bomber policy and it is to be questioned whether any concept of operational effectiveness in the nuclear strike role influenced selection of the supersonic bomber.

Although the operational rational behind the Low Altitude Bomber is constantly reiterated in a variety of reports, that of the supersonic bomber is scarcely discussed at all at first. When it is, its obvious shortcomings are immediately revealed and discussion is suppressed, as will be related. Possibly the most striking factor in the decision making process behind the supersonic bomber project is that rather than being the initial motivation for starting the project, questions of operational effectiveness and role are not addressed until well after the project has commenced.

2.4 The Air Staff and the Supersonic Bomber

If operational effectiveness in the strategic strike mission did not play a major role in the decision to supplant the Low Altitude Bomber, what did? Several factors can be discerned that had considerable bearing on the decision, acting to make the supersonic bomber a far more palatable proposition for both the Air Staff and the Ministry of Supply.

As far as the Air Staff were concerned, the ability of the Avro 730 to undertake limited war operations was a major attraction. However, less tangible considerations also appear to be at work. As was discussed in the previous chapter, the Low Altitude Bomber had fallen foul of totemic and aesthetic considerations. This was due to the twin facts that its 'smaller-slower-lower' concept was the antithesis of the accepted path of aviation development and, as the design submissions illustrated, it would also have been an extremely ugly aircraft. On the other hand, the Avro 730 was the ultimate expression of the grand tradition of aviation development. Twice as big as a V-bomber and nearly three times as fast, its needle-nosed 160ft of glittering stainless steel was the epitome of modernist aesthetics.

Aviation technology's exponential development in the first half of the twentieth century represented the visible manifestation of the triumph of modernist 'progress'. Most of the senior officers in the Air Staff at this time would have been born before the Wright brothers first flight, and even the junior officers would have begun their careers flying biplanes. To men who, as children, would have marvelled at Bleriot's monoplane, the Avro 730 must have seemed staggering, even compared to the aircraft of less than ten years before. 'If it looks right, it is right' was a guiding principle of aviation design in the first half of the twentieth century. Unfortunately looks were to prove deceptive with the Avro 730.

The totemic value of the supersonic bomber might, however, be argued to have a value with regard to strategy making. In the previous chapter, the differences in approach to the deterrent role within the Air Staff were described as due to different reactions to the perception of Britain's unique vulnerability to nuclear attack. These manifested themselves as one interest group who thought the deterrent should be operationally effective and another who though it should merely be token and the resources actually optimised for limited warfare. There are indications that, for some at least, the concept of the supersonic bomber was a more elaborate and less cynical expression of the latter opinion. For this group, the supersonic bomber was possibly an attempt to maximise the 'symbolic' effectiveness of the deterrent. When it came to listing the advantages of a manned bomber the Air Staff put first and foremost:

> A manned weapon system will remain for some time to come the most effective and convincing method for peacetime demonstration of air power. It may have a higher first cost, but it is capable of repeated demonstration over a period of several years without major replacements.[13]

The usefulness of a large and impressive manned aircraft like the 730 for 'good will flights', in which bomber formations flew to threatened corners of the globe as a symbol of military commitment, was manifest. This type of aerial 'Gunboat Diplomacy', an essential component of 'peacetime' deterrent operations, was something that a missile, hidden in its silo, could not do, and the small, ugly and possibly even propeller driven Low Altitude Bomber could not do convincingly. With regard to aesthetics, what impressed the subconscious of a RAF Staff Officer could well be expected to impress that of his Soviet opposite number. This points again to the maintenance of a broader concept of deterrence by the Air Staff than is usually accepted. This perhaps explains why an aircraft that would be capable of headline making, record-breaking deployments to far flung corners of the Commonwealth might be seen as more of a deterrent than one that could actually penetrate Soviet defences. Whilst it cannot be said to form a definite strategy, there was certainly an attitude in the procurement and operational planning branches of the Air Staff that saw the true operational rationale of the supersonic bomber in its ability to perform the essential 'peace-time' operations of the deterrent. This is evinced by the comments of DDOR6 regarding the relative merits of free-fall and stand-off bombing:

> There is, however, one further point I which would like to make and this is to query the definition of 'Deterrence' in paragraph 20. Surely our ability to do unacceptable damage must be <u>manifest</u> to our likely enemy...If this is so are they likely to be

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[13] AIR20/7723 The Advantages of a Manned Bomber (undated).

> deterred by a fleet of obsolete V-bombers threatening to 'poop-off' into the blue a weapon which clearly will be too secret to show to anybody?[14]

The need for a mobile, high profile system suitable for the 'demonstration of air power' almost certainly played a prominent role in the supplanting of the Low Altitude Bomber by the Avro 730. Such symbolic factors may seem to be intangible and implausible reasons for selecting a nuclear deterrent system. However, the symbolic power of the large supersonic aircraft was such that even when finally rejected for military service, it was still able to fly in the face of economic and environmental rationales to manifest itself as the Anglo-French Concorde, this time as the ultimate symbol of European union. There were though, other drives behind the adoption of the Supersonic Bomber Project, from actors other than the Air Staff. Like the 'Beam Weapon', the large supersonic aircraft was a technological solution in search of a problem to resolve during the second half of the twentieth century. It did not, though, totally depend upon the potency of its totemic symbolism in this hunt.

[14] AIR20/617633 DDOR6 to DDOR, 9 October 1956 (emphasis in the original).

2.5 The Supersonic Bomber, Aeronautical Science and the Ministry of Supply

The Avro 730's conformity to the ethos of 'bigger-faster-higher' did not just stir aesthetic sentiments. Aviation's scientific community had followed this logic in all its separate fields, not at all anticipating the great plateau in aircraft speed and height performance that would stretch from the mid-fifties to the end of the century and beyond. Research at all levels was geared to answering the problems of high-altitude, high-speed flight. Research institutes, installations and indeed careers, had been built on this assumption.

Conversely, the problem of the low-level bomber was a question that very few had a vested interest in answering. When selecting the technology for a technological fix, policy makers could only choose from the technology offered to them by the technologists. The vested research interests of the leading technologists and research establishments, both in the public and commercial sectors, were the only font from which new projects could spring. This leads to the question of whether the persistence of certain technological solutions was merely structural, as there was no other choice, or whether projects were being generated by the need to justify certain lines of research. Certain structural determinants can be seen. For instance, the manner in which German wartime aeronautical research was divided between the victorious powers after VE day was to have a major influence on the evolution of aeronautical technology in each country, as exploiting these windfalls was seen to be crucial in gaining an advantage in the technology dominated post war military environment. Britain's inheritance of German high-test peroxide research was, for example, to have a major effect on the evolution of a wide variety of British defence projects that was not mirrored elsewhere. It is very notable that Britain's other main acquisition from Germany was data on high-speed aerodynamics. However, it is also true that many projects had a continued persistence long after their original justification had ceased to exist.

Whilst the title of Derek Woods hagiographical *Project Cancelled* has become possibly the epithet best associated with the post war British aircraft industry, in many respects 'Project Continues' would be more appropriate.[15] Not only did the supersonic bomber transmogrify into the supersonic airliner, but the Low Altitude Bomber eventually became TSR2 and Blue Streak became the ELDO satellite launcher. A little-known radar project intended for the abortive CVA 01 aircraft carrier project in the early 60s went on to fail disastrously as the Nimrod AEW3 in the mid-1980s.[16]

Collaborative European projects were particularly fertile ground for this process. For example, when the Italian Fiat G91 won the Nato Light Combat Aircraft Competition, its unsuccessful rival, the French Breuget Taon, became the basis for the winning contender for the Anglo-French fighter/trainer requirement, emerging as the Jaguar.[17] The British loser to this requirement, the BAC P45, went on to become the basis for the British/Italian/German Tornado project.[18] It is important to note, however, that this continuity existed only at a certain level of the project hierarchy. Cancellations led frequently to the closure of factories and the collapse of long established firms. Notwithstanding this, the technocratic elite of senior scientists, designers and administrators, particularly in the public sector, generally managed to hop from one sinking ship to another.

The Avro 730 fitted very well into the established research interests of Britain's aeronautical research community, unlike its predecessor the Low Altitude Bomber. However, more immediate and specific considerations also favoured the supersonic bomber. For the Ministry of Supply, an important factor in favour of the Avro 730 project over the Low Altitude Bomber was that, despite its complexity, it would fit within the Ministry's existing project management structure. Although the Avro 730 created horrendous problems

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[15] Woods, D., (1986) *Project Cancelled: the Disaster of Britain's Abandoned Aircraft Projects*, London: Janes.
[16] Agar, J. and Hughes, J., "*Open Systems in a Closed World*" in Budd, R. and Gummett, P., (eds.) (1999) *Cold War, Hot Science* Harwood Academic Publishers, Amsterdam, p. 241.
[17] *Encyclopaedia of Aircraft* (1981) Orbis London vol. 4, p. 880.
18 *Ibid*, p *447*.

for the engineers, organisationally, as far as the Ministry of Supply were concerned, it could be dealt with fairly conventionally. The major innovations were limited to the airframe and the engines, without the electronics and systems complications of the Low Altitude Bomber. Airframe and engine companies had always had to work together, and the existing Ministry management structures could, it was believed, well cope with the demands the project would place upon it.

The Ministry of Supply might have had another reason as well for looking favourably upon the supersonic bomber, and that was that it would create the design experience and industrial infrastructure necessary for what it imagined would be the next generation of commercial aircraft. However, determining the relationship between these two projects is far from simple.

2.5.1 The Supersonic Transport Aircraft

The relationship between the Avro 730 project and the Supersonic Transport Aircraft project, which ultimately emerged as Concorde, is extremely ambiguous. At first glance, it may seem to be a simple question of determining which is the chicken and which is the egg. Unfortunately, the rather implausible answer 'both' seems in this case to be true, demanding a slightly different mode of analysis.

Determining the exact location and level of the connections and continuities between these two projects is extremely problematic. For instance, it is certainly worth noting that the Supersonic Transport Aircraft Committee started meeting in November 1956, when problems with the Avro 730 were starting to reach crisis point, and involved the same senior RAE and Ministry of Supply figures who had worked on the Avro 730. The neatness of the timing of this suggests that the supersonic airliner was a convenient means of continuing a favoured line of research. However, decision-making regarding the Avro 730 was certainly influenced by the prospect of a supersonic airliner well before this time, as this memorandum from the Avro company makers clear:

> I cannot say we are happy about the proposal, (i.e. possible use of Mutual Weapons Development Project aid) but I think I said to you before that we are in a cleft stick; if we object, then there may be no money for the projects to proceed, whereas, if we agree, then it seems the Americans will have a pretty open road in obtaining from us all our 'know how' and knowledge. We are particularly worried about this with relation to OR33O because of its possible development as a civil aircraft. For example, what would there be to stop the Americans passing all our knowledge and 'know how' over to, say, Lockheeds, whom we already know are thinking in terms of supersonic civil aircraft, possibly with very much the same cruising range as we are.[19]

This illustrates that at the industrial level, the aircraft companies had always thought that OR330 was but a stepping-stone to a supersonic transport aircraft. However, at a senior military level the Deputy Chief of the Air Staff was to comment to ACAS (OR), as late as April 1957, that 'politically later on there may be a need to back a national development for a supersonic passenger carrier, but I doubt if that is yet.'[20] This, it could be argued, illustrates the different paths of bureaucratic influence at work with regard to the project. The manufacturers and the research establishments, with whom the vested interests lay, were able to directly influence the Ministry of Supply themselves. However, the Air Staff could only be influenced if pressure was transmitted through their political masters. By the time that the decision to cancel the 730 was taken on 14 March 1957, this had obviously been at work. Whatever DCAS thought, the Chief of the Air Staff, possibly due to his more direct political connections, thought differently. Two days previously the ACAS (OR) had been informed by the CAS that he was 'anxious' that a requirement should be issued for 'a long range transport aircraft, possibly supersonic, for Transport Command from 1965 onwards.'[21]

In other words, the supersonic bomber was dead, but long live the supersonic airliner. However, the nature of the exact relationship between these

[19] AVIA53/516 J. Kay to AS/AIR B2, 25 October 1956.
[20] AIR20/10954 DCAS to ACAS (OR), 12 April 1957.
[21] AIR20/10954 ACAS (OR) to DCAS, 12 April 1957.

interlinked military and civil programs continued to create ambiguity even after the cancellation of the Avro 730. Costello and Hughes claim the French complained in the early sixties that the British merely saw Concorde as a means of getting them to pay for half the development costs of TSR 2's engines.[22]

It is therefore extremely difficult to say which project rode on the back of which, if at all. It gives an intriguing insight into the way new technologies were sponsored. In this particular case, the Ministry of Supply almost certainly saw the technology maturing, decided that a manufacturing capability would need to be created, and then went in search of projects to justify that capability. By running both a military and a civil application, each could be used as a justification for the other if either civil or military priorities changed. Each project would be claimed to reduce the costs and provide useful research for other. 'Bootstrapping' such as this is generally associated with self-generating perceptions of required military capability linked to 'mirror imaging' in intelligence assessments, but the concept could be argued to work just as well with regards to industrial capability. Certainly the persistence of projects involving large supersonic aircraft at this time points to the existence of a powerful self-generating project/capability nexus. The emergence of such a phenomenon can be detected both in the demise of the Low Altitude Bomber and in the selection of the Avro 730 as a replacement.

It can be seen that the decision to procure the supersonic bomber was multi-faceted in the extreme. There was no single specific rationale for the Avro 730's development, it apparently 'just grew' due to the confluence of a wide variety of interests, totally in defiance of the needs of its putative role, strategic nuclear strike. The degree to which technological prudence and orthodox considerations of operational effectiveness were abandoned is nowhere better illustrated than by the problems that started to beset the project once it had been adopted.

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[22] Costello, J and Hughes, T., (1976) *Concorde: the International Race for a SupersonicPassenger Transport*, London: Angus & Robertson, p. 53.

2.6 Technological Problems

Having selected the high altitude supersonic bomber, the Air Staff soon found that a great many birds were returning rapidly to roost. The major problem, to start with, was the sheer technological impracticality of the project. Although the Low Altitude Bomber Project had ostensibly been cancelled due to its technological complexity, the technical problems facing its successor were even more daunting. Not only was there the difficulty of meeting the extremely demanding range and speed requirements, with all the attendant aerodynamic problems, but also there was a major problem from the structural point of view. Prolonged flight at Mach numbers in excess of 2.5 would cause aerodynamic heating of the airframe to temperatures of up to 800 degrees Fahrenheit in some places. To put this into perspective, a domestic oven reaches a maximum of about 450 degrees Fahrenheit, and a soldering iron around 600 degrees.[23] Exotic materials would have to be used to construct the airframe, and a whole host of related problems solved. The airframe would stretch several inches due to expansion caused by the heat, with, for example, possibly disastrous consequences for cable runs. The internal equipment and crew would also have to be protected from the ferocious heat. Even the tyres, for instance, would be extremely vulnerable to the heat unless the wheel wells could be cooled in some way. To solve a similar problem on the XB70 bomber, North American had to evolve a rubber compound formed largely from aluminium powder.[24]

The only suitable material available to British manufacturers to build such an aircraft was stainless steel, an extremely heavy and intractable material that was very difficult to form or weld. Technological problems began to mount with the programme from the beginning. Before long, knowledge of these

[23] Thompson, W., "Flight Testing the SR71 Blackbird" *Combat Aircraft* (1999) vol. 2, no. 3, p. 211.
[24] *Encyclopaedia of Aircraft* (1981) vol.18, p. 4266.

became widespread throughout the Ministry of Supply and the Air Staff, as the ADORA pointed out in September 1956:

> You are no doubt aware that Messers A V Roe are facing considerable difficulties with regard to weight growth and performance of their aircraft to meet OR330.[25]

The difficulties were indeed considerable. Whereas the Low Altitude Bomber had been condemned for potentially weighing 200,000lb, the Avro 730 was approaching 300,000lb, twice the weight of a V-bomber, with further weight gain in sight. Drastic measures were needed:

> The firm are worried about the gradual increase of basic weight of this project and since, for a supersonic aircraft with extended range, an increase in payload is reflected in a twenty-fold increase in the all-up weight, they believe that substantial improvements could follow reductions in planned payload.[26]

Avro requested that the requirement for a second pilot be eliminated and that an even lighter nuclear weapon be developed. They also wanted the operational ceiling requirement reduced. The Air Staff, who had already relaxed their stringent take-off and landing requirements that had posed such problems for the Low Altitude Bomber, reluctantly conceded the point on the second pilot. However, reducing the weight of the bomb was more problematic. The aircraft had been intended to carry the Blue Rosette bomb, which utilised a Green Bamboo warhead. This was, at around 6,000lb, approximately half as heavy as Blue Danube, and had a 50 inch diameter case as opposed to 62 inch for Blue Danube.

Avro, however, due to their work on Blue Steel, became aware of a special lightweight warhead for use on missiles, Orange Herald, that could conceivably be fitted in a bomb with a combined weight of 3500lb and a diameter of 40 inches.[27] The experimental nature of this weapon, however, and doubts as to its availability within the required time span caused the Air Staff to resist this demand. Likewise, reduced operational ceiling, which was

[25] AIR20/7723 ADORA to DORD, 14 September 1956.
[26] AIR20/773 DDOR1 to D of Ops (B&R), 18 October 1956.

already below that expected of the Mark 2 V-Bombers, was not acceptable. The speed required for the project was already the bare minimum, and desperate attempts to reduce radar cross-section, such as the replacement of the cockpit canopy by a series of periscopes, were plainly inadequate. Whilst references to 'avoiding radar detection by use of an anti-echo coating' and the shielding of engines against infra red detection are contained in at least one Ministry of Supply file,[28] the perfection of Stealth technology was in no way regarded as imminent. The huge air intakes for the aircraft's conventional turbojets, in any case, provided such massive radar reflecting surfaces that counter measures would have been totally ineffective.

Design problems were not the only ones casting a shadow over the project. When work commenced on the prototype's fuselage, it also became rapidly apparent that Avro had not realised quite what an intractable material stainless steel was to work with. Difficulties with making it conform to a double curvature bedevilled construction of Blue Steel as well as the Avro 730.[29] The technological problems continued to escalate throughout the project's life span. By the end of 1956, it was anticipated that the aircraft would weigh in the region of 350,000lb. Only two years earlier, 200,000lb had been the absolute maximum weight that the RAF had been prepared to consider for any bomber.

2.7 Opponents of the Supersonic Bomber

However, technological problems were not the only problem facing the Avro 730. The 'Bomber Lobby' were not totally without opposition within the Air Staff, although they held the crucial ground, particularly the post of ACAS (OR), occupied by Air Vice Marshall Satterly, a committed partisan of the high altitude manned bomber. The most vocal opposition within the Air Staff to the supersonic bomber came probably from Air Vice Marshall, the Earl of

[27] AIR20/773 DDOR1 to D of Ops (B&R), 18 October 1956.
[28] AVIA54/772 OR203, 14 August 1953.

Bandon, ACAS (Training). An extremely colourful and outspoken character, Earl Bandon's opposition to the supersonic bomber may well have been influenced by his experiences during the Second World War. When Earl Bandon was the commanding officer of 82 squadron in 1940, the entire squadron was lost flying totally inadequate aircraft on a single ill-conceived mission.[30] This made him particularly sensitive to matters regarding the survivability of the manned bomber. Subsequently, when on the staff of Number Two Group, he fell into dispute with AM Stevenson over the disproportionate losses suffered by the Group's bombers on anti-shipping sorties.[31] Also, as ACAS (training), he was responsible for a matter that by its very nature required a long- term view, and from the beginning the Earl was unconvinced by ACAS (OR)'s rationale for retention of the manned bomber. As early as August 1955 he wrote:

> Surely...the long term solution of the problem of offensive capability lies in the acquisition of an Intercontinental Ballistic Missile, so that, the sooner we devote all our energies to the production of an effective weapon of this description, the sooner we can 'rest easy in our beds' so to speak; and despite what the experts may say, I cannot believe that a goodly proportion of the technical skill and equipment needed to produce a manned, M.=3 bomber aircraft could not fairly readily be diverted to the development of an IBM with a far better all round performance.[32]

However, whilst Earl Bandon's criticisms were politely refuted by ACAS (OR)'s deputy, Air Commodore Kirkpatrick, other junior and less redoubtable critics were far less charitably dealt with. Satterly personally gave a notably vicious rebuke to the writer of OR 16's report on the relative merits of free-fall or guided bombing:

> ...it seems to be extremely biased to me and gives the impression that the author had already made up his mind about his conclusions and recommendations before he had completed examination of all the evidence. This sort of statement should be avoided in any such critical analysis.[33]

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[29] Interview with Professor John Allen 23 August 2000
[30] Hastings, M., (1979) *Bomber Command*, London: Joseph, pp. 56-61.
[31] *Ibid.* p. 76.
[32] AIR20/7733 ACAS(Training) to ACAS (OR), 22 August 1955.

Virtually every passage in the report was criticised, comment even being extended to the author's use of English: 'I believe you can make statements on these lines if you choose your adjectives carefully'. The real reason for Satterly's wrath was, however, contained in paragraph 29, in which the report's writer had stated:

> The supersonic replacement for the "V" bombers (OR330) will not have sufficient performance to carry out free fall bombing on strategic targets and must, on account of its vulnerability, employ stand-off bombing from its introduction into service if it is to be effective.[34]

Satterly commented acidly on this, 'if we accept the statement about OR330 at the end of the paragraph we might as well stop building OR330 now.'[35]

OR16's comment and the Air Vice Marshall's reply graphically illustrate both the extent to which the supersonic bomber was known to be operationally inadequate, and the extent to which many in the Air Staff were determined to ignore this. Satterly's response gives a decided impression that, as far as he was concerned, the Avro 730 was an end in itself for which members of the Air Staff were required to find a justification. Satterly did, however, seem to accept that the unsatisfactory conclusions in OR16's report were in part due to the phrasing of the question he had asked them, particularly the mention of 'Relative Merits'.

The next report that the Air Vice Marshall commissioned from OR16 contained no such hostage to fortune, the title set being 'The Advantages of a Manned Bomber'.[36] As assessment of operational effectiveness was the main part of the OR16 department's task, the shortcomings of the Avro 730 in this respect were particularly blatant to them and OR16 remained one of the projects principal opponents throughout its existence. It also becomes clear that Air Commodore Kirkpatrick was also not wholly convinced by the

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[33] AIR20/10954 ACAS (OR) to OR16, 15 July 1956.
[34] AIR20/10954 OR16 Report: *The Relative Merits of the Free Fall and Stand-Off Bombing Systems in the Strategic Role*, October 1956, p. 6.
[35] AIR20/10954 ACAS (OR) to OR16, 15 July 1956.
[36] AIR20/7723: *The Advantages of a Manned Bomber* (undated).

supersonic bomber, but, as Satterly's deputy, the amount of opposition he could articulate was limited. Satterly's eventual replacement by Kirkpatrick as ACAS (OR) in the autumn of 1956 was possibly the decisive nail in the coffin of the Avro 730. Certainly the offending OR16 report was re-submitted to Kirkpatrick and accepted without comment.

2.8 Justifying the Supersonic Bomber

As has been illustrated, finding justification for maintaining a manned, supersonic, bomber force became a major preoccupation for certain sections of the operational requirements staff. In some respects, this was a self defeating exercise, as the supersonic high altitude bomber was a concept that had little military effectiveness in any role, and mooting alternative roles for it merely encouraged close analysis, which highlighted its inadequacies.

Three major arguments were forwarded in succession, as each previous one became untenable. The first argument was that there was no alternative to the supersonic bomber as no other suitable system was in sight. ACAS (OPS) stated, in October 1954, 'if we could produce a ballistic rocket...the supersonic bomber would not be required, but my understanding of the problem is that it cannot be done in the period under consideration.'[37] The supremacy of the ballistic missile was easily conceded in the autumn of 1954 as the Air Staff still considered it a weapon of the far future:

> Present estimates of the time we shall have to wait for the ballistic rocket vary from 10-15 years from today. The project is an ambitious one, and there are very great problems to be overcome. Not only do I incline to think that we will need more than 10 years to bring accurate long range rockets into service in effective numbers, but I am certain that, since we have no certain date to work on, we must be pessimistic rather than optimistic.[38]

[37] AIR20/7723 ACAS (OPS) to ACAS (OR), 17 October 1954.
[38] AIR20/7723 ACAS (OR) to ACAS (P), 20 December 1954.

The Air Staff's lack of pessimism at their chances of designing, developing, and putting into service a fleet of supersonic bombers within ten years is noteworthy here. The supersonic bomber was touted as the only means of bridging the 'gap' between the expected obsolescence of the V-force by the early sixties and the introduction of ballistic missiles in the seventies. How this was so was not explained; it was merely assumed that a faster, higher-flying aircraft would be 'better' and no attempt was made to justify this in operational terms.

However, within two months it had become apparent that the ballistic missile was not so distant a possibility as had first been thought. The same breakthroughs in warhead miniaturisation that made the supersonic bomber possible, coupled with the development of efficient gyros had made the ballistic missile suddenly possible too. The Air Staff started to hedge their bets with regard to the supremacy of the ballistic missile:

> ...there is a danger that we may over-simplify the problem if we regard the supersonic bomber merely as a means to span a gap in the development of our offensive power. The supersonic bomber will in itself of course have a functional role which it can continue to fulfil even after the advent of the ballistic rocket.[39]

That 'functional role' was effective counterforce strike.

The emphasis on counterforce strike led to a brief re-shuffle in the Air Staff's internal advocacy coalitions. Support for the Avro 730 had been made up to a great extent of those who believed in a symbolic deterrent and a major emphasis on limited war capability. These were left high and dry, and replaced, temporarily, by the interest group who believed in effective nuclear war-fighting. The bulk of the Avro 730's other supporters were part of a new advocacy coalition that was forming of manned bomber enthusiasts, who were starting to bury the hatchet with regard to differences over high or low level operations, in order to see off the threat of long range rocketry. As will

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[39] AIR20/7723 ACAS (OR) to ACAS (P), 20 December 1954.

be seen when TSR2 is examined, this would eventually become a cohesive interest group in its own right.

The basis of the bomber lobby's belief that counterforce strike provided a viable operational role for the Avro 730 was that 'for many years to come the aircraft will be able to deliver a heavier weapon at greater ranges and more accurately than a ballistic rocket.'[40] This was emphasised by ACAS (OPS) in November 1954:

> As I see it the only worth-while targets for this type of attack (ballistic missile) would be centres of population and industry. To attempt to attack enemy rocket launching sites with rockets would probably be ineffective. It follows that our best defence against enemy ballistic rocket attacks may well be pin-point attacks by manned bombers against part of the enemy system, be it launching sites, storage areas, transportation or factories.[41]

Counterforce targeting therefore became a prerequisite for the retention of the manned bomber. There is something rather problematic about this statement, however. It seems to infer that ACAS (OPS) thought he was promoting a new strategic concept, something that is supported by statements by other procurement officials, as will be discussed. However, the existing historiography insists that counterforce targeting had been British policy since 1952 at the latest. Addressing this anomaly reveals a quite different concept of nuclear strategy at this level within the Air Staff to that at the articulated to the Defence Committee by the Chiefs of Staff.

2.8.1 The Counterforce Strike Debate

Revisionist historiography regarding British nuclear strategy has highlighted counter-force targeting as one of its distinguishing characteristics. However,

[40] AIR20/7723 ACAS (OPS) to ACAS (OR), 17 October 1954.
[41] *Ibid.*

there has been some debate between revisionist historians as exactly when this strategy emerged, and also as to when it became superseded. Despite this disagreement as to exactly when it emerged, it is regarded as a very prominent landmark in the debate at the High Policy level. It is therefore quite startling to find that there is very little evidence for the existence of a counterforce strategy at the Operational Planning level. This seems to support Simon Ball's contention that 'discussions of counter-military targeting are usually found as rhetorical points in the disputes over the allocation of the defence budget', although he locates this attitude in the late 1940s, not the mid 1950s.[42] John Baylis believes it is merely a manifestation of strategic uncertainty in the late 1940s, and that a 'significant shift towards counter-force targeting' did take place in the early 1950s.[43]

With regard to OR330, none of the middle-ranking officers and officials involved in the procurement process seemed to be aware of exactly what British nuclear targeting policy was, or of the great debate that surrounded it. All the pertinent points of that debate did surfaced in Air Staff discussions at this level, but totally without reference to similar discussions going on between the Chiefs of Staff and other high officials.

The best the Director of Operations (Bombing and Reconnaissance) could do when asked what targeting policy was, in August 1956, was to describe it as being aimed at:

> ...centres of administration, communication and industry. Attacks on industry would probably take into account, amongst other things, the importance of oil, electrical power, ship-building, vehicle production, atomic installations, electronics guided weapons and aircraft production. Attacks may also have to be carried out on ports and naval bases, on airfields and on guided weapon installations.[44]

[42] Ball, S., (1991) *The Royal Air Force and British Nuclear Strategy, 1945-49*, (Ph.D thesis, Cambridge University) p. 46.
[43] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-56*, Oxford: Clarendon, pp. 91-92.
[44] AIR20/10954 D of Ops (B&R) to DDOR1, 10 August 1956.

It is highly noticeable that airfields are regarded as no more than a 'possible' target, second-from-last on the list. In theory, 40 Soviet airfields had provided Britain's nuclear objectives in the early to mid-fifties, to be arbitrarily replaced by 40 Soviet cities in 1957 when counterforce strike was finally regarded as untenable,[45] but this is not at all mentioned. Indeed, discussion of airfields as targets only takes place due to the fact that they would require a far higher resolution radar to find them compared with any other target. It should also be noted that a 'centre of administration, communication and industry' was a Bomber Command euphemism for a city. The use of this euphemism was to cause some confusion in the ensuing debate. Instead of implying countervalue targeting that relies on the psychological effect of threatening a few of the enemies major population centres, it was taken by some to infer a large scale attritional campaign aimed at paralysing enemy production and communications. This is illustrated by the comment of OR1 to DDOR1, which contrasts the targeting of administrational, communications and industrial targets with a countervalue targeting strategy:

> All the talk of administrative, industrial and communications target systems suggests a massive force and possibly a prolonged war. The former is now almost certainly beyond our economic resources. The latter is out of the question to us if atomic weapons are used and anyhow assumes that the deterrent has failed. I believe that our main aim should be to have a real deterrent of unquestionable efficiency even if we can only have it in sufficient quantity to threaten a percentage of choice targets.[46]

This is an intriguing statement for several reasons. If it is not a misunderstanding, which is possible, then it suggests the Air Staff's actual targeting policy was neither strictly speaking 'counter value' nor 'counter force', as it has previously been understood. Whatever the real meaning of this statement, it also underlines the inescapable fact that Britain's resources

[45] Baylis, J., (1995) *Ambiguity and Deterrence, British Nuclear Strategy 1945-64,* Oxford: Clarendon, p. 304.
[46] AIR20/10954 OR1 to DDOR1 13 Feburary 1956

were viewed as no longer sufficient for it to sustain anything other than a countervalue policy, no matter how strategically valuable alternatives might be. In October 1956, DDOR1 argued that:

> In so far as a global war is concerned we are only really interested in the deterrent. In this context it seems hard to justify the selection of airfields as targets. Since the choice of targets has a direct bearing on the degree of accuracy and therefore the weapon system required, it is reasonable to assume that, as far as the deterrent is concerned, the likely targets will be cities or large industrial complexes, that can, if need be, be easily identified on radar that does not demand very high resolution.[47]

It becomes apparent that the concept of counterforce targeting was not taken at all seriously by middle-ranking officers in the Air Staff and Bomber Command. Even the inclusion of airfield targets second-from-last in terms of targeting priority was thought to over-rate their significance as this remark by DDOps (B) makes clear:

> However, what DDOR1 has written certainly tallies with my thinking, and with Bomber Commands thinking and I do not see how we can seriously include airfields as deterrent targets. If you will refer back to your minute at Enclosure 53A you will see that in paragraph 2 thereof airfields are given only an incidental importance. I agree that we must also bear in mind that we may have to put part of our force on to airfield targets...though many of us feel that this will be a waste and misdirection of effort.[48]

OR (B) confirmed this:

> I agree that airfields as targets do not represent a deterrent. If cities, as I believe they must, are to be our target in a global war then a low resolution radar would suffice.[49]

[47] AIR20/7723 DDOR1 to D of Ops (B&R) Bomber Command, 18 October 1956.
[48] AIR20/7723 DD Ops (B) to D Ops (B&R) 21October 1956
[49] AIR20/7723 DOR (B) to DDOR1, 5 November 1956.

The fact that this whole discussion is uninformed by the long running strategy debate amongst the Chiefs of Staff and others at the High Policy level, and its protagonists ignorant of the supposed prevalence of counterforce targeting in British nuclear strategy, is made even more manifest in this suggestion by DOR(C):

> Whilst city targets will probably remain the most important from a deterrent point of view, I believe that when each side is capable of delivering megaton weapons more and more attention will have to be paid to knocking out the enemy's offensive potential. In this time scale this means enemy ballistic missile sites and I believe we should aim for this standard of accuracy in future manned bombing systems.[50]

This promoting of counterforce targeting as a new concept in comparison to a supposedly well-established policy of countervalue targeting is at total variance to the high policy decisions regarding British nuclear strategy at this time. It raises further questions about the actual prevalence of counterforce targeting at the operational level, and particularly about the exact influence of high policy decision-making on British strategy. The latter is particularly open to question as it is the debate at this operational planning level that will irrevocably determine, through technology selection, Britain's future nuclear strategy options. Needless to say DOR (C)'s argument was rejected. In reply, DOR (B) had stated:

> I find it increasingly difficult to raise any convincing argument that either side can win a global war by destroying the enemy's strike force before he is able to employ them. This infers a capability in the form of a one-effort strike and also infers the need to strike first.[51]

This was economically and politically impossible. As far as the Operational Requirements Staff of the Air Staff were concerned, any consideration of counterforce targeting, in the accepted sense, was dead by mid 1956, when

[50] AIR20/7723 DOR (C) to DDOR1, 7 November 1956.
[51] AIR 20/7723 DOR(B) to DOR(A) 11 November 1956

OR16 was able to definitely pronounce in a report that 'our strategic deterrent policy does not call for the destruction of pin-point targets.'[52]

The attempt to find a solution to Britain's perceived 'unique vulnerability' to atomic attack via a nuclear war-fighting solution was not immediately abandoned by its supporters, as will be described with regard to Blue Streak, but any thought of promoting the Avro 730 as a counterforce system was now redundant. The full implications of this were forthrightly expressed by DOR (B): 'I regard the manned bomber as dead against Russia, beyond the time scale of the 1000 mile powered bomb in a subsonic bomber.'[53] The qualification 'against Russia' reveals, however, that a limited war role was not at all ruled out.

This brief foray into the promotion of nuclear war-fighting by the manned bomber enthusiasts reveals several characteristics and consequences of the strategic perceptions of this strata of the procurement hierarchy. As has been discussed with regard to the V-Force, the differences in strategic perception between the upper and middle echelons of the procurement hierarchy can be partly attributed to the 'strategic culture' of the RAF. This was something that was far more likely to manifest itself in internal Air Staff discussions than the rhetoric of inter-service debate, the problems of interpreting which have been pointed out by Ball.[54]

However, it is noteworthy that most of the officers involved in this discussion were mainly Group Captains and lower, and therefore the confusion might also be blamed to a large extent on the endemic 'compartmentalisation' of information and communication that characterised British defence projects in the post war period. Kate Pyne has commented that, at Aldermaston, it was a recognised fact that different departments and groups of people had totally

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[52] AIR20/10954 0R16 Report: *The Relative Merits of Free-Fall and Stand-Off Bombing Systems in the Strategic Role,* October 1956.
[53] AIR20/7723 DOR (B) to DOR (C), 26 February 1957.
[54] Ball, S., (1991) *The Royal Air Force and British Nuclear Strategy, 1945-49,* (Ph.D thesis, Cambridge University).

different perceptions of the 'purpose' of the deterrent, and this was actually taken into account when briefing them on weapons development.[55]

Another significant characteristic of this phenomenon, which to a certain degree is also substantiated by Pyne's observation, is that it created ambiguity as to the location of actual authority regarding particular matters. It is obvious from the Avro 730 targeting debate that middle ranking procurement and operations officials plainly thought that they were the appropriate authorities to be deciding Britain's nuclear strategy. Not only do they attempt to decide some of the most significant questions with regard to strategy making, but there also seems to be no attempt to determine the views of the Chiefs of Staff on these matters, or indeed any recognition that the Chiefs had such views. This had several consequences. The principal one was that procurement decisions were being made that did not conform to significant high policy decisions. Whilst in many ways the evolution of the strategic debate regarding targeting at the operational planning level did mirror that at the high policy level, although over a much more condensed time period, it is notable, for instance that its perspective was limited to the consideration of a unilateral British strike against the Soviet Union, the military and political likelihood of which was remote in the extreme. No consideration was given to the political requirement for integration into the United States targeting plan, which required attacks on a wide range of counterforce and defence suppression targets, particularly by the first wave of which the British would reasonably expect to be part. This emphasises the seriousness of the strategic differences between the two levels of decision-making, particularly as the procurement decisions made would themselves constrain the policy options open to high policy makers once the equipment was in service.

The ultimate consequence of the debate over targeting for the Avro 730 was to blatantly illustrate the aircraft's lack of effectiveness in the strategic strike role. The brief wedding of interests between the war-fighting interest group and the manned bomber enthusiasts was broken. The manned bomber

[55] Pyne, K., "Red Snow" British Rocketry Oral History Project Conference Paper 1999

enthusiasts were now very much on the defensive. Their most powerful supporter, Air Vice Marshall Satterly was about to relinquish the post of Assistant Chief of the Air Staff with responsibility for Operational Requirements. However, this did not mean the end of the debate. As the bomber lobby perceived the maintenance of a manned bomber force as a necessity, some role had to be found for it to fulfil. The Trenchardian concept that heavy bombing and strategic air operations were applicable at all levels of conflict, an intrinsic part of the RAF's strategic culture, provided an answer to this, as DDOR4 pointed out:

> It is reasonable to assume that, as far as the deterrent is concerned, the likely targets would be cities or large industrial complexes. But this does not mean that we shall never have to attack pin-point targets, and we also, of course have to keep limited war in mind.[56]

Efforts to save the Avro 730 therefore shifted to emphasising the utility of the aircraft in limited war situations, in the hope of winning back the supporters who had been abandoned in the switch to a war-fighting role. Unfortunately for the Avro 730 and its advocates, the confusion and ambivalence displayed towards nuclear war-fighting did not extend to operational effectiveness in limited war situations, which was taken far more seriously.

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[56] AIR20/7723 DDOR4 to DOR (B), 19 February 1957.

2.8.2 Limited War Capability

The original specification for the 730 called for a nuclear only capability but, unlike their failure with regard to the Low Altitude Bomber, the Air Staff soon had this amended to require the aircraft to carry the complete range of conventional weapons. When OR16 first presented its controversial report on the continued viability of free fall bombing, one of Satterly's ripostes was as follows:

> I would also like to mention once again the fact that your paper apparently is limited to a war against Russia and you have not considered the problem of limited war. I believe you must take into account limited war and this would have a very considerable effect on your conclusions and recommendations.[57]

The value of a manned system in limited war was expounded by DDOR1:

> This aircraft is almost certain to be used in limited war as well as global war. In the former case it may well be dropping H/E, and it may also be necessary to retain a degree of control over the mission which would not be possible in a fully automatic system. This may only be possible by the use of a man.[58]

The DOR (B) insisted:

> We must decide of course whether the aircraft should be equipped solely for global war or whether it should also be considered for use in limited wars. My view is that we must include the latter even at risk of complication.[59]

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[57] AIR20/10954 ACAS (OR) to OR16, 15 July 1956.
[58] AIR20/7733 DDOR1 to D of Ops (B&R) 21 October 1956
[59] AIR20/7723 DOR (B) to DDOR1, 7 November 1956.

However, OR16 remained a voice of dissension. In the revised version of the rejected report on free-fall bombing, OR16 answered Satterly's criticism about the lack of consideration of limited war by dismissing it thus:

> In a limited war, our future tactical aircraft should be capable of carrying out all necessary operations; the use of extremely expensive strategic bombers leading to a possible loss in our deterrent strength and the effect on the rest of the world by the use of nuclear weapons, constitute a risk we may not be prepared to take.[60]

This, however, was not the decisive argument against the use of the high altitude supersonic bomber in the conventional role. A technological limitation had started to rear its head, in the shape of the poor bombing accuracy that could be expected from aircraft such as the Avro 730.

Worries about the bombing accuracy of the supersonic bomber had first surfaced at the Advisory Design Conference as early as May 1956. Interestingly, it was Air Commodore Kirkpatrick, Satterly's deputy and later successor as ACAS (OR), who drew most attention to it. Here the problems of supersonic aircraft with relation to their 1G-ceiling became apparent. This phenomenon, although it nominally effects all aircraft, was regarded as a particular problem with high altitude, high-speed aircraft. The 1G ceiling is the maximum altitude an aircraft can maintain whilst performing manoeuvres with an acceleration of 1G. If more violent manoeuvres are undertaken, causing increased accelerations, the pilot is faced with two options. If height is to be held, then speed must be increased. If the aircraft is at maximum speed already then height will have to be lost. Supersonic aircraft, with a lift-to drag ratio that is approximately one third of that of a subsonic aircraft are particularly prone to this effect, and the necessary speed and height changes would be extreme. At 2G, the aircraft would have an initial rate of descent of 35,000ft per minute. Even at 1.15G, the rate would be 4,000ft per minute. It was expected that the aircraft's turn radius at Mach 2.5 at its 1G-ceiling would

[60] AIR20/10954 OR16 Report: *The Relative Merits of the Free Fall and Stand Off Bombing Systems in the Strategic Role*, October 1956, p. 6.

be in the order of 120 miles.[61] The rapid succession of small turns, combined with constant height and airspeed, associated with a bombing run, would be impossible for the 730 unless it drastically reduced speed and attitude over the target, exactly when it needed it most. Thus the aircraft could either scatter its bombs at random or make itself a sitting duck whilst aiming. This was compounded by an RAE report on the likely accuracy of a weapon released at high altitude by a supersonic aircraft. The report stated that:

> ...the sort of accuracy that can be expected from a Mach 2.5 bomber at 55,000 ft is:
>
> | | | |
> |---|---|---|
> | Free-fall | high terminal velocity | 730yrds |
> | " " | high drag 20mls. trail | 1400yds |
> | " " | " " 40 " " | 1800yds |
>
> They point out that high velocity bombs may have to be limited in yield for considerations of aircraft safety, although this may not be so critical at higher altitudes.[62]

What this meant was that the Avro 730 would not be able to guarantee putting a bomb much closer than half a mile from the target even if it was operating far below its G-ceiling. It must be noted that these figures assumed that the aircraft was able to accurately identify its target and was able to manoeuvre sufficiently to drop the bomb with the best accuracy possible, both of which contingencies the Air Staff already knew were unlikely to be fulfilled.

This was a crushing blow to the advocates of the supersonic bomber. It totally ruled out any conventional role for the supersonic bomber, and even in the nuclear role made it no more accurate than a stand-off bomb. However, this information does not seem to have received wide discussion whilst Satterly was still ACAS (OR), although DUP (C) did comment in June that: 'in my view we should regard the OR336 vehicle as a powered, guided, bomb-carrier from the outset.'[63]

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[61] AIR 20/7733 ACAS (0R) to DCAS, 6 May 1956.
[62] AIR 20/10954 0R16 Report: *The Relative Merits of Free-Fall and Stand-Off Bombing Systems in the Strategic Role* October 1956.

Once Satterly was replaced by Kirkpatrick, however, this view became more commonly aired. In November 1956, DDOR 4 commented that:

> Even in a limited war the aircraft could achieve tactical flexibility only by reducing height and speed...It is very unlikely that sufficient accuracy could be obtained to make the use of HE worthwhile. With everything in our favour we might just do well enough to use the tactical A-bomb.[64]

This led to an almost inevitable conclusion, as expressed to DOR (A) in February 1957:

> It is of course difficult to foresee whether or not 'small' nuclear weapons will ever be employed in limited wars. It can be argued that the introduction of nuclear weapons will not bring a limited action to a speedy conclusion but, on the contrary, will enormously increase the risk of initiating a global war. For this reason, I suggest the requirement for limited war weapons should be considered in isolation from the deterrent requirements. In most (and perhaps all) limited war situations that can be foreseen, the OR330 and successor type aircraft may be unsuitable weapons.[65]

This was echoed by DDOR4:

> I do not agree that manned weapon systems could be devised which would be suitable for use both as the deterrent and in limited wars. If they were effective deterrent systems they would be too large, too inflexible, too complex, too scarce and too costly for use in limited wars.[66]

This marks the beginning of the end of the Air Staff's concept of Bomber Strategy and the ideal of having one system capable of performing both deterrent and limited war roles. The concept of dividing bomber systems into separate limited war and deterrent types, that was to manifest itself in the adoption of TSR2 and Blue Streak respectively, now starts to form. The failure to prove the case for the supersonic bomber as a limited war weapon also marks the final stage of the delamination of the advocacy coalition behind the Avro 730. Having already lost the support of the war-fighting lobby, the bomber enthusiasts were now losing the recently regained support of the limited war advocates too. In order to retain at least some of the latter's

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[63] AIR20/10954 DUP (C) to 0R1, 4 June 1956.
[64] AIR20/7723 DOR (B) to DDOR1, 7 November 1956.
[65] AIR20/10954 DOR (A) to DOR (B), 12 February 1957.

support and find one final refuge for the Avro 730 in terms of an operational rationale, the bomber lobby now returned to the original justification for what became the Avro 730; strategic reconnaissance.

2.8.3 The Reconnaissance Debate

Proponents of the manned bomber believed that reconnaissance was a timeless military requirement that would provide an unshakeable justification for the Avro 730. As ACAS (OR) Air Vice Marshall Satterly put it, 'whatever we may do about bombing I believe we shall always need a manned aircraft to go and look at the target, both before and afterwards.'[67] However, the OR330 project provoked a major debate regarding the necessity for retaining a strategic reconnaissance capability.

Three perspectives emerged during this. One regarded such a capability as necessary for strategic air operations, the second regarded it as necessary only for limited war operations, whilst the third thought it unnecessary and merely an excuse for retaining the manned bomber. This third point of view was largely articulated by the ACAS (Training) the Earl of Bandon. As early as August 1955, he argued that strategic reconnaissance was a thing of the past:

> I am well aware that, on the face of it, radar/photo reconnaissance of the other fellow's hinterland is a most important requirement for the future, and that an aircraft of the performance postulated in OR336 might be operable safely in such a role for a fair time to come. But our national policy commits us to employing our strategic weapons and, indeed, our armed forces overall, primarily as a deterrent to war and, as I see it, the threat of annihilation of whole cities, the geographical location of which we know quite well already, and hence we do not need to establish by reconnaissance, is likely to prove a much more potent deterrent to a realistic people such as the Russians, than the threat of similar treatment being meted out to airfields, factories, marshalling yards, river crossings and the like. In short, I am suggesting

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[66] AIR20/7723 DDOR4 to DOR (B), 19 February 1957.
[67] AIR20/10954 ACAS (OR) to OR16, 15 August 1956.

> that a requirement for pin-point reconnaissance of the depths of Russia is not likely to arise in the lifespan of the 1965 medium bomber, and that to claim this requirement as part justification for proceeding with the design of this aircraft is unwarranted.[68]

Two points can be made regarding these comments. Firstly, it is obvious that this debate is intrinsically linked to that regarding targeting and, secondly, that the Earl plainly considered the reconnaissance requirement as merely a ploy to retain the manned bomber, which leads to the suspicion that he also considered counterforce targeting likewise.

However, there was definitely an element within the Air Staff that saw a legitimate military rationale for strategic reconnaissance. This included the future CAS, Sir Stuart Menaul, who at that time was a Wing Commander recently returned to the Air Staff from observing British nuclear tests. He agreed with Bandon's hypothesis that the manned bomber was obsolescent; however, as he wrote to ACAS (OR)'s office:

> I do not however agree with ACAS (Trg) when he says that the geographical location of the cities and towns in Russia are known to us already and that we do not need to establish their position by reconnaissance. It will be vitally important that we know exactly the position on the earth's surface of any target selected for attack by a ballistic weapon, far more necessary than when the attack is to be launched by a manned aircraft. One of our biggest problems to-day is establishing the exact position of many important targets on the Russian continent. The maps available to us are in some cases very inaccurate and for vast areas we have no maps at all. With the manned aircraft fitted with scanning radar it is possible to look for and find these towns or targets from the limited information available, but this is not so with an intercontinental ballistic rocket.[69]

The importance of a strategic reconnaissance aircraft as an essential adjunct to a ballistic missile force, however, raised other questions. Firstly, if pre-strike reconnaissance was essential for missile operations, it would have to be carried out by clandestine missions in peacetime. This raised the question

[68] AIR20/7723 ACAS (T) to ACAS (OR), 22 August 1955.

of whether the Government would authorise such missions. The RAF had carried out several series of clandestine over-flights of the Soviet Union and China during the 1950s, usually at the behest of the USAF and the USN. The utility of these missions towards furthering Anglo-American relations was seen by the RAF as a useful political lever for furthering the manned bomber, as DDOR1 pointed out in January 1957:

> In our case for a manned aircraft I think we should mention the fact that an unmanned aircraft would be unable to carry out clandestine reconnaissance.[70]

However, by this time, clandestine operations were becoming increasingly unpopular with the Foreign Office and it was a matter of some debate as to whether any more would be authorised. The Director of Operations was of the following opinion, which also raises a second point, that of contemporary conceptions of the nature of nuclear war:

> I do not think we should plan on the assumption that we shall never carry out reconnaissance in peacetime. Circumstances may well be such that the Government would be willing to authorise this. Quite apart from this, however, reconnaissance is essential for accurate location of new targets for second and third strikes and for checking whether certain important first strike targets have in fact been hit. The accurate location of targets also becomes increasingly important as we get into the era of the powered guided bomb and of the ballistic missile. We should therefore regard a small reconnaissance force as an integral part of the deterrent.[71]

The talk of multiple strikes betrays a belief that there would be a 'winnable' nuclear campaign almost certainly involving counterforce targeting and that need for strategic reconnaissance was directly linked to a counterforce strategy.

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[69] AIR20/7733 AD Ops (B&R) to SO ACAS (OR), 30 August 1955.
[70] AIR20/10954 DDOR1 to 0R1, 2 January 1957.

As the counterforce argument lost ground, the theme of the manned bomber lobby changed towards emphasising the necessity for reconnaissance in limited war:

> If we foresee possible future limited wars as following the Korea pattern, then reconnaissance will be essential and the manned aircraft has a most important application for this and for the bombing of inaccurately known targets.[72]

However, there was an intrinsic flaw in this argument with regard to 0R330, as DDOR4 pointed out:

> I do, however, agree with the paper that reconnaissance will, in the foreseeable future, be best carried out by manned weapons systems. But I believe a much shorter range than is asked for will be adequate, particularly if augmented by flight refuelling.[73]

In other words, the type of reconnaissance that would be undertaken in a limited war situation did not require an aircraft of the size and complexity of the Avro 730. The general opinion soon mirrored that of DDOR 4:

> I also think that, when the next deterrent system is being considered, the possibility of giving it a limited reconnaissance capability should not be ignored, but, at the same time, I do not think that this is a strong enough requirement to influence the basic design of the system.[74]

The attempt to find a military justification for the Avro 730 in the deterrent role was now foundering rapidly. The aircraft's original role – reconnaissance – had now become its last refuge in terms of securing a useful operational rationale. In February 1957, the deputy director (airframes) RAE commented that 'if anything ACAS (OR) feels that the future of manned systems is now almost entirely dependant on their ability to undertake reconnaissance successfully.'[75] However, by then it was becoming painfully obvious that this was far too tenuous a reason to continue with the project. DOOR(A) commented to OR1:

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[71] AIR20/7723 D of Ops to DOR (A), 7 November 1956.
[72] AIR20/7723 DOR (C) to DDOR1, 7 November 1956.
[73] AIR20/7723 DDOR4 to DOR (B), 19 February 1957.
[74] *Ibid.*

I believe we can no longer justify a manned bombardment system as the deterrent against Russia. In the same context, LR recce is not a requirement...Only an aircraft of superb performance could alter these conclusions, and even then a missile system would be cheaper.[76]

2.9 Cancellation

Nothing better illustrates the determination amongst certain elements of the Air Staff to retain the manned supersonic bomber, despite its manifest operational unsuitability than the defiant yet perplexing response of the DOR(C) to the Avro 730's patent vulnerability to Soviet defences:

> When painting a picture of the problems of penetrating defences we must not be too weak kneed. We most certainly would not have won the First World War if we had assumed that every round from a machine gun would kill a man merely because we knew that one round could do so. [77]

This illustrates that the operational effectiveness of its nuclear deterrent was something that some in the Air Staff were quite prepared to leave to conjecture and a robust attitude. However, the operational effectiveness of the aircraft in the non-nuclear role was something that would, in all probability, be put to the test and, despite the institutional importance of the Avro 730, the Air Staff could not risk it being found wanting.

The traditional approach of specifically designing aircraft for the strategic role and letting its tactical application 'take care of itself' was obviously no longer tenable. In the megaton era, the tactical role was in some ways far more demanding than the strategic and in future it might be necessary to design dual purpose aircraft specifically for the tactical role and provide an 'add on'

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[75] AIR20/7723 DD (A) RAE, 11 February 1957.
[76] AIR20/10954 DOOR (A) to OR1, 18 March 1957
[77] AIR20/8573 DOR(C) to DOR(A), 10 September 1956.

strategic capability, rather than the other way round. The Air Staff took note of this, and the philosophy can be seen to manifest itself in the TSR 2 project, which got underway at just this time. With the lack of a requirement for counterforce targeting and reconnaissance also apparent, and the technological problems getting worse by the minute, there was definitely nothing to loose by cancelling the project. It is even possible that with a major defence review looming, requiring a ritual sacrifice to the Treasury, the Air Staff saw that there might even be something to gain by cancelling the Avro 730.

Unfortunately, now that the writing was so plainly on the wall for the project, problems arose in devising a means of cancelling the Avro 730 without admitting that a technologically impractical project with no real military rationale had formed the centrepiece of British defence policy and had been allowed to run for so long. Providently, threat provided the answer. The cancellation was attributed to two factors; programme delays and a newly discovered vulnerability. The continual time slippage in the program was a genuine worry but it is notable that the project was replaced by one that did not promise to be in service any earlier. What was more heavily emphasised was the emergence of a new threat to the manned bomber:

> The Air Staff have been strongly influenced by new information on the effectiveness of SAGW with nuclear warheads. We have all along been concerned at the chances of survival of such an aircraft against a SAGW defence system even when using conventional HE warheads. However, the information which we now have on the availability and effectiveness of nuclear SAGW in the timescale in which we might expect the aircraft to enter service has led us to the conclusion that the aircraft would have a low chance of successfully reaching its objective.[78]

The comment that the Air Staff had been concerned about vulnerability to SAGW 'all along' is disingenuous in the extreme. As has been illustrated, they actually had to deliberately ignore it all along, as the project would not

[78] AIR20/10954 ACAS(OR) to CA, April 1957.

have been started at all if the implications of the Low Altitude Bomber threat analysis had been acknowledged.

The purpose of mentioning nuclear-tipped surface-to-air missiles seems to be merely a camouflage to enable the 730 to be cancelled without recrimination. By stating that a 'new' factor – nuclear tipped surface-to-air missiles – had made the aircraft vulnerable, attention would be drawn away from the original decision to develop the aircraft, and its deeply flawed rationale. The fact that the Avro 730 had always been vulnerable to non-nuclear air to surface missiles was not mentioned.

This suited all the interested parties. The Avro company received a substantial compensation settlement from the Treasury. This it would not have done had the aircraft's performance been revealed to be unsatisfactory with regard to the original specification, which would unavoidably have happened had the project continued. The Ministry of Supply got Blue Streak, which suited its purposes perfectly, as will be related later. The Air Staff 'bomber lobby', although forced to accept the demise of the manned bomber in the strategic nuclear role and adopt the ballistic missile as its successor through lack of any other option, turned their attention towards TSR 2.

Unfortunately the reluctance with which many 'bomber enthusiasts' abandoned the nuclear deterrent role to the missile was to leave a fatal legacy for the ballistic missile project, Blue Streak. The most blatant signal of this attitude was that two days before the decision to cancel the Avro 730, ACAS(OR)was instructed by the CAS to draft a requirement for 'a means of continuing the deterrent apart from the ballistic missile.'[79] Two factors are implicit in this request. Firstly, although the ballistic missile fulfilled the functional requirements for a deterrent, this was not regarded as the prime determinant of the RAF's deterrent policy. Secondly, the ballistic missile was a temporary expedient until such time as an alternative more suited to both

[79] AIR20/10954 ACAS(OR) to DCAS, 12 April 1957.

the RAF's 'institutional essence' and the demands of 'Bomber Policy' could be found.

Threat, in the form of operational effectiveness in the nuclear strike role, was a consideration that played little or no role in the decision to proceed with the supersonic bomber project. It was used, however, to justify its cancellation. This emphasises its role as an external circumstance that can be ignored if required and yet invoked if blame for failure needs to be found outside the bureaucratic system. However, it could be argued that the procurement decision was, to a certain degree, based on a concept of operational effectiveness, although of a very different kind. This was one that prioritised the requirements of peace-time deterrent operations over nuclear war fighting capability. This was because of a perception that the British deterrent was not a passive, 'ultimate preventer' of global war – that was SAC's role – but was, in fact, an active means of amplifying British power in peace time, and this required a system that was very visible and mobile, even at the expense of actual war-fighting capability.

Evidence for such an attitude can be discerned but, to avoid admitting that British military power was essentially a paper tiger, it was not openly articulated. The question of operational effectiveness that could be openly discussed and did affect the decision-making process was with regard to limited war fighting capability. This was a consideration that was not part of the High Policy regarding the British nuclear deterrent but one that was of concern purely to middle-ranking officials in the Air Staff. It illustrates again that supposedly overriding national policy objectives had to take their place in the queue behind departmental and even personal agendas once they were placed in the hands of those who were entrusted with their execution.

In the final analysis, the Supersonic Bomber Project was cancelled because the sheer implausibility of the Avro 730 from both the technological and operational perspectives became too difficult to hide. Unlike most of the other projects in this study, understanding why the Avro 730 was cancelled is infinitely easier to grasp than why it was instigated in the first place. According to Derek Woods, after cancellation the incomplete fuselage of the prototype Avro 730 was cut into sections, which were then used as waste bins around the Avro factory at Woodford.[80] If this is so, then at least a useful role had finally been found for the supersonic bomber.

[80] Woods, D., (1986) *Project Cancelled: the Disaster of Britain's Abandoned Aircraft Projects*, London: Janes, p. 57. From the progress reports it would appear more likely that this was, in fact, the fuselage of the mock-up

Blue Steel

3.1 Introduction

The Blue Steel Project was the only one of the Air Staff's 'V-Bomber replacement projects' to enter service. As such, it provides an opportunity to examine a variety of bureaucratic politics issues, influences and actors that do not manifest themselves with regard to the other projects studied. It might be argued that, because it actually entered service, Blue Steel and these other aspects of bureaucratic politics have no relevance to the main themes of this study, which are, after all, concerned with project failure. However, despite equipping Bomber Command units for several years, the Blue Steel project was regarded by some, both at the time and subsequently, as a major procurement failure. Many of the major themes of this study manifest themselves in the story of Blue Steel, and the story itself adds additional insight into their nature.

The question as to whether Blue Steel was a success or a failure brings to light various conflicting perspectives on the nature of the deterrent. These illustrate not only the strategic confusion surrounding it but also the negative effects of the 'compartmentalisation' of knowledge and communication which characterised the British procurement process.

One of the most striking aspects of the Blue Steel project are the two entirely contrasting attitudes towards the weapon held between those who created it and those who commissioned it and eventually came to operate it in service. To the technologists, Blue Steel represented a triumph. A noted aeronautical scientist has described it as one of the three greatest post-war achievements of the British aircraft industry.[1] Despite the challenge of the specification

[1] Interview with Professor John Allen, 23 August 2000

Blue Steel conformed extremely well to the Air Staff's performance requirements. Indeed, with regard to range, it exceeded their requirements by over 20 *per cent*.

Blue Steel was a complex system that required the successful solution of a number of very difficult design and engineering problems. These were all successfully overcome, and in several respects the resulting weapon was technologically superior to other contemporary systems. The contrast between this perspective and that of the technologist's customer, the Air Staff, was extreme. From an operational point of view Blue Steel was regarded as little short of a nightmare by the Air Staff. In several important respects, its introduction into service actually degraded Bomber Command's operational capability, particularly with regard to Quick Reaction Alert. Most significantly, however, it did not enter service until it was virtually obsolete, according to the threat analyses that should have guided the project. Such was the defence establishment's disillusionment with the system that Blue Steel became regarded a mile-stone in Whitehall's eventual rejection of all-British projects in favour of either collaborative ventures or direct purchase from the United States. In between these two perspectives lies a story of bad management at various levels, strategic confusion and ambiguity of purpose that throws into sharp relief the problems facing the maintenance of Britain's independent deterrent by the late 1950s.

3.2 The Operational Requirement

Blue Steel was a winged cruise missile, or 'stand-off bomb', intended to prolong the life of the V-Force in the face of the threat from Soviet surface to air missiles. It was intended as a temporary 'stop-gap' to fill a perceived gap in the credibility of the British deterrent. This would occur from 1960, when it was anticipated that the V-Bombers would become obsolete due to the introduction of Soviet surface-to-air missiles, and end in 1965, when the new second-generation delivery system would enter service.[2] In order to bridge the gap between the high altitude V-Bombers dropping free-fall weapons and whatever form the next generation system would take, it was decided to develop an air-launched supersonic cruise missile, which could be carried by the V-Bombers in place of their free-fall bombs. This would enable the vulnerable bombers to avoid coming within range of the short-range surface-to-air missile batteries defending specific targets. It was anticipated that a supersonic cruise missile would be un-interceptable to these weapons until 1965, when it was expected that improved surface-to-air missiles able to achieve high-altitude supersonic interception would become available. The introduction of these weapons, in connection with the extension of Soviet missile coverage from being merely point-defence to a full perimeter defence system, would render the cruise missile concept obsolete, making the introduction of the next generation system imperative.

As far as the Air Staff were concerned, the key requirement governing the Blue Steel project was that the weapon should be in service by 1960. Blue Steel missed this target by over 3 years, totally undermining the strategic conception behind it, which required the closing of a capability gap that would exist between 1960 and 1965. The situation was worsened by the fact that, in 1957, the intelligence assessment had been revised. The gap became 1960 to 1963. As the missile was not declared operational until February 14 1963, and was not fully cleared for Quick Reaction Alert duties until August 28 of the same year, the grounds for regarding Blue Steel as a procurement failure can be easily appreciated.[3]

That these delays occurred is in many respects surprising, as the operational requirement was specifically framed with the attainment of the 1960 entry into service date in mind. Not only did it merely require performance figures that had previously been determined to be attainable by 1960,[4] but, more

[2] DEFE 7/2333 DRPS Meeting Minutes, 3 June 1955.
[3] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 219.
[4] DEFE 7/2333 Note Air Staff requirement for a Guided Bomb, 24 June 1954.

surprisingly the specification did not even demand the performance necessary for the missile to actually be operationally effective. From the very beginning, Blue Steel was intended to be principally a symbolic weapon only. This is made plain by the operational requirement, which will now be examined.

Operational Requirement 1132 issued in 1954,[5] perceived the threat to the V-Force by 1960 as being:

> ...that the USSR will have a fighter defence using supersonic aircraft with ceilings of over 50,000 ft. The most recent intelligence survey JIC (55) 20 (final) D.R.P./p(55)18 gives little information about possible SAGW defences. We will <u>assume</u> that for the defence of vital areas the USSR will have, initially, a weapon ...having an impact range of 20-25 ml. and a ceiling above 50,000ft. The range might well be increased, say, to 50-60 miles some 4-5 years after the introduction of the first weapon.[6]

What is immediately noteworthy is the fact that in all subsequent discussion of Blue Steel's ability to maintain the viability of the V-Force, the fighter threat is never mentioned again. The reason for this is partially made clear in the original document:

> V-Bombers would not be able to use guided bombs to reduce their vulnerability to fighter attack to any great extent until a guided weapon with a range of 400 to 700 miles became available. This calls up many difficult problems of guidance and target information.[7]

In other words, the existing technology could not solve the problem of the V-Bomber's vulnerability to fighter attack by 1960, therefore it was decided to ignore this problem and concentrate on a problem that the technology could solve. This is highly significant in terms of estimating Blue Steel's potential operational effectiveness. In 1961, Sir Kenneth Cross estimated that less than one in three Blue Steels would reach their targets.[8] This was based on

[5] DEFE 7/2333 Air Staff Requirement No OR1132A: *Propelled Air-to-Surface Missile for the V-Class Bombers*. 3 September 1954
[6] *Ibid.* p. 2.
[7] *Ibid.* p. 2.
[8] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 454.

the assumption that all the bombers carrying them would reach their release points. Exactly what the figure would be if attrition due to fighters were to be taken into account did not appear in any of the discussions regarding Blue Steel, and the operational effectiveness of the missile alone against surface-to-air missiles becomes the only criteria for assessing the systems worth. It is worth noting that even by 1958, computerised air defence systems controlling missile-armed fighters were demonstrating an effectiveness that was sometimes as high as 96 *per cent* against attacking aircraft in exercises.[9]

Looking at the aircraft/missile combination as a whole, and the extent to which Blue Steel improved the viability of the force in that context, the manner in which Blue Steel subsequently became regarded as the solution to Bomber Command's penetration problems is very surprising. In many respects, it seems that the Air Staff were relying almost totally on the totemic significance of the phrase 'guided missile', much as they had relied upon the totemic significance of the phrase 'supersonic bomber' with regard to the Avro 730. The first thing to emphasise is that the 100-mile range requirement was explicitly chosen as the maximum foreseen as being technically possible by 1960,[10] not, as has already been discussed, that necessary to perform the required task. As the date of entry into service was the crucial factor, not the weapons actual effectiveness, it can be strongly argued that what the Air Staff were actually looking for was evidence of some kind of air-to-surface missile capability by 1960 as a response to Soviet surface-to-air missile defences, rather than a guarantied means of evading them.

The extent to which the acceptance of the 100-mile range weapon was a concession at the expense of British nuclear strategy, rather than a solution to its problems, is evident in the targeting difficulties that it created. Even ignoring the 750-mile penetration problem with regard to fighter defences, the 100-mile range weapon would be inadequate against even point defences if the current target set was adhered to. The threat analysis states:

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[9] Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press. pp. 257-258

> ...it seems that a 250-mile guided bomb would be needed for the attack of all targets situated in large industrial areas which may have a combined defence. Using a 100-mile guided bomb only 1/3 – 1/2 of such an area could be attacked.[11]

The targeting policy at the time was that the targets would be selected from the 40 largest cities in the Soviet Union, in itself a strategic fudge due to the fact that the 40 long-range bomber bases originally selected no longer represented the bulk of the Soviet nuclear threat to Britain.[12] Where several of the target cities formed large industrial areas with a combined defence, it would no longer possible to attack them using Blue Steel. The improvisation of strategy to fit the weapon system is illustrative of the extent to which strategy was a hostage of both technological decision-making and the politico-diplomatic requirements of the deterrent.

In particular, Blue Steel Mk1 can be seen as very much a product of the advocacy coalition within the Air Staff that favoured optimising the strategic forces for limited war with only a symbolic deterrent function. Blue Steel would ensure that a sizeable bomber fleet would be maintained. This was the principal objective of a major part of the coalition – the 'bomber lobby' – who saw it as essential for the maintenance of the RAF's 'institutional essence'. That bomber fleet would remain a viable operational system for limited war use long after its obsolescence in the strategic role, which would satisfy another major constituent of this particular advocacy coalition, who might be defined as the East of Suez/Limited war lobby.

That Blue Steel was regarded as a totemic, rather than an operationally effective, deterrent is consistent with repeated Air Staff assertions throughout the period that 'as far as global war goes, we are only interested in the deterrent.'[13] Certainly by the time that Blue Steel's in-service date had

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[10] DEFE 7/2333 Note Air Staff requirement for a Guided Bomb, 24 June 1954

[11] DEFE 7/2333 Air Staff Requirement No OR1132: *A Propelled Air-to-Surface Missile for the V-Class Bombers*, 3 September 1954 p. 4.

[12] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, pp. 43-46.

[13] AIR20/7723 DDOR1 to D of Ops (B&R) Bomber Command, 18 October 1956.

slipped to 1962, the Defence Staff were prepared to make any concessions with regard to operational effectiveness as long as something visible was in service, as Geoffrey Rippon wrote to the Minister of Defence in January 1961:

> We are likely to suggest release in June 1962...to a somewhat lower 'emergency' standard than previously planned.[14]

In fact all the 'somewhat lower 'emergency' standard' allowed was the carriage of the unfuelled weapon on board the aircraft, but not its launching.[15] By the late 1950s, the internal Air Staff opinion regarding the symbolic nature of the deterrent was reinforced by the fact that the technological ante had been raised to such an extent that Britain's ability to maintain an operationally effective nuclear deterrent was very open to question, whilst the political requirement for it remained constant. It was this state of affairs that highlighted the ambiguous nature of Britain's rationale for the deterrent, as the political requirement to maintain the deterrent demanded that new nuclear systems be developed regardless of their potential effectiveness. This had the effect of undermined the authority of threat analyses and placing them in an unfortunate limbo, which was to cause further difficulties when attempting to define the operational characteristics of subsequent systems.

However, despite the above, the advocacy coalition supporting Blue Steel Mk 1 was not unopposed within the Air Staff. There remained a strong element that saw an operationally effective deterrent as an essential means of enabling Britain to escape the implications of its 'unique vulnerability' to nuclear attack. Such an overtly totemic requirement as that for Blue Steel Mk 1 would have been an anathema to this group, but the demise of their favoured Low Altitude Bomber indicates that theirs was a minority view in 1955. However, the success of the campaign by this grouping against the similarly symbolic Avro 730 found them to be ascendant by 1957. Pressure from both this group and the Avro Company seems to have been crucial to the emergence of the Blue Steel Mk 2 project, greatly assisted by an attack of

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[14] AVIA65/1436 Rippon to Watkinson, 19 January 1961.

[15] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 213.

doubt within the defence establishment regarding the practicality of Blue Streak.[16] The Mk 2 requirement attempted to give Blue Steel the performance, particularly with regard to range, that would be necessary if the missile was to actually be capable of completely fulfilling its mission. The Blue Steel Mk 2 saga demonstrates perhaps better than anything else the strategic and technical dilemma that the British deterrent forces were facing by the mid 1950s, and graphically illustrates the increasingly confused nature of the Mk 1 requirement.

3.3 Blue Steel Mk 2

Even at the very beginning of the Blue Steel Mk1 project, it was quite plain that the stand-off bomb was a concept with a strictly limited shelf-life, in both practical and totemic terms. Indeed, one of the earliest suggestions made by DRPS staff regarding Blue Steel was that 'as the time-scale was so important we should give a date after which the missile would be valueless.'[17] Had this suggestion been adopted, the programme would not have survived beyond 1957, when the date of its anticipated vulnerability to Soviet SAM defences was revised from 1965 to 1963, and its anticipated entry into service had already slipped to 1962. Although an abstract of the operational rationale for the weapon was included in the Operational Requirement issued to firms, it is surprising to note that its characterisation of the stand-off bomb as a transitional weapon with a limited operational life-span was largely ignored by the Avro company. Avro invested a great deal of effort and resources into trying to convince the Air Staff that Blue Steel's performance could be considerably enhanced. The rather tenuous nature of Blue Steel's existing operational rationale was undoubtedly a boon to Avro in this respect, although the logic by which this worked is a classic example of the thinking which created the Cold War's notorious baroque arsenals. If Blue Steel Mk 1's performance was inadequate, and the system would not meet the operational

[16] DEFE 7/2333 SoS to DCAS, 26 March 1956

deadline anyway, it would be far better to ignore the deadline and produce a more capable weapon. The fact that after the deadline that class of weapon would be obsolete no matter how good its performance was tacitly ignored, as the logic of this would inexorably lead to a recommendation of cancellation of the whole project, and as an obvious capability gap loomed regarding the existing systems, something would have to be pulled out of the hat to replace them. Avro's lobbying concerning this soon bore fruit. Nigel Birch, the Secretary of State for Air visited the firm in March of 1953 and stated that he was:

> ...much impressed with the development potential of Blue Steel .The firm considered that by 1961/62 they could produce a developed weapon with a range of a thousand miles, travelling at Mach 2.5 and weighing about 15,000 pounds...They consider that the weapon possesses still further development possibilities.[18]

Birch added, "I shall be glad if you would set in hand an urgent Air Staff appreciation of these possibilities." A particularly notable codicil, with regard to subsequent projects, attached to these remarks argued that Blue Steel would "give to the bomber force a flexibility which has been claimed for a carrier strike force."[19] Exactly what type of 'flexibility' was meant is somewhat obscure, however this is a very early manifestation of the Bomber-vs-Carrier debate that was to increasingly dominate aircraft procurement decisions until the late-1960s, and shows that the forthcoming battle with the Admiralty was already beginning to influence the Air Staff's thinking.

However, a more compelling reason for the Air Staff to pay attention to Avro's overtures were the doubts that were already beginning to be raised with regard to what would become the Blue Streak IRBM. Writing to the Deputy Chief of the Air Staff, Nigel Birch noted that the need for Blue Steel was:

> ...increased by the discussions I have had both at the seminar in the Air Ministry and at Farnborough about the British IBM. There is little doubt that this weapon will be much later and there is much concern about the way development of this weapon is

[17] DEFE 7/2333 DRPS Meeting Minutes, 3 June 1955.
[18] DEFE 7/2333 SoS to DCAS, 26 March 1956.
[19] *Ibid.*

co-ordinated and the amount of effort which is being devoted to it. The development of Blue Steel does not seem to pose any problems comparable to re-entry. Perhaps therefore we should give its further development top priority and accept a temporary reduction of R7D effort on the IBM until we know more of American success in overcoming its formidable engineering problems, or even go for a ground-launched development of Blue Steel (which can have a 2,000 mile range) instead of the IBM.[20]

Thus the question arose as to which was the more important 'capability gap'; the one that would appear from 1960 if Blue Steel Mark 1 did not enter service on time, or that which would appear from 1965 if Blue Streak failed.

If the British nuclear deterrent had been based around a purely military rationale, the answer would have been simple. According to the Air Staff's threat assessments the whole winged high-altitude stand-off bomb concept, no matter how high its performance, had little operational credibility beyond 1965. Therefore there was nothing to be gained from the Mark 2 even if Blue Streak failed to come to fruition. The fact that this was not felt to be a binding consideration is a strong indication that the level of military content in the deterrent's rationale was not enough, even in 1957, to have a decisive influence on decision making. The political and diplomatic purposes of the deterrent required some sort of system with even the barest degree of plausibility to be in service by 1965. This illustrates the dubious authority of threat assessments based on purely military considerations when there were in operation two different criteria for judging the effectiveness of deterrent systems, one military and one political.

Things seemed to swing in favour of the Mark 2 weapon when, in July 1957, the Air Staff's threat assessment regarding Soviet missile defences became much more pessimistic, undermining the military case for the Mark 1. A DRPC paper noted that:

> ...the V-Bombers with the short range guided bomb (Blue Steel) and E.C.M. now under development, are expected to be capable of meeting the offensive requirement until 1963, but after this date may no longer be able to operate effectively.[21]

[20] DEFE 7/2333 SoS to DCAS, 26 March 1956

[21] DEFE 7/2333 Note on Operational Requirement for a Long-Range Guided Bomb, 1 July 1957.

The same paper also, however, for the first time, acknowledged that V-Bomber bases would, by 1964, 'be seriously vulnerable to enemy ballistic missiles', which was not good news for Blue Steel Mk2 either. However, this further challenge to the viability of the stand-off bomb concept was circumvented by the following argument:

> We cannot be sure of this, but we shall be able to assess the threat much more certainly in, say, three years time. However, we cannot postpone the decision to go ahead with the long-range guided bomb until then or it will not be available until 1967. Further, the expenditure in the first three years of a major project such as OR 1149 is only a small fraction of the full term development and production costs. Thus, if the decision is made now the worst that can happen is cancellation after a relatively small expenditure has been made. The price would be small for the insurance value obtained.[22]

Another argument for the powered bomb was also made; one that was to surface again later in the project. This was that the stand-off bomb would provide an additional system to the ballistic missile, so that:

> ...in this way enemy defences will be faced with two different weapons which will force them to spread their resources.[23]

In abstract terms, this was a suggestion that had some validity. However, in the politico-military context of the Cold War, suggesting that the Russians might configure their defences purely in response to British moves, at a time when the United States was already developing virtually every conceivable type of offensive nuclear system, illustrates well the air of strategic unreality that was by now pervading the British deterrent programme. For the time being, it was decided to proceed with both projects. This had an unfortunate side-effect in that Blue Steel Mk 1 remained cocooned within a circa-1954 threat assessment, whilst responses to the rapidly evolving tactical circumstances were programmed into its putative successor. These

[22] DEFE 7/2333 Note on Operational Requirement for a Long-Range Guided Bomb, 1 July 1957.

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principally involved the abandonment of rocket power for either ram-jet or turbo-jet propulsion, which would allow a far more rapid reaction time to counter the ballistic missile threat to the aircraft/missile combination on the ground, and vastly improved range to enable the carrier aircraft to avoid fighter defences.

Unfortunately, it had already become apparent that these attributes were required by 1963/64, whilst it was becoming equally apparent that even Blue Steel Mk 1 would not enter service until 1962 at the earliest. This led to further pressure to terminate the Mark 1 project. However, the Avro company, which had been given the task of developing the weapon, insisted that from a technological point of view Blue Steel Mark 1 was an essential stepping stone to more advanced variants. The Air Staff accepted this, but the proposal was made by the MoD that although trials and development should continue, its production for service use should be abandoned. The DCAS, Air Marshall Sir Geoffrey Tuttle thought, though, that it was "quite unacceptable to agree that the short range Blue Steel should not be engineered for production" and, in a rare and frank admission of the practice of bureaucratic manipulation, added:

> ...and we are handling the matter that way. Nevertheless, as things stand at the present I could, of course, not refuse to have the matter examined.[24]

Captain Hill-Norton of the DRPS did not agree. He stated at a DRPS meeting in March 1958 that:

> Blue Steel Mk 1 provided only a marginal improvement over the free falling bomb, and it certainly was not true to say that its introduction was indispensable to the timely and effective introduction of its successor. We already have a gap in our Deterrent, which would not be fully effective even by 1961. He, therefore, felt we might accept a further two or three years without much loss...The savings in R&D effort and finance that

[23] DEFE 7/2333 Note on Operational Requirement for a Long-Range Guided Bomb, 1 July 1957.
[24] DCAS to SoS, 16 January 1958.

would accrue from a decision not to continue with Mark 1 could be put into a more useful project.[25]

However, the moment the DRPS attempted to define Britain's strategic nuclear requirements, they immediately ran in to the thorny problem of attempting to determine the purpose of Britain's deterrent. Captain Sarell's opinion was "that much depended on the decision to make a contribution to the Western deterrent or to have an independent deterrent of our own." In answer to this, the committee Chairman:

> ...quoted from the draft 1957 Review saying that the words 'some measure of capability' do not imply either that several different methods of attacking Russia should be developed or that we should develop the ability to wage war against Russia on our own. The possession of an independent contribution to the Western deterrent was a political instrument and not a military one.[26]

As attempting to define the military requirements of a political instrument appeared futile, the committee turned its attention to other matters. The DRPS final conclusion with regard to Blue Steel Mk2 was that it represented:

> ...an insurance having only a short independent life: Air Staff should reconsider whether this...was the right insurance in the present financial climate or whether they would prefer to use the money to accelerate Blue Streak if this was technically possible: it was important not to accept cutting this out of the programme and at the same time slowing down Blue Streak.[27]

Blue Steel Mk 2 eventually fell victim to the Air Staff's preference for the Skybolt system. The repeal of the McMahon Act by the Eisenhower administration following the 'Sputnik panic' opened the doors to the possibility of acquiring advanced American weapons. Skybolt, with its promises of immunity to interception due to its ballistic exo-atmospheric flightpath, appeared a far more advanced weapon than Blue Steel Mk 2, and the delays already experienced with the Blue Steel project had created a very jaundiced

[25] DEFE7/2333 Minutes of DRPS Meeting, 27 April 1958.
[26] DEFE7/2333 Minutes of DRPS Meeting, 12 July 1957.
[27] *Ibid.*

attitude to the weapon in British official circles. Blue Steel Mk 2 was therefore cancelled and replaced by Skybolt as the 'insurance system' for Blue Streak.

However, by the time this happened, the needs of the Mk 2 project had ensured the continuation of the Mk 1 programme. With the notion of a capability gap from 1960 onwards still firmly implanted in the mind of Whitehall, the fact that Blue Steel Mark 1 was the only weapon under development that could address that gap guaranteed its survival, despite its now quite apparent shortcomings.

The Blue Steel programme can be characterised by four factors. Firstly, its most important requirement was that the weapon would be in service by 1960. The specification was tailored to the achievement of this even at the expense of operational and strategic considerations. Secondly, although the weapon became synonymous with the solving of Bomber Command's anticipated penetration problems between 1960 and 1965, in fact it only addressed this problem partially. Both this and the above characteristics point to a more totemic function for Blue Steel than a purely military one. Thirdly, the focus of the threat analyses changes during the lifetime of the project, from penetration survivability to pre-emption survivability. Finally, underlying doubt about the availability of a genuine second-generation delivery system brings about a requirement for a more advanced weapon, Blue Steel Mark 2, which, in conjunction with the change in perceived threat acts to complicate and confuse the focus of the all the threat analyses used. With these four factors in mind, the Air Staff's two principal complaints with regard to the project can now be examined to determine the extent to which these problems were either generated by the Air Staff themselves, or by other interests. The first of these complaints to be to be examined is that pertaining to Blue Steel's operational readiness performance.

3.4 Operational Readiness Problems

Discussing the operational readiness of Blue Steel immediately begs the question that if the weapon was largely totemic in nature, why was the Air Staff concerned about operational readiness? Answering this requires that the nature of the Air Staff as a bureaucratic entity should be recognised. Firstly, by its very nature the totemic quality of a deterrent is not something that can be openly articulated. Secondly, pursuit of operational effectiveness was largely an organic function that can be explained in terms of the Air Staffs bureaucratic structure. Whatever the thrust of general policy was, the OR department was structured in such a way that it could only create increasingly complex technological requirements and increasingly tough operational demands with each succeeding project. It had mid-ranking officers each tasked with a responsibility for one of the various aircraft sub-systems or operational tasks. To justify their existence they each had to ensure that their demands were up-rated with regard to each project.[28] Therefore even if general Air Staff policy favoured a purely totemic weapon, the OR department would still endeavour to ensure that it was a technologically superior totemic weapon.

However, the Air Staff's schizophrenia with regard to operational effectiveness was also due to it being the nexus between the competing political requirements of the Government and the operational demands of Bomber Command. The complaints regarding operational readiness largely had their origins at Bomber Command HQ at High Wycombe, whereas those regarding the weapons late entry into service came from Westminster. However, the fact that there were complaints relating to both Blue Steel's totemic value and its operational value points to a third agenda at work on the project, not merely a two-way tug-of-war between Bomber Command and the Government with the Air Staff as the rope.

Bomber Commands principal concern with regard to Blue Steel, by the time the missile entered service, was its suitability for Quick Reaction Alert duty. This was due to the prime perceived threat to the Blue Steel/V-Bomber combination changing from that threatening its penetration survivability to that threatening its pre-emption survivability. This can be attributed to the rapid emergence of Soviet medium-range ballistic missiles, which could target the V-Bomber bases.

The extent to which Blue Steel failed to meet the contemporary requirements can best be judged from the concerns expressed by the AOC Bomber Command, Air Marshall Sir Kenneth Cross to the Chief of the Air Staff, Marshall of the Royal Air Force Sir Thomas Pike in July 1960. As Humphrey Wynn records, Pike first pointed out that:

> The chances of a missile being fit for powered launch at the launch point were no better than 40% and the probability of a missile reaching its target after launch was about 75%.[29]

This meant that:

> ...of, say, six weapons on Readiness, two or at the most three will be launched and the remainder will have to be carried over the target and dropped free-fall. Of those launched, one will probably fail to reach the target.[30]

Considered in the context of a full-scale generation of 75 *per cent* of the Blue Steel force during an alert, he concluded:

> ...the low reliability implies that on present assessment only 14 missiles out of 36 could actually be launched, and 11 would reach the target.[31]

[28] Interview with Professor John Allen, 23 August 2000.
[29] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 219.
[30] *Ibid* .
[31] *Ibid*.
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The frequency with which the aircraft / weapon combination would have to be changed would also be far higher than with a free-fall bomb.[32] Sir Kenneth also stated that it was already obvious that the time needed for Blue Steel weapon generation could not be reduced below seven hours and, if defects manifested themselves, the time could be as high as 10 to 15 hours.[33]

Much of this unreliability was no more than could be expected due to the complex nature of the weapon and its guidance system. However, the most serious problems with Blue Steel from the perspective of operational readiness were a direct consequence of a decision concerning technology selection made at the very beginning of the programme. This was the choice of a liquid-fuelled rocket as the propulsion system for the weapon, and the operational readiness problems this created were principally due to its High-Test Peroxide (HTP) fuel. With regard to this, Sir Kenneth believed that the real concern was the time it would take to recover from either a full-scale exercise or an emergency generation of weapons. Owing mainly to the need to dry out missiles after draining the HTP fuel, the time could be "as long as 15 days for a Station to recover its normal peacetime preparedness"[34] with only one drying unit being scheduled for each station. Sir Kenneth added:

> No doubt improvement in performance will occur as with as with other equipments in the past, but there are so many basic faults in Blue Steel from a readiness aspect that it is doubtful whether they can be overcome.[35]

The other problems created by the use of HTP regarded safety clearances, which brought a plethora of restrictions from the Ordinance Board and more particularly the Nuclear Weapons Safety Committee. The power of these institutions within the procurement system should be noted, as they formed one of the greatest institutional obstacles to allowing the introduction of a largely totemic level of operational effectiveness. The widespread adoption, during the nineteenth and twentieth centuries, of increasingly sophisticated

[32]Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO,p 454.
[33] *Ibid.* p. 455.
[34] *Ibid* p. 455.
[35] *Ibid.* p. 219.

technology, potentially as dangerous to its user as to its target, has ensured that most branches of the military in fact spend more time and effort assimilating safety procedures than perfecting the art of killing. The centrality of the safety culture to every-day military life has given the various military safety authorities an unchallengeable grip on many areas of military activity. These safety authorities often have far more influence on military matters than operational considerations.

Fortunately, perhaps, this was particularly true with regard to nuclear weapons, and Blue Steel was no exception. Worries regarding the safety of HTP meant that the Nuclear Weapons Safety Committee withheld the authority to fuel missiles at readiness on the aircraft when the warhead was fitted, the authority to fit thermal batteries to readiness missiles and indeed, leave them installed, and it also withheld the authority to fly the aircraft with the missile, when the warhead was fitted, to a dispersal base.[36] For a not inconsiderable period of its short service life, Blue Steel could either have a warhead or fuel, but not both. When, finally, it could have both, it could not have the batteries fitted to activate the warhead. It was not until February 1965, that a means of safely installing the batteries and still being able to scramble the aircraft in the specified time was cleared.[37]

The propensity of Blue Steel to fuel leakages brought doubt about the advisability of flying the aircraft at all when the weapon was fuelled.[38] It also transpired that aircraft de-icing fluids would instantaneously explode if they came into contact with HTP. The only alternative was not to use de-icing fluids on aircraft equipped with Blue Steel. This was discovered just at the onset of the winter of 1964. Fortunately in this case a change of procedures was very rapidly evolved that effectively solved the problem.[39] In some respects, the problems with HTP were solvable by the use of additional equipment such as heaters for the missiles on QRA duty and extra provision

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[36] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 457.
[37] *Ibid.* p. 460.
[38] *Ibid.* p. 457.
[39] *Ibid.* p. 459.

of specialised drying equipment for the missiles once de-fuelled. The shortfall in the provision of the latter, which should have been foreseen, is perhaps further evidence of the Air Staff's ambivalence towards the actual operational effectiveness of the force.

However, this was not the only specialised equipment that HTP demanded. There was also a plethora of specialised storage and handling equipment that could have been avoided if the missile had been powered by a conventional kerosene fuelled engine, either a ramjet or a gas turbine.

In some respects, the technology selection for Blue Steel was a victim of radically changing perceptions regarding the threat to the manned bomber during the late 1950s. In the early 1950s, this was principally gauged to be from surface to air missiles during the penetration phase. The introduction of long-range ballistic missiles changed the focus towards the bomber's vulnerability to pre-emptive strike. Very different design choices would be made for a weapons system optimised to survive one or other of these, and different ones again for a system that could survive both. However, it is notable that both ramjets and the afterburning De Havilland Gyron Junior gas turbine were considered in late 1954 as alternative power plants for Blue Steel[40] and, indeed, both of these powerplants were already under development for other systems and would certainly be available for the in-service deadline of 1960, thus being perfectly viable for Blue Steel Mk 1. The Armstrong Siddeley Stentor rocket engine chosen, however, was a new and unproven design that would have to be specifically developed for Blue Steel. The technical reasons for choosing the rocket motor have been outlined by Professor John Allen, the deputy chief engineer of the project, as being due to the superior speed and altitude performance it could provide, which was further enhanced by the superior aerodynamic cleanliness due to suppression of the air intake needed for an air breathing motor. This also reduced the missile's radar cross-section considerably.

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[40] Interview with John Allen, 23 August 2000.

Certainly the concentration on speed and altitude performance emphasises the focus on penetration capabilities rather than readiness. However, by 1955 when the project had only just got underway, it was already becoming obvious that ballistic missiles would be a threat to the force on the ground. The specification for Blue Streak was issued that year, and the AOC Bomber Command Sir George Mills was already advising the Chief of the Air Staff that the deterrent could not be deemed viable until the force could be dispersed against pre-emptive strike. Air Staff documents in fact show the first signs of concern about this problem as early as 1952, when the specification for the Low Altitude Bomber was up-rated to give the aircraft a readiness capability similar to that of a fighter.[41] A prominent signal that Blue Steel might be considered vulnerable to pre-emption came in June 1957, when the USAF refused to provide MDAP funding for the weapon on the grounds that it was obsolete.[42] This was shortly after the Americans had cancelled their almost completed Rascal programme, a stand-off bomb of very similar performance to Blue Steel, partially on the grounds that its liquid fuelled rocket motor was unsuitable for the emerging readiness requirements.[43] However, even if the need for a QRA capability had not been apparent, the operational requirement's prime specification was that the weapon be in service by 1960, which would require all urgency if it were to be met. It would therefore appear strange that the propulsion unit with the least development progress was chosen. Why then was rocket propulsion favoured? Answering this question demands that the origins of the Blue Steel project be examined. This is a subject of some debate, not only for historians but also still for those originally involved in the project.

[41] Interview with Mr Terry Dyke, 24 August 2000.
[42] AIR 9/1666 Blue Steel Costs, 3 June 1957.
[43] Francillon, R., (1994) *Bell Aircraft since 1935*, London: Putnam, p. 236.

3.5 The Origins of Blue Steel

Tracing the design origins of Blue Steel is a complex task, as the project can be seen having originated from three separate sources. Firstly, both Stephen Twigge and Humphrey Wynn have emphasised its evolution via the Blue Boar TV guided bomb.[44] Certainly the work on Blue Steel's guidance package originated in work done for an inertially guided Blue Boar variant, Red Cheeks, and the policy decision to cancel Blue Boar was integral with the decision to concentrate, instead, on a stand-off bomb.[45] However, whilst this has a certain truth from an administrative perspective, it does not take into account either the technological or strategic origins of Blue Steel.

The strategic requirement for Blue Steel's development arose due to the Air Warfare Committee's investigations into the full implications of Soviet surface-to-air missile development during 1951.[46] It became rapidly obvious to them that such a Soviet development would seriously compromise the credibility of Britain's nuclear deterrent by the early 1960s. However, from a technological point of view, work on producing a stand-off bomb at the Royal Aircraft Establishment, Farnborough pre-dates both these particular events quite considerably. Group Captain Vielle was undertaking research on this type of weapon, and pressing for its development, in the late 1940s long before any requirement, operational or otherwise, was issued.[47] This is highly significant if the RAE's manner of conducting and promoting research during this period is taken into account.

The RAE saw its role in the immediate post war years as not merely advisory, but also in terms of advocacy. Farnborough's role as an advocate of advanced weapons systems can clearly be seen with regard to the supersonic fighter, and Concorde with regard to civil projects. Farnborough lobbied both the aviation ministries and the aircraft industry to undertake

[44] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 188.
[45] *Ibid.*
[46] Interview with John Allen, 23 August 2000.
[47] *Ibid*

these projects, for which there was little initial enthusiasm.[48] Determining the motivation for this advocacy with regard to stand-off weapons provides a key to understanding the evolution of Blue Steel's design.

In an era of exponentially advancing technological progress, the RAE's active promotion of particular technologies and applications was probably very necessary to keep the Air Staff and the aircraft industry alive to new potentialities. However the manner in which the RAE undertook research led to the possibility that the projects that it promoted were not those necessarily in the best interests of either Britian's industry or its defence policy. This problem arose because Farnborough's work, by deliberate policy, was not demand led. In this way the RAE did not so much resemble the advanced projects division of a major company, instead it was essentially an academic institution, with research agendas that were determined more by the interests of individual personalities within the Establishment rather than by external demand. As Andrew Nahum has pointed out:

> ...the surprising feature of work at the RAE in this period is that in spite of all the pressing needs and perceived dangers implicit in this world order, the direction of the research performed there...was done with a remarkably light touch. Indeed, much influential work was done because RAE scientists themselves felt that it would be strategically significant, or that it would be scientifically interesting.[49]

Nahum adds that the reason for this freedom was the:

> ...prevailing sense throughout universities and research institutes, which lasted until the Thatcher era, that advanced research should not be shackled to closely to specific ends. Useful results would certainly accrue but, the argument went, who could say where?

This was enhanced by the fact that the massive advances in aircraft performance, and the onset of the supersonic era, meant that few outside the

[48] Nahum, A., 'The Royal Aircraft Establishment from 1945 to Concorde' in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press, p. 3.

upper echelons of aeronautical research had much idea of what the future of aeronautical science held. Nahum concludes from this that:

> ...post-war British aeronautical work can be seen as being led as much by scientific research as by military requirements and military perceptions of threat.[50]

Whilst there was constant interchange with the Air Staff and RAF officers regarding operational requirements, the self–directing nature of the RAE's research carried the danger that particularly favoured lines of research might be fed into requirements that would be better met by other solutions, or in fact generate requirements that would never have been issued without hard lobbying from scientists looking for an application for their work. The predilection of aeronautical scientists for research into the technologies of high altitude, supersonic flight during this era has already been commented upon in the previous chapter regarding the Avro 730, and is of great significance with regard to Blue Steel, too, as will be discussed.

However, this was not the only major focus of research interest at the time. High Test Peroxide research was very much a favoured line of research hunting for an application in Britain during the immediate post war years, and the decision to use HTP on Blue Steel needs to be examined in this context, no matter how reasonable its selection may seem in isolation.

3.5.1 HTP Research

Hydrogen Peroxide became almost the 'characteristic technology' of post war British advanced projects.[51] The only successful all-British satellite launch, made by the Black Arrow launcher in 1971, remains the only space flight

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[49] Nahum, A., 'The Royal Aircraft Establishment from 1945 to Concorde' in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press.
[50] *Ibid.* p. 3.
[51] Spufford, F., 'Spitfires to Other Planets' BBC Radio Four, 22 October 1999 (transcript) p. 1

undertaken by a Hydrogen Peroxide powered vehicle.[52] Rocket powered interceptors, vertical take-off fighters, missiles, assisted take-off packs, submarines and torpedoes were all built to try and exploit Hydrogen Peroxide technology. Blue Steel was the only one of them to reach operational service.

Hydrogen Peroxide's promise was beguiling to scientists and engineers, providing enormous power with merely oxygen and water as exhaust products. One Armstrong Siddely engineer later stated that:

> ...the magic of the stuff was that it flowed into one end of a catalyst pack as 'cold water', half an inch later it would be fizzing like soda water, and an inch and a half down the pipe we had superheated steam. It's an engineer's delight.[53]

Part of the problem with HTP was the disparity between its enormous theoretical potential, which scientists found so bewitching, and the nightmarish experiences of those who had to handle the technology on a daily basis. The volatility that gave HTP its potential as a power source also made it highly unstable, explosive and corrosive. The Luftwaffe found that the HTP powered Me163 rocket interceptor would easily explode during heavy landings, and protective suits had to be provided to protect pilots against the caustic effects of a fuel tank rupture. Although a number of Me 163's were captured after the war, neither Britain nor the US conducted powered trials with the aircraft due to safety considerations.[54] The RAE was forced to conduct experiments with an HTP powered vertical take-off fighter model from a landing craft anchored in Cardigan Bay, after several dangerous incidents during engine development ruled-out operation from the Aberporth launch complex itself.[55] As has been seen, it was not just the safety aspects that complicated the operation of HTP systems, but the array of special ground facilities that were needed to ensure its reliability.

[52] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press, p. 205.
[53] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press, p. 7.
[54] Butler, P., (1994) War Prizes: an Illustrated Survey of German, Italian and Japanese Aircraft Brought to Allied Countries During and After the Second World War, Leicester: Midland Counties Publishing, pp. 54-55.
[55] Taylor, H.A., (1974) *Fairey Aircraft since 1915*, London: Putnam, p. 385.

Despite this the number of HTP projects multiplied. The interest groups behind HTP research were sufficiently powerful to ensure its application to a number of projects that might have benefited from an alternative technological approach. The most significant of these from a strategic perspective was the provision of rocket assisted take-off equipment for the V-Force. The RATO saga provides a good example of a pressing strategic need compromised by inappropriate technology seeking an application.

3.5.2 The RATO Debacle

The second strike capability of the V-force during the mid-1950s was dependent on adequate dispersal. However, there were not sufficient airfields in the United Kingdom with long enough runways from which a fully laden V-bomber could take-off. Therefore it became essential that a method be derived that would enable the aircraft to use shorter runways. The most obvious was Rocket Assisted Take Off (RATO). The Royal Navy had had considerable experience of using this technique during the Second World War,[56] and the USAF's Strategic Air Command had adopted it for the B47 Stratojet.[57]

However, instead of adopting the usual simple, disposable, solid fuel rockets, which could be easily stored in existing facilities and handled and installed without much specialist training by RAF armourers, an HTP system was evolved for the V-force. This, the De Havilland Sprite RATO unit, was a self-contained pod consisting of a liquid fuel rocket motor and parachute recovery system.[58] The Luftwaffe had used a much simpler and smaller unit during the war. This was a 'cold' unit that just used the superheated steam generated by decaying HTP to create thrust. In one application, eight of these were

[56] Thetford, O., (1991) *British Naval Aircraft since 1912*, London: Putnam, p. 165.
[57] Peacock, L., (1987) *B47 Stratojet*, London: Osprey, p. 36.
[58] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press, p. 25.

used to assist the Me321 tank-carrying glider into the air.[59] For the V-Force, however, a far more powerful 'hot' unit was evaluated, in which the HTP became the oxidizer in a fully-fledged rocket motor.

Although extensively tested, the logistical requirements made the system extremely expensive, with its requirement for special facilities and specially trained personnel. It did not at all meet the need for a system that could be deployed at a dispersal airfield for 30 days with the minimum support facilities. There were also a number of safety issues, not least of which concerned the effect of a motor failure on take-off. The usual solid fuel rocket system got round this by having large numbers of small units attached to the fuselage. If any failed there would just be a slight loss of thrust, not automatically fatal. With the Sprite, due to its size, there were only two units, one attached to each wing. A failure would result in the aircraft cart-wheeling to destruction. Given the extremely dubious level of safety inherent in some British nuclear weapons at the time, this was a totally unacceptable risk.

Problems such as this led to the cancellation of the project, and the V-Force's take-off capabilities remained limited until the arrival of the Mark 2 aircraft with their vastly more powerful engines. Attempts to apply HTP other fields were similarly frustrated. The submarine project resulted in the completion of the submarines Explorer and Excalibur, but these remained experimental vessels only. This was partly due to the emergence of nuclear power, but also the short range and unreliability of the vessels, which were nicknamed the 'Exploders' by the service.[60] This is further underlined by the ill-fated attempt to produce an HTP powered torpedo, which ended disastrously when one exploded onboard the submarine HMS Sidon, sinking it and killing 13 men.[61] The attitude of the Navy towards HTP by the end of the 1950s is encapsulated by the words of one submariner, who opined that 'the best thing

[59] Encyclopaedia of Aircraft (1982) London: Orbis, p. 3986.
[60] Ring, J., (2001) *We Come Unseen: the Untold Story of Britain's Cold War Submariners*, London: John Murray, p. 51.
[61] Preston, A., (2001) *The Royal Navy Submarine Service*, London: Conway Maritime Press, p. 163.

we can do with HTP is to pursued a potential enemy to adopt it.'[62] Ironically, the Russians did exactly that and it is widely believed that an HTP torpedo explosion sank the nuclear submarine Kursk in August 2000.[63] Why Britain persisted with HTP for so long can largely be explained by the ethos of Britain's science and technology policy during the immediate post war years.

3.5.3 Science and Technology Policy

Scientific and technological development in Britain in the aftermath of the war can be broadly characterised as an effort to exploit particular areas of expertise, so as to create advanced technologies with which to out-flank more efficient and productive economic rivals, particularly the USA. The Comet jet airliner project is probably the prime example of this.[64] It is noteworthy that such a strategy, prioritising as it does a few advanced projects in preference to the continued refinement of existing products, was also one that best suited the emphasis on long term research that government research institutes favoured, and gave them the maximum influence as well. By taking the focus away from competition with the United States in the fields of conventional technology, in which it would merely be undercut and out – produced, British scientific and technological developments became dependant on locating fresh areas of expertise to exploit. Although jet-engine development, computers, and nuclear technology were all ripe existing fields for this, more were needed. A possible source for this was the recently defeated former enemy, Germany. In the months following the end of the war, teams of specialists from all Allied countries scoured the former Third Reich for technological secrets. Agreement was reached regarding the allocation of material located, and whilst the USA and the Soviet Union divided the spoils of German V-Weapons research between them, the British acquired German research into Hydrogen Peroxide.

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[62] Gunston, B., (1975) *Submarines in Colour*, Poole: Blandford Press, p.159
[63] 'Torpedo Test May Have Sunk Kursk' *The Times*, 28 August 2000.
[64] Birtles, P.J., (1967) *The de Haviland Comet*, Leatherhead: Profile Publications, p. 3.

As the major facilities concerned with HTP research and production were in the British Zone of Occupation it would seem that there was a geographical basis for this. However, although it is to be expected that the reality did not match the agreement, the agreed redistribution of the captured knowledge was not based on geographic location.[65] Certainly the other allies would have been entitled to claim a share of the research if they had been interested. Therefore, there is a slight question mark as to why Britain got the German HTP research. Whether this was because the other allies, particularly the Americans, had little interest in this line of research and so left it as a scrap for the British, or whether the British already had an existing interest in this subject is open to conjecture. Scientific advice given to British intelligence sources during the war had initially surmised that both the V1 and V2 were powered by HTP, tending to indicate that there was some prior awareness of the potentialities of this technology. Certainly DA Baxter of the RAE was heavily involved in the assessment of German progress in this field,[66] which is also possibly why HTP research was allocated to Farnborough. It is notable that the RAE had to specially establish a rocket research outstation at Westcott in Buckinghamshire to handle the HTP project, whilst other advanced propulsion projects were undertaken by other research institutes.[67]

It might be argued that in some respects, if it had to be powered by a liquid fuelled rocket, HTP was the best choice for an air-launched missile such as Blue Steel. It was easier to store for long periods than liquid oxygen, and it did not require the potentially unreliable ignition systems of other oxidant/fuel combinations, as it would spontaneously ignite kerosene. Professor John Allen is convinced that the choice of power plant was correct at the time and was chosen on purely practical grounds.[68] However, the decision was also the product of an environment in which HTP research had many vested interests, and applications for which were actively being sought. The

[65] Lister, L., *High Test Peroxide for Propulsion Purposes*, Paper given at RAE Society Lecture 1997, (transcript) p. 7.
[66] *Ibid.*
[67] *Ibid.*
[68] Interview with John Allen, 23 August 2000.

propagandist attitude taken by Farnborough with regard to other technologies was certainly not absent with regard to HTP.

It must also be asked when, in fact, the decision to use a rocket motor was actually taken. As the entire nature of nuclear warfare was evolving with dramatic speed during the 1950s, this is a point of great significance with regard to Blue Steel's operational viability. It also raises the question of whether Blue Steel chose HTP, or HTP chose Blue Steel. It is important to note that both John Allen and Hugh Francis, the project's Chief Engineer, have stated that all the options were thoroughly reviewed when the project began at the end of 1954. However, John Allen has inferred that the design decisions regarding Blue Steel were taken some two years earlier, when the Air Warfare Committee first investigated the need for a 'stand off bomb.'[69]

Certainly whatever appraisal was done in September 1954 confirmed an already well-established configuration. Blue Steel bears a striking resemblance to the Red Cat missile design prepared for the Low Altitude Bomber Project by the RAE's weapons division in 1953.[70] Even this design almost certainly had earlier origins, as although the Low Altitude Bomber Committee discussed in detail the options for virtually every aspect of the missiles performance and interface with the aircraft, one thing that never entered the discussion was the weapon's layout. This suggests that an existing design layout was merely adapted for the task, which already incorporated the dual chamber rocket motor, monoplane 'twist and steer' aerodynamic controls and canard flying surfaces that came to characterise both Red Cat and Blue Steel. This may well have been the basic design proposal for the Air Warfare Committee. Due to the exponential development of aviation technology during the 1950s, this puts it in a markedly different strategic and technological environment to that existing barely four years later when the Blue Steel project officially commenced. What strategic concept influenced this design, if any, is unknown, but it would not resemble the type of strategic considerations that would have to be taken into account by 1955.

[69] Interview with John Allen, 23 August 2000.

However, of greatest significance is the possibility that it was not a strategic consideration that prompted the design at all. The unique ability (at this time) of the rocket motor to provide Mach 2 performance – albeit for a fairly small airframe over a relatively short range –may have suggested the concept of the stand-off bomb in the first place purely as an application for this technology with no reference to strategic necessity. It seems highly probable that this was what prompted Group Captain Vielles efforts.[71]

Even if there is no direct connection between Blue Steel and these earlier designs, their 'dead hand' can be seen as influencing the project through the specification itself. This is evident in the fact that the specification for Blue Steel only required a range of 100 miles, despite a 700-mile penetration problem. This was based on the assumption that it was the best range that could reasonably expected from such a weapon by 1960. This figure was almost certainly based on the estimated performance of the original RAE design studies, which were all based on the use of a rocket motor, as a turbojet could have been expected to achieve considerably more range. Therefore, as the specification's required performance figures were informed by studies that almost certainly originated as applications for HTP rocket technology, it is hardly surprising that an HTP powered weapon was what emerged.

It appears that despite the inherent problems of HTP, that the Air Staff at least should have been more aware of, Blue Steel was almost pre-destined to receive an HTP propulsion unit. If the general enthusiasm for HTP within the RAE and other government establishments did not sweep up Blue Steel's design staff, then the fact that the specification, if somewhat unwittingly, had been virtually written around the use of an HTP unit would also act to ensure its adoption. Neither of these influences were originally motivated by the tactical and strategic needs of the deterrent, but by the need to find application for a particular technology.

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[70] AVIA 54/749 Report 'A Missile For 0R314' (undated).

The nuclear deterrent, despite being the number one priority with regard to the Government's defence policy for most of the 1950s, was in fact hostage to the priorities of those trusted with the implementation of that policy. Just as the needs of the Low Altitude Bomber project were secondary to the Ministry of Supply's industrial strategy, so the needs of the Blue Steel project had to fit within the favoured research interests of the RAE and the rest of the defence research establishment. As will be seen, however, this was not the only 'alternative' influence to thwart the Air Staffs intentions for Blue Steel.

3.6 Programme Delays

As far as the Air Staff, the Ministry of Defence and the Government were concerned, the biggest shortcoming of the Blue Steel programme was the enormous delay in getting the weapon into service.[72] From the very beginning, the potential for serious delay to the project was obvious. In December 1955, the Deputy Director of Operational Requirements wrote to the ACAS(OR) Of all the problems that might delay this ambitious target, the DDOR suspected that the greatest of these might be the time required for trials:

> ...as you know, the Blue Steel development programme is aimed at getting the missile into service in 1960...Trials may be the holding factor in the programme as there is doubt as to the ability of any trials team to complete the work at Woomera in the estimated time of two years.[73]

The trials indeed proved to be a major source of delays, and have been the target of much criticism regarding the project.[74] However, as the DDOR was only too aware, there were several problems that confronted all guided weapons trials teams in Britain during the 1950s.

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[71] Interview with John Allen, 23 August 2000.
[72] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p.202.
[73] AIR2/16984 DDOR5 to ACAS (OR) 6/12/55.
[74] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p.195.

Britain's general lack of facilities for guided weapons trials, particularly when the overall demands of the guided weapons programme are considered, must be acknowledged when Blue Steel's problems are examined. These problems were due to a number of factors. Firstly and unavoidably, there were problems of geography. In a densely populated island such as Britain, it was extremely difficult to find suitable land on which build test facilities and, even when such land became available, it was not always possible to get planning permission for the facilities. Armstrong Siddeley suffered serious delays in their rocket engine testing programme due to a public enquiry into the building of the test stands at their works in Ansty, and this was not an isolated occurrence.[75] This caused a general shortage of test facilities, particularly for large rocket motors, which presented enormous noise and safety problems yet which also needed to be near the relevant company's works.

It was also a fact that the British weather was also not conducive to the testing of guided weapons, and that the alternative use of the Woomera test range in Australia presented formidable logistics problems. As the MoD's chief scientist was to comment later in the programme:

> Delays through unserviceability of aircraft for tests are very familiar. Shortage of range capacity, to exploit the small amount of fine weather we get in this country, is another chronic trouble...The moral seems to be that we ought not to spread ourselves over such a wide range of projects.[76]

'Red tape' at the Ministry of Supply also hampered trials. Obtaining suitable telemetry equipment through official channels proved so long winded and ineffective that it generally proved easier to buy suitable equipment and components from government surplus stores.[77] These problems caused

[75] AVIA 65/1289 Robertson to Gregory, 9 Febraury 1959.
[76] AIR8/2145 Chilver to Watkinson, 23 March 1961.
[77] Interview with Terence Dyke, 24 April 2000.

considerable difficulties for the trials programme, making it a focus for ministerial concern and criticism.[78]

Whilst the trials were perceived as the principle cause of the delays, this perspective could, in fact, partially be explained as a product of the 'social hierarchy' of the aircraft industry. Terrance Dyke, who headed the Blue Steel trials programme, was acutely aware of the extent to which the company's trials personnel were regarded as 'poor relations' by people on the design and manufacturing side, particularly the 'new aristocracy' of the aerodynamicists.[79] This in turn led to a tendency for the trials organisation to be 'dumped' with the blame for many delays that were not of their making. Any delay in design or manufacture would inevitably cause a corresponding delay in the trials. However, the delay often came to be perceived as being a 'trials delay'. This was exacerbated by the fact that there were so many small delays. As the Defence Minister, Harold Watkinson, was to comment, Blue Steel was seemingly 'bogged down by minor problems' from the very beginning of the project.[80] As early as September 1956, the Deputy Director of Armaments had already reported:

> The second Blue Steel Progress meeting was held yesterday and it revealed serious deficiencies which can result in setbacks to the programme unless immediate action is taken. The particular deficiencies are gyros and accelerometers for the inertia navigators and engines for missile propulsion.[81]

At a progress meeting in May 1958, a long list of components still outstanding from subcontractors was presented,[82] whilst in August it was pointed out that a lack of suitably trained Royal Australian Air Force personnel was holding up maintenance on the V-Bomber trials aircraft.[83] Later the same month, the Chief Engineer had to report that Avro had underestimated the number of jigs required for producing the trials weapons.[84] However,

[78] AVIA65/1436 Watkinson to Sandys, 18 May 1960.
[79] Interview with Terence Dyke, 24 April 2000.
[80] AIR8/2145 Watkinson to Thorneycroft, 1 Feburary 1961
[81] AVIA 65/1436 DDArm to DGTD (A), 25 September 1956.
[82] AVIA65/1436 Blue Steel Progress Meeting Report, 15 May 1958.
[83] AVIA65/1436 Blue Steel Progress Meeting Report, 13 August 1958.
[84] AVIA65/1436 AD/RAF/B1 to DAP, 23 August 1958.

despite all the difficulties inherent in the trials process, two particular decisions regarding the trials programme can be seen as contributing in a major way to the delays that afflicted Blue Steel. One was the decision to use semi and full-scale models as part of the trials programme, whilst the other was the decision to stage the full-scale trials simultaneously in Wales and Australia.

3.6.1 Model Trials

With regard to criticism of the model trials, it should be noted that the practice of using free-flying scale models for aerodynamic evaluation of designs was a marked characteristic of British aeronautical research during the 1950s. In the case of large aircraft like the V-bombers, the models might be as large as 1/3 size and be piloted aircraft in their own right.[85] This was a practice also occasionally used in the Soviet Union, and was not totally unknown in the USA, one of the few examples being the Bell X9 research rocket, which acted as a sub-scale model for the United States Blue Steel equivalent, the GAM 63 Rascal.[86]

This practice largely came about in Britain due to the shortage of wind tunnel facilities during the early to mid-1950s. Manufacturers until then largely relied upon those of the RAE. The Avro company, for example, did not have a wind tunnel of its own when design of the Vulcan was being undertaken. This was largely a legacy of the 1920s and 1930s, when the main focus for aeronautical progress had taken place in the field of airframe structures rather than aerodynamics. Most companies had a 'Chief Aerodynamicist' but he would usually also be the only aerodynamicist. Again, Avro did not even have a post of Chief Aerodynamicist till post war.[87] The development of the gas turbine, which pushed aircraft performance into the transonic zone, with all its

[85] Jackson, A., (1973) *Avro Aircraft since 1908*, London: Putnam, p.189.
[86] Francillon, R., (1994) *Bell Aircraft since 1935*, London: Putnam, p. 236.
[87] Jackson, A., (1973) *Avro Aircraft since 1908*, London: Putnam, p. 73.

danger and attendant mysteries, ushered in an era of the primacy of aerodynamic research which Britain was ill-equipped to cope with on the scale necessary. This was particularly acute as the Air Staff had decided to skip a generation of combat aircraft for economic reasons, which also dealt a hefty blow to traditional British engineering empiricism. Therefore free flying models became a standard means of circumventing Britain's aerodynamic infrastructure shortfall.[88] However, David Andrews, aeronautical consultant and a former senior Armstrong Siddeley designer, has voiced severe criticism of very concept of the model testing, which was at the core of the Blue Steel trials programme:

> No one has ever been able to afford to await the results of free-flight testing once a project has been committed. Design and development of a model is a project in itself, demanding first rate design and development effort, which – if available at all – is desperately needed at the start of the design of the weapon. Every bit of the development experience lavished on a model is wasted because it is irrelevant to the weapon. By the time the results are obtained from model testing, it is too late to take account of them. Even when results are available there must be doubt about their relevance to the full size vehicle.[89]

David Andrew's analysis of the actual utility of model research, and its effect on the effort available for full-scale research, is substantiated by the Air Staff's own findings. As early as 1955, the limitations of this approach were highlighted in a report by OR16 on shortcomings in British aircraft development practices.[90] In light of this, it is somewhat surprising that the Blue Steel trials programme evolved around this practice. With respect to the delays that this might have caused to Blue Steel, it is worthy of note that Hugh Francis, the project's Chief Engineer, justified these trials principally on the basis that they were predominantly required to familiarise personnel with the operating procedures for these weapons, rather than as aerodynamic aids.[91] This is somewhat puzzling in that it is unclear to which personnel this might apply. The range personnel at Aberporth needed little introduction to

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[88] *Ibid.* p. 439.
[89] Letter from David Andrews to John Allen, 11 June 1996.
[90] AIR9/1666 Report on Swift Project, 24 June 1956.
[91] Francis, R., 'The Development of Blue Steel' Paper given at RAE Society Lecture 1965, (transcript) p. 3.

handling guided weapons, and the RAF's No4 JSTU at Woomera had little involvement in the model trials. It is possible that this justification was, in fact given in order to deflect criticism of the model trials programme, given that in 1965 much of the acrimony that surrounded the Blue Steel project was still evident in certain circles.

3.6.2 The Round 6 Fiasco

Although the extent to which the model trials were a source of delay is a subject of debate, there was one decision concerning the trials that was recognised at the time as being an enormous mistake. This was the decision to split the full size trials between Woomera and Aberporth, and it became the principle source of the noted acrimony regarding Blue Steel. It is notable that this decision was made by the Ministry of Supply, not by the Avro trials organisation, and can be seen as an ill-advised attempt to inject some haste into the project, possibly due to mounting frustration with the Avro management. Splitting the trials seemed to carry the advantage of gaining several months by avoiding the long journey out to Australia for a lot of the test equipment, therefore enabling the trials to start earlier. The aim of this was almost certainly to bring forwards the test of Round 6, the first missile to fly with the full guidance system installed.

This test, in itself, was not of significantly greater importance in terms of knowledge to be gained than most of the other trials, as it would not be attempted until all the sub-systems of the weapon had already been proved reliable. However, it was of enormous symbolic significance, particularly to the Air Staff and Government Ministers, as ACAS (OR) emphasised in a note to a senior official:

> The Air Staff has always regarded the firing of the first navigated round as an essential demonstration of a progressive and logical development plan...Full

> performance free-flight trials as early as possible in a programme are essential to establish confidence in the validity of the concept.[92]

Therefore the trial was more about raising confidence and proving the development plan rather than proving the missile itself. If this could be done then it would take the political heat off the development programme, and subsequent delays would not seem so serious. Unfortunately this plan totally backfired.

The use of Aberporth as a means of speeding the trials in fact virtually brought them to a standstill and exacerbated the systems delays. In order to accommodate full-scale firing at both sites, one of the two trials aircraft originally converted for Woomera had to be sent to Wales. This meant there was no back-up aircraft on either side of the globe. The Aberporth aircraft almost immediately fell victim to a string of minor serviceability problems. An Air Staff memo noted, almost despairingly, that the aircraft:

> ...was damaged whilst loading; there were leaks in the fuel tanks; there were difficulties with the refrigeration equipment; there were difficulties with the navigating equipment.[93]

When the aircraft was serviceable, either the Welsh weather conspired against the trials or errant shipping intruded onto the range. After nearly a year of frustrations, attempts to launch Round 6 at Aberporth were abandoned, and Round 10 at Woomera was to become the first navigated round to be fired, over a year after the original firing date for the test. The desired effect of relieving political pressure with a successful early trial was now reversed. The delays to the Round 6 firing instead roused a political hornets nest, all the way up to Harold Watkinson, the Minister of Defence, and led to what Humphrey Wynne has described as an unparalleled bitterness by Whitehall towards a major British defence project.[94]

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[92] AIR8/2145 ACAS (OR) to PS to SoS, 27 January 1961.
[93] AIR9/1666 SoS to ORD, 16 February 1962.
[94] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 202.

This bitterness is clear from the tone of Whitehall correspondence regarding Blue Steel. This correspondence also illustrates the extent to which the apex of the policy-making pyramid was hostage to the decisions of technologists on matters pertaining to the nuclear deterrent.

The deterioration in the Government's attitude towards the project was already visible before the Round 6 fiasco. In June 1960, Watkinson wrote to Zuckerman, the Ministry of Defence's Chief Scientist that "the Blue Steel position is quite unacceptable. We must see what we can achieve from the firm."[95] He had also already begun to put pressure on his Cabinet colleagues. Duncan Sandys, recently demoted to Aviation Minister, had received this note from Watkinson in May:

> Both the Secretary of State for Air and I are extremely worried about Blue Steel. We are all committed to the statement that Blue Steel Mark 1 will be available as the weapon for the Mark II V-bombers as they come into service. At the moment, there seems to be no hope at all that it will in fact be ready for the Vulcans as they begin to come in next year...I think we must take some special action, or we shall be in a very serious position. If you agree, the Secretary of State and I would like first to see Sir Roy Dobson or Mr Kay, his Managing Director to impress on them personally the need for steps to be taken to give a massive acceleration in production and delivery.[96]

The fact that the capability gap existed had now become widely acknowledged in both the press and Parliament. Blue Steel had been touted as its solution, vastly raising the weapon's political profile. At this stage, the weakness in the program was identified by most within the Air Staff and the MoD as the fault of Avro's project management:

> There is plenty of evidence of a weak management structure in the missile division at AV Roe, and this may yet need further overhauling.[97]

The 'overhauling' of Avro's management structure was a panacea that Avro purported to have undertaken on several occasions. Criticism was raised in

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[95] AVIA65/1436 Watkinson to Zuckerman, 24 May 1960.
[96] AVIA65/1436 Watkinson to Sandys, 18 May 1960.
[97] AIR8/2145 ACAS (OR) to PS to SoS, 27 January 1961.

1958, but was attributed to the particular demands of the early research phase of the project. Once the project 'broadened out', the Ministry of Supply were assured the situation would improve.[98] By January 1961, Geoffrey Rippon was reporting to Watkinson:

> We were at that time alarmed at AV Roe's rate of progress and had for some time past been putting strong pressure on AV Roe to review and improve their whole organisation...Having completed their review and strengthened their organisation, particularly on the Trials side, the firm are confident that, despite delays to date, they can hold to the programme which would permit initial release in May 1962.[99]

However, by April 1961, the Round 6 crisis was at its peak and the press had started to question the management of the project. Yet another Minister of Aviation, Peter Thorneycroft received a thinly veiled 'warning note' from Watkinson, which revealed the full depth of Governmental concern:

> I am anxious that you should not get the feeling that I am breathing down your neck about Blue Steel. I entirely recognise that the management of the business is your responsibility and I do not want to interfere...On the other hand, the House of Commons regards a Minister of Defence as having some responsibility for everything of importance in the defence programme and in particular for anything to do with major weapons. In fact, in the case of Blue Steel, one might say that the standing of the Government as a whole was involved...our colleagues may be wondering whether the firm have let us in for something of a scandal that will discredit both British industry and the Government, and whether Blue Steel and Skybolt are now so close together that the expense of Blue Steel is difficult to justify.[100]

Although Watkinson had something of a reputation as Macmillan's 'enforcer', the letter was actually sent on the advice of RC Chilver, who said of Thorneycroft:

> It is important to ensure that he is on your side in wanting to eliminate further risks of delay, and does not get diverted into defending his own people against criticism... you should suggest to him that as this is something that engages the reputation of the Government he should circulate a paper on it at the defence committee [101]

[98] AIR9/1666 Blue Steel Progress Report, 18 February 1958.
[99] AVIA65/1436 Rippon to Watkinson, 7 January 1961.
[100] AVIA65/1436 Watkinson to Thorneycroft, 19 January 1961.
[101] AIR8/2145 Chilver to Watkinson, 23 March 1961.

The resignation with which Whitehall was, however, forced to accept the Blue Steel situation becomes apparent in the Assistant Under-Secretary for Air's comment on the Watkinson note and its proposal to raise the matter via a paper for the Defence Council:

> The paper was inspired by the knowledge that the Daily Telegraph were about to publish an article suggesting that Blue Steel was so behindhand that it would have to be cancelled...It is questionable whether any good will come of ventilating this issue in the Defence Committee. There are not, on the face of it, any practical steps which can be taken to accelerate the Blue Steel programme; on the other hand this may be an opportunity for the Treasury in fact to suggest to the Chancellor that we should cut our losses by cancelling the weapon.[102]

Worries about the Treasury were not ill-founded. By this stage, the cost of the Air Staff's 'cheap fix' had also become a major worry. Cost estimations for the Blue Steel project submitted to the Government's Chief Scientist in May 1960, showed that in 1955 the project was estimated to cost £12.5 million. By February 1958, this had risen to £19 million. However, between then and December of the same year, the estimate rocketed to £35 million. By the time the report was issued, the cost was estimated at £55 million. In a note to Zuckerman, the DRP outlined his perception of the reason for this immense escalation of costs:

> The main reason for this re-assessment is that AV Roe have considerably and consistently underestimated their task.[103]

The political attitude towards Blue Steel's problems was not assisted by the rapid progress exhibited by the United States current stand-off weapon, Hound Dog. By comparison with Hound Dog, Blue Steel appeared in a highly unfavourable light, certainly as far as Harold Watkinson was concerned. In December 1960, he commented to the CAS that:

> The Americans already have Hound Dog in service. It is a more advanced weapon than Blue Steel and they started after us. Yet Blue Steel seems to be bogged down in

[102] AIR8/2145 AUS(A) to PS to SoS, 17 March 1961.

> minor technical problems, and we shall have to make concessions on the operational requirement to get it into service even at the present date.[104]

The fact that, in four years, the Americans had designed, developed and got into service a weapon that, from an operational point of view, was far more capable than Blue Steel, being turbojet-propelled and having seven times the range, was a source of particular rancour to many in Whitehall. In many respects, however, it was an unfair comparison. Blue Steel was Britain's first large powered and guided bomb. The first American weapon in this class, Rascal, took 11 years to reach fruition, by which time it was totally obsolete. Also, notwithstanding the use of Hound Dog to berate Blue Steel, neither the Government nor the Air Staff would accept Hound Dog in lieu of Skybolt when it was offered to them. Anecdotal evidence has suggested that Macmillan thought the name detracted from the extent it could be taken seriously as a weapon.[105] If there is any truth in this, it illustrates the extent to which assessment of operational effectiveness is inadequate for defining the political effectiveness of a deterrent system.

Many of the delays that impacted upon Blue Steel's operational effectiveness can be attributed to the circumstances in which weapons development occurred in Britain during the immediate post-war years. Two sources of delay can be characterised as possible errors of judgement by decision–makers: the model trials issue and the Round 6 fiasco. However, there is a further source of delay that sheds a very different light on the significance of Blue Steel's belated entry into service. This is the delay caused by the adoption of a stainless steel airframe for Blue Steel. The unanticipated difficulties with the steel airframe caused perhaps the most serious delay of all those that afflicted the programme. As early as the end of 1956, the model trials programme was already six months late due to the problems Avro had experienced in stretch-forming stainless steel.[106] John Allen has estimated

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[103] AVIA 65/1436 DRP to Zuckerman, 5 May 1960.
[104] AVIA 6/19059 Watkinson to CAS, 12 May 1960.
[105] Neustadt, R., *Report to the President: Skybolt and Nassau*, Aberystwyth Nuclear History Archive (copy) p. 40.
[106] AVIA65/1436 AD/RAF/B1 to DAP, 23 August 1958.

that resolving this problem delayed the programme by at least 18 months in total.[107]

This is of importance as it was a problem with which the project need never have been troubled if the Air Staff's threat analyses had been the guiding light of the project. The reason that this was not so throws its own illumination on the authority of threat analyses in the British strategic weapons procurement process, and the hierarchic levels at which decisive decision making power could be wielded in the procurement system.

3.6.3 The Influence of Personality

Whilst bureaucratic, political and industrial influences are all manifestly evident in the literature regarding weapons procurement, and have been discussed elsewhere in this study, one powerful factor that is often overlooked with regard to procurement issues is that of personality. Whilst it has occasionally been acknowledged with regard to politicians, such as Sandys or McNamara, or military men such as Mountbatten or Le May, the effect that the personality of a technologist may have on the course of a project is often neglected.

The Blue Steel project is particularly revealing in this respect. The impact on the project of the personality of its Chief Engineer, Robert Hugh Francis, was far reaching and provides a key to understanding many aspects of Blue Steel's development.

According to those who knew him, Hugh Francis was notable in two respects. Firstly, he was an engineer of extreme vision, with a predilection in his work for the advanced and the unconventional. This was evident whether he was working in fields that were as archaic in the late 1940s as flying boat design,

[107] Interview with John Allen, 23 August 2000.

or as advanced as guided weapons were in the mid 1950s. Secondly, he was an extremely shy man, difficult to know and given to excessive secrecy regarding his work.[108] In some respects, these qualities may seem to be ideal for leadership of an advanced and highly secret nuclear programme. This, however, was not to prove the case with Blue Steel. Francis' vision was perhaps greater than the project originally required, and his shyness and obsessive secrecy led to serious communications breakdowns regarding both the purpose and the management of the project.

It could be argued that Hugh Francis' personality did not merely create structural problems for the project. There is reason to believe that Francis had a very particular view of what the project should be attempting to achieve, and was not afraid to pursue this even when knowingly at variance with the Air Staff's wishes. Hugh Francis certainly had the opportunity to do this, largely due to three factors. Firstly, as the senior technical authority on the project, his views were extremely difficult for administrators and planners to challenge, particularly as Blue Steel represented a totally new technological concept in many respects. Secondly, the ministerial project management structure above him was deeply flawed. The report on the Blue Steel Project prompted by the Round 6 crisis noted that one of the three major shortcomings of the project was:

> ...the decision to divide development responsibility between a number of branches in C.A. and C.G.W.L which made executive control of the project as a whole exceedingly difficult.[109]

This is yet another manifestation of the Ministry of Supply's deep reluctance to adopt the 'weapons system' project management approach in its entirety. As has been discussed in detail with regard to the Low Altitude Bomber project, this was because it challenged Ministerial control of projects and, indeed, undermined the whole rationale for having such a Ministry. This fatal division of management oversight above Francis gave him immense opportunities to run things as he wanted. The degree of control over the

[108] Interview with Professor John Allen, 23 August 2000.

project Hugh Francis regarded as necessary is best summed up by his deputy, Professor John Allen. With regard to who decided the most fundamental design decisions, such as the degree of development potential to build into the weapon, Allen believes

> I think Francis decided...I would think that Francis would have taken all these big decisions and he wouldn't have had them handed down to him, either by Farren or Dobson [Avro senior management] or the Air Staff.[110]

Allen's judgement of this is based his 28 years experience of working with Francis. That even he, Francis' deputy could not be absolutely certain as to the origin of these decisions reveals the third factor that provided Hugh Francis with his control over the project.

This third factor was Hugh Francis' notorious personal predilection for secrecy. This was a by-product of his shyness, which meant that few either above or below him knew the true extent of what was happening with regard to the programme. One illustration of the extent of this secrecy is Francis' relationship with Terry Dyke. Despite the fact that Dyke was head of the trials programme, he had been involved with the project for several weeks before Francis gave him an inkling of what it involved, and even then he was only informed that Blue Steel "was something along the lines of a small fighter aircraft." Dyke finally had to approach John Allen to be fully briefed.[111] Despite the undoubted secrecy of the project, Francis' attitude was regarded as unusual by his staff, almost all of whom had been involved previously in other equally secret projects.

Whilst this obsessive secrecy infuriated many of his subordinates and led to accusations of an inability to delegate both from the Air Staff and colleagues, it was also a useful tool that Francis could have used to his advantage to consolidate his control over the project. The interface between technologists and administrators was fraught with difficulty, as is frequently the case with

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[109] AIR8/2145 Review of Blue Steel Programme, June 1961.
[110] Interview with Professor John Allen, 23 August 2000.
[111] Interview with Terence Dyke, 24 April 2000.

projects such as this. There was a mutual lack of trust and the technologists experienced difficulties in explaining successfully the nuances of the art of weapons development to the administrators. Unwarranted intervention caused much effort to be diverted to the answering of questions that in fact had little relevance to the progress of the project. Hugh Frances' virtual wall of silence was but one answer to a universally perceived problem amongst technologists.

However, both Francis' supporters and detractors agree that he took this attitude to extremes. John Allen for example recalls that essentially Francis never told the government anything.[112] At progress meetings, Francis dealt only in broad generalities whenever he could, giving away as little as possible.[113] As his reticent manner was well known, it did not arouse the suspicion it might have done from anyone else. Francis also kept his deputy, John Allen, away from as many official meetings as possible. Allen attributes this to the almost paternal nature of Francis's relationship with him, which led to a desire by Francis to keep him 'unsullied' by the sordid politicking of such events.[114] Whilst this is probably true, it might also be that Hugh Francis did not want John Allen to have too great an awareness of the Air Staff's requirements, lest Allen might challenge his decisions. It is likely that he was also concerned in case Allen let slip anything unfortunate to the Ministry representatives.

In addition to this, it seems that Francis went to some lengths to insulate the project from the Avro Board. Francis had been recruited from the RAE specifically to establish Avro's Advanced Weapons Division to produce Blue Steel. The company had originally intended that a member of their design staff, AJ K Carline, who was close to several senior members of the board, should be Francis's deputy. However, at their first meeting, Francis was so hostile towards Carline and dismissive of the ideas Carline had for the aerodynamics of the weapon that Carline told the board that there was no

112 Interview with John Allen, 23 August 2000.
113 Interview with Terence Dyke, 24 April 2000.
114 Interview with John Allen, 23 August 2000.

way he could work with Francis, and subsequently resigned from the company.[115] The removal of Carline, who had the ear of Sir Roy Dobson, Avro's Managing Director, was almost what Francis wanted to achieve. This is demonstrated by Francis' later adoption of Carline's views on Blue Steel's aerodynamics and his offer, prior to this first meeting, of Carline's job to his own protégé, John Allen.

The secrecy that gave Hugh Francis his hermetic grip on the project resulted in the true cause of many delays being concealed and also prevented detailed criticism being made of his design decisions by both those inside and outside of the project. However, the root of Hugh Francis' obsession with secrecy can be traced to his intense personal shyness. This raises the interesting possibility that following a strong personal vision with regard to a project was actually Francis' coping strategy to mitigate his difficulties with successfully interacting with his peers and superiors and ascertaining their views. John Allen has commented that Francis could not at all play 'hail fellow well met' with the Air Marshals.[116] This was a more significant failing than it may seem, as British project management at this time was heavily dependant on informal contact with a network of acquaintances, rather than a formalised structure to resolve problems, as Andrew Nahum has pointed out.[117]

Although there were elaborately constructed tiers of administration above him replete with 'progress meetings', Francis' tactics ensured that these were generally lines of confrontation rather than of communication. Whatever the cause of the communications breakdown between Francis and the Air Staff, that there was such a breakdown is manifest in the design of the weapon.

The key to determining Hugh Francis' aims and the extent to which he contravened the Air Staff's requirements can be seen in his decision to use a stainless steel airframe. It is essential to note that this was not necessary to

[115] Correspondence with AJK Carline.
[116] Interview with John Allen, 23 August 2000.
[117] Nahum, A., 'The Royal Aircraft Establishment from 1945 to Concorde' in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press, p. 32.

achieve the stated performance requirements of Blue Steel Mk 1 and created a foreseeable risk that the all important in-service date could be severely compromised. Not only did the Bell Corporation of the United States use a conventional alloy airframe for the Rascal missile, whose flight performance was virtually identical to Blue Steel,[118] but Francis used a light alloy airframe on the Double Spectre powered full-size models, when fabrication problems with the stainless steel ones delayed trials. A light alloy airframe would have been perfectly capable of meeting the Air Staff's requirements. The Bell Corporation, the company with perhaps the most experience at this time of building supersonic airframes, calculated that an alloy airframe was good for speeds up to Mach 2.8, well in excess of the Mach 2.5 required by the specification.[119]

A real indication of the degree to which the steel airframe exceeded the official requirement is demonstrated by the single test in which the missile was flown using the big boost rocket chamber the whole way, rather than switching to the small cruise chamber once the missile had accelerated to cruising speed. This flight reached a speed of Mach 3.6, and the airframe had still not exceeded its design limitations.[120]

The fact that this test was undertaken at all gives a strong indication of what was possibly behind many of the design decisions regarding Blue Steel. As was discussed with regard to the Avro 730, the exploration of the high altitude high mach number environment and the technologies associated with it was a driving enthusiasm for technologists involved in many similar projects at this time. It appears that Hugh Francis' ultimate intention was to stretch the weapon into a rocket powered 700-mile range Mach 4 performance vehicle.[121] This is what was, in fact, suggested for the Blue Steel Mark 2 requirement, although in that particular case the Air Staff put their foot down and insisted on a ramjet powered Mach 3 vehicle, which would be able to

[118] Francillon, R., (1994) *Bell Aircraft since 1935*, London: Putnam, p. 236.
[119] *Ibid.*
[120] Interview with John Allen, 23 August 2000.
[121] *Ibid.*

perform QRA duties.[122] As much of the impetus to develop the Mark 2 originated from Avro themselves, it could well be argued that it was this weapon that Francis wanted to build all along, rather than the lower performance 'rush job' that the Air Staff had commissioned from him. John Allen suspects that had Francis been over-ridden with regard to his conception of Blue Steel and forced to go for a simple low performance design he would have resigned because he would not have been able to believe in the project.[123]

Although Hugh Francis' previous experience with the Blue Danube free-fall atomic bomb seemingly gave him perfect credentials to run the Blue Steel project, in many respects he was a bad choice to lead a project that needed to produce a quick and cheap solution to a transitory requirement. A product of the RAE, Francis was far more a scientist interested in long-term research, rather than an industrial manager. As an aeronautical engineer, Francis' research interests were always with the unconventional and the advanced. This interest manifested itself even when he was posted to the Marine Aircraft Experimental Establishment at Felixstowe, where he managed to revolutionise flying-boat design at a time when it was in its death throes.[124]

Inadequate and divided supervision provided Francis with an opportunity to further his own particular vision. John Allen concedes that if the priority had been to build something to be in service by 1960, he would have gone for an alloy airframe and turbojet propulsion, but it would have been "no bloody good".[125] This comment by John Allen in August 2000 indicates both the extent to which Hugh Francis disregarded the Air Staff's wishes, and also the way in which he managed the programme. The very fact that even in 2000 his deputy John Allen was not aware that meeting the in-service date of 1960 was the Air Staff's driving consideration speaks volumes for the manner in which Hugh Francis used his penchant for secrecy to control the project. It

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122 *Ibid* Interview with John Allen, 23 August 2000
123 *Ibid.*
124 *Ibid*
125 *Ibid.*

also underlines the full implications of Francis' decision to build the weapon with a stainless steel airframe and rocket motor.

As has already been discussed, in isolation the decision to adopt the HTP rocket motor can be seen as a perfectly reasonable technology selection for the time, given the focus of the threat assessment on penetration survivability. Put into context, though, with the widespread promotion of HTP technology throughout the defence research establishment, it starts to look a little less firmly based on the Air Staff's operational requirements. If these considerations are, in turn, put in context with the decision to use a stainless steel airframe, then it becomes apparent that the Air Staff's views on the matter had become somewhat irrelevant. To take the risk, on a project in which time was absolutely of the essence, of adopting not only a powerplant that was as yet un-built, but a construction technique of which there was no prior experience and that promised nothing but difficulties, speaks either of incredible irresponsibility, particularly when off-the-shelf alternatives were available, or of a wilful disregard for the wishes of the customer.

A suspicion might linger that Hugh Francis was using the Blue Steel project to indulge a personal research interest. For the implementation of the Air Staff's specification, the stainless steel airframe was unnecessary and use of a rocket engine was but one possible option. For the investigation of the hypersonic environment, which was the main centre of interest for most aeronautical engineers in the 1950s, a rocket engine and a stainless steel airframe were essential. Notwithstanding this, to surmise that Francis manipulated the programme totally in pursuit of his own research agendas would be to lapse into caricature. Hugh Francis, even by the account of his worst detractors, was never regarded as being that cynical. He may well have been attracted to solutions that required the type of advanced technologies that he found intellectually stimulating, but it is also obvious that he believed that these would provide the Royal Air Force with a superior weapon.

John Allen has characterised Francis' view of the job facing them as being that something simple could have been made in four years that would have been easy for the RAF to use, but that there would be no the point if it was going to get shot down every time. Doing three years work and then having to start again from scratch when the RAF decided it was not good enough.[126] This illustrates not only that manipulating the requirement was a conscious decision, but doing so was also viewed as a necessary function of project management, at least partly in order to ensure the project's survival. That this analysis did not accord with that of the Air Staff provides a useful insight into the utility of the threat assessments used by the Air Staff at this time, particularly when they were intended to guide a senior aeronautical engineer.

The obvious problems that Hugh Francis had in accepting the Air Staff's threat assessments were probably very largely due to their source. The aircraft industry provided much of the technical analysis of threat that guided its own work. AJK Carline and the Avro design team, for instance, undertook a study of the Myasichev M-4 'Bison' strategic bomber for the Air Staff in 1954, and, in cases when the Soviet technology was totally unknown, the simple expedient of 'mirror imaging' western aeronautical capability was assumed.[127]

It would seem likely that as far as Hugh Francis was concerned, the threat assessments regarded aeronautical technology and were based upon the opinions of aeronautical engineers, therefore they were open to question by other, more senior, aeronautical engineers. It might also be that Francis had become too used to generating his own threat assessments whilst at Farnborough. There, as Andrew Nahum has pointed out, with regard to the origins of certain projects:

> The perception of threat would be very likely to derive from the aeronautical scientists' own appreciations of what the potential enemy might be able to achieve.[128]

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[126] Interview with John Allen, 23 August 2000.
[127] Correspondence with AJK Carline

Whilst this may well, on occasion, have proved far more accurate than the threat analyses provided by the Air Staff, it did not make for a cohesive defence policy.

With regard to the question of what Francis sought to achieve by his manipulation of the project, the answer appears to be that he intended to provide the Royal Air Force with a more advanced weapon than the requirement demanded, largely because he disagreed with the threat analysis informing the project, and possibly also because he found it more intellectually stimulating. With regard to the question of why he thought he could do this, the matter of opportunity has already been addressed. However, not every individual would feel at liberty to run a major project in such a fashion, no matter what opportunity presented itself.

Whilst the key to this may possibly lie deep in the personal psychology of Hugh Francis, well beyond the reach of this study, it is very probably no co-incidence that the aeronautical engineering profession was passing through an extremely 'bullish' phase in terms of confidence at this time. Therefore Francis' independent attitude is perhaps best explained in the context of the general attitude of technologists towards the project, which had a markedly different perspective with regard to Blue Steel than that of the Air Staff, and also by the perception of the role of the aircraft designer in the 1950s that had been formed both within the industry and within general society.

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[128] Nahum, A., 'The Royal Aircraft Establishment from 1945 to Concorde' in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press, p. 32.

3.6.3.1 Social Perceptions of Aeronautical Engineering

As has been remarked on in the introduction to this chapter, Blue Steel was regarded as a procurement disaster by the Air Staff. It was so delayed that it was obsolete before it entered service and, once it did, it proved to be a maintenance nightmare. However, to the technologists, Blue Steel remains a triumph of British engineering.

Despite working on over 200 projects, Professor John Allen still regards Blue Steel as one of the British aircraft industry's three greatest post-war achievements, on a par with the Harrier and Concorde.[129] The Air Staff's perception of Blue Steel as a cheap stop-gap answer to an embarrassing but hopefully brief gap in capability was totally at odds with that of virtually all the technologists, not just Hugh Francis. They regarded Blue Steel as a mammoth leap, a first chance to explore the high altitude supersonic environment where it was believed that the future of aeronautics lay.

A guided weapon of this size and performance created problems that would stretch British aeronautical technology to its limits and, from the outset, the engineers and scientists attached to the project regarded it as being a challenging exploration at the very cutting edge of technological development. This view of the project is very different in ethos to the Air Staff's view that Blue Steel was a cheap, easy, throwaway solution to a transient problem. Therefore, two completely contrasting perspectives regarding the project were in place from day one and were to confound its progress until Blue Steel finally entered service.

Allied to the 'technologists perspective' of Blue Steel was the technologists' own view of themselves. It was this that gave the profession the supreme self-confidence to both challenge the Air Staff's views and impose their own. Not only was there the exhilaration of being in a profession that was at the very cutting edge of scientific endeavour and undergoing an unparalleled

[129] Interview with John Allen, 23 August 2000.

expansion in its knowledge, but one that also, through a fluke of wartime propaganda allied to the ethos of high modernism, had a notable and very particular public profile at the time. This manifested itself as an heroic image of the aircraft designer as a single-minded genius forging a weapon with which to simultaneously cut through a Gordian knot of red tape and save the country. This was most notably expressed on film.

Although largely a product of wartime propaganda, this specific piece of folklore was already well established in the lore of the industry before the Second World War, with examples such as Sir Richard Fairey's battle with the Air Ministry to create the Fairey Fox light bomber, which rendered obsolete all serving RAF fighters.[130] During the War, this image was also stretched to include Company Chairman, such as Sir Thomas Sopwith, whose decision to build 500 Hurricanes as opposed to the Air Ministry order for 50 'won the Battle of Britain' or even the occasional administrator, such as Sir Wilfred Freeman, whose 'Freeman's Folly' became the immensely successful De Havilland Mosquito.[131]

However, it was the aircraft designer who remained the true bearer of this image. The image reached its apotheosis in Leslie Howard's portrayal of Reginald Mitchell, designer of the Spitfire, in the wartime film, *First of the Few,* and was echoed in the portrayal of Barnes Wallis, inventor of the bouncing bomb, in the 1950's film, *The Dambusters.*[132] David Edgerton has commented with regard to both these films that they are

> ...elaborations, and very effective ones, of national stereotypes, which are implicitly, and sometimes explicitly, connected to a broader picture of England: as a nation attacked, not a nation which attacks; as a lethargic nation raised to genius by emergency and saved by heroic, aristocratic pilots and shy boffins.[133]

[130] Taylor, H.A., (1974) *Fairey Aircraft since 1915*, London: Putnam, p. 78.
[131] Armitage, M.J., (1995) *The Royal Air Force*, London: Arms and Armour Press, p. 71.
[132] Edgerton, D., (1991) *England and the Aeroplane, an Essay on a Militant and Technological Nation*, London: Macmillan Academic and Professional Press, p. 61.
[133] *Ibid*

A consistent theme in both these films is the triumph of individual genius over short-sighted officialdom. In RJ Mitchell, that genius saved the nation from invasion, whilst that of Barnes Wallis provided the 'brilliantly clever retaliation'.[134] These stories of Fairey, Sopwith, Freeman and Mitchell 'battling officialdom' are all of dubious authenticity. As noted aviation historian HA Taylor said of the Fairey Fox story:

> No legends are ever true – they are invariably embroidered as time goes on.[135]

This is particularly true with regard to the lore of the aircraft industry. The Spitfire was built to an Air Staff requirement and was heavily supported by the RAF, Freeman <u>was</u> an official and initial orders for the Hurricane amounted to over 600 aircraft.[136] This suggests a pre-existing ethos within the aviation industry that created these legends, one of great self confidence in the ability and judgement of the profession and little confidence in that of its customers. This might be seen as an inevitability in an industry with a strongly entrepreneurial culture that found itself constantly interlocked with state institutions.

This heroic view of the aviation technologist was further reinforced by the beginnings of the 'space race', when the appellation 'rocket scientist' emerged to denote those at the very cutting edge of advanced science. This had not yet been transmuted into the dark and sinister character of Dr Strangelove, which was a product of the anti-nuclear unease of the late 1950s and early 1960s.[137] There were, however, some aspects of this concern at the consequences of the blind pursuit of science at the expense of human existence been explored in Ralph Richardson's portrayal of an aircraft company director in David Lean's 1952 film, *The Sound Barrier*.[138] This was perhaps an early sign of the eventual shift in public perception and the

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134 Edgerton, D., (1991) *England and the Aeroplane, an Essay on a Militant and Technological Nation*, London: Macmillan Academic and Professional Press, p. 61
135 Taylor, H.A., (1974) *Fairey Aircraft since 1915*, London: Putnam, p. 78
136 *Encyclopaedia of Aviation* (1982) London: Orbis, p. 705.
137 Edgerton, D., (1991) *England and the Aeroplane, an Essay on a Militant and Technological Nation*, London: Macmillan Academic and Professional Press, p. 61.
138 *Ibid*

establishment of a negative view of the practitioners of high technology. It had not, however, by the mid 1950s, supplanted the view of aviation technologists that had manifested itself, as early as 1935, in the film, *Things to Come*, which portrayed the 'Air Men' as the saviours of progress and civilisation against the forces of barbarism and destruction.[139]

It was, however, the highly technological nature of the Second World War, coupled with the ancient necessity to create heroes with which to rally the nation, that gave the aircraft designer a social and media prominence that had only previously been only accorded to military men. The psychological importance of the Allies' first victory – the Battle of Britain – to wartime morale was integral to Lord Beaverbrook's propaganda efforts on behalf of the Ministry of Aircraft Production. This resulted in the transformation of a mass produced machine – the Spitfire fighter – into a symbol of victory the to which the whole country had contributed, from saucepan-donors to 'Spitfire Fund' collectors and factory workers.[140]

Whilst this had a tendency to diffuse the concept of the hero amongst the wider industrial society, the old, original cultural form of the hero was not suppressed and continued to co-exist side by side with the new variant, leading via the "Few" to the "First of the Few", the aircraft designer Reginald Mitchell and the portrayal of him through one of the era's pre-eminent mass media, cinema.

Whilst it would be inane to suggest that every aeronautical engineer secretly saw himself as Leslie Howard, there was certainly a strong and particular legitimising element both in contemporary culture and in the lore of the aircraft industry to encourage an aviation technologist to trust his own judgement above that of officialdom, leading to more than just a certain 'bullishness' in the profession. John Allen has contended that Sir Sydney Camm, chief designer of Hawker Siddeley was the only figure in the aircraft industry who

[139] Edgerton, D., (1991) *England and the Aeroplane, an Essay on a Militant and Technological Nation*, London: Macmillan Academic and Professional Press, p. 45.
[140] *Ibid.* p. 69.

had the power and influence to impose his own views on Government Ministries.[141] Whilst acknowledging the relative disparity between the influence of Camm and the rest of the profession, it can be argued that what distinguished Camm from his colleagues in this respect was his power rather than his attitude. What Camm did openly the rest of the profession would do by stealth if the opportunity presented. Sir Solly Zuckerman's observation was that:

> ...military chiefs, who by convention are a country's official advisors on national security, as a rule merely serve as a channel through which the men in the laboratories transmit their views.[142]

This is in many respects an obvious result of the power relations between the technologists and their customers that had come to pass by the mid-1950s. Only 20 years earlier this would not have been true. Anyone who had ever serviced their own car would have felt quite familiar with the technology of the Bristol Bulldog and its Jupiter engine, the standard RAF fighter in the early 1930s. By the mid 1950s, the technology had evolved so far and so fast that even someone with a training in aeronautical engineering would have to take on trust the views of those at the leading edge. This provided the opportunity to exercise 'professional judgement' if the decisions of military and political customers appeared to warrant it.

Hugh Francis' manipulation of the Blue Steel requirement can be therefore be attributed more to a contingent professional hubris than to personal ego. It is clear though, that certain specific personal characteristics of Francis' did affect Blue Steel, particularly his shyness and consequent obsession with secrecy. However, it was poor overall management of the project by the Ministry of Supply that enabled these characteristics to take the effect they did. This, it could be argued, extended to the premeditated virtual usurpation of the strategy-making prerogative of the upper policy making echelons, and it is this that is perhaps the most striking and significant aspect of the Blue Steel project.

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141 Correspondence with Professor John Allen.

142 Zuckerman, S., (1982) *Nuclear Illusion and Reality*, New York: Viking, p.105.

This raises two very important issues with regard to technology policy-making and the control that non-technologists can wield over it. These are the relative power of technologists in the decision making process, and the ability of individuals to impose there own view upon an established policy. It also raises a significant question with regard to the authority of threat assessments when they are derived from the knowledge of the same group they are supposed to inform.

3.7 Conclusion

Although Blue Steel was the only one of the Air Staff's putative 'V-Bomber replacement projects' to enter service, its development was extremely troubled. Amongst other things, it raised an antipathy in Whitehall towards all-British projects that helped to ensure that future major weapons systems would either originate from the United States or be multinational collaborations.

In many respects, the story of Blue Steel could be characterised as a power struggle between the government, one the one hand, who were totally dependent on a few very particular pieces of technology to ensure the credibility of its defence and foreign policy, and, on the other hand, a powerful and overly confident technological elite determined to pursue their own favoured lines of research. However, this view needs to be heavily qualified. Rather than being the victim of a conspiracy of crypto-Dr Strangeloves, Blue Steel was, in many respects, the product of an ill-placed scientific ethos expanding to fill a void created by bad management, strategic confusion and ambiguity of purpose. A conjunction of ambition and opportunity for the technologists involved in the project gave them a far stronger influence over its course than otherwise could have been expected.

The opportunity derived from two sources. Firstly, the threat analyses that should have guided the project lacked authority as they derived from the same group that intended to utilise them. This lack of authority was exacerbated by strategic vagueness caused both by the rapid evolution of nuclear strategy and an inherent ambiguity of purpose with regards the British deterrent. This ensured that the projects central objectives were prone to being obscured and misconstrued, effectively making them a 'blank canvas' for a technologist with a particularly strong personal vision. Secondly, an extremely fragmented management structure, caused largely by the Ministry of Supply's desperate attempts to safeguard its own position, gave possibility to anyone with the confidence and desire to impose their own views. On top of all this was the ever-present compartmentalisation of knowledge and communication within the defence establishment. This added the final twist, that if some one did decide to try and improve the weapon beyond the requirements of officialdom there was scant chance that they could accurately gauge what was, in fact, regarded as 'improvement' by those officials.

It was perhaps an unhappy coincidence that these opportunities occurred at a time when aeronautical science was imbued with a particular self-confidence and assertiveness. This was due to yet another conjunction, this time of cultural and structural factors. The ethos of high modernism, intensified by the needs of total industrialised warfare had made a hero out of the unlikely figure of the aircraft designer. Linked to this was the structural circumstance that during the period under study not only were the aeronautical sciences at the very cutting edge of scientific endeavour but they were undergoing the most rapid evolution in their history, attracting the best and most ambitious of talent and promising enormous breakthroughs for those following the 'right' research paths. The technologies of high altitude high speed flight were foremost amongst these, and a desire to explore these as thoroughly as possible was a motive behind many design decisions during this period. These factors helped to give aviation technologists both the motive and the confidence to take advantage of the opportunities presented to them.

Blue Streak

4.1 Introduction

This chapter will examine the bureaucratic politics of the cancellation of the Blue Streak strategic missile system. As has been discussed in the introduction to this study, explaining the cancellation of Blue Streak is perhaps the acid test of any historiographical interpretation of British defence policy in the 1950s. Whereas orthodox interpretations of the cancellation have highlighted the role of the Treasury, revisionist writers have seen the concurrence of the Chiefs of Staff that Blue Streak was a 'launch on warning' weapon, and therefore unsuitable as a deterrent system, as a vindication of the revisionist strategy based perception.[1] Whilst accepting that both economic and strategic considerations were significant factors in the demise of Blue Streak, this study will argue that the situation was far more complex than has previously been described and that the behaviour of the various actors was heavily governed by the bureaucratic politics agendas already examined with relation to the Low Altitude Bomber, Avro 730 and Blue Steel. In order to understand the influence of bureaucratic politics upon the cancellation of Blue Streak, it is first necessary to outline the role of bureaucratic politics in the origins of the Blue Streak project.

4.2 Why Blue Streak?

The long-range ballistic rocket had been seen as a possible deterrent system even before the end of the Second World War. However, it was to be 10 years until any serious work was done on such a project. As with the demise of Blue Streak, bureaucratic politics also played a significant role in the

[1] Clark, I., (1994) *Nuclear Diplomacy and the Special Relationship: Britain's Deterrent and America 1957-62*, Oxford: Clarendon Press, p. 181.

project's instigation, as will be illustrated by this evaluation of the motivation of the principal actors.

4.2.1 The Air Staff

There were several reasons for the emergence of Blue Streak following the failure of the Avro 730. From the perspective of the Air Staff, there was now little other choice. Despite the later sponsoring of the Mark 2 variant of Blue Steel as an insurance against the failure of Blue Streak, it was obvious that any bomber-launched atmospheric missile would have little credibility against the surface-to-air missile defences of the late sixties. As for a manned bomber, after the demise of the Avro 730, that concept was even less credible in the strategic role. Due to this, the various interest groups and advocacy coalitions that had formed around the supersonic bomber project were now at something of a loose end, particularly as any hope of encompassing the entire spectrum of bomber roles in one airframe had conclusively failed. It was obvious that the traditional all-encompassing 'bomber strategy' would have to bifurcate into quite separate strategic and limited warfare strands; this was first propounded in a paper entitled *Manned Bombardment and Reconnaissance Systems* written before the Avro 730 was cancelled.

This paper identified two requirements 'which may justify the need for manned weapon systems at a time when we can have the Medium Range Ballistic Missile in service.'[2] One of these was reconnaissance but the second requirement was for 'a flexible, accurate and economic bombardment system for limited war purposes.'[3] The abandonment that followed of attempts to integrate the whole scope of 'bomber strategy' in a single airframe

[2] AIR20/7723 Report *Manned Bombardment and Reconnaissance Systems* (undated: probably 1956).
[3] *Ibid.*

ended the intense rivalry between factions intent on imposing the primacy of their particular interest upon the development priorities for such as system. A period of relative stabilisation and coexistence amongst the different Air Ministry interest groups then resulted. The bomber lobby, which now embraced both high altitude and low altitude tactical enthusiasts, combined with the 'East of Suez /Limited War' lobby in turning its interests towards the Canberra replacement, OR339, which became TSR2. Untrammelled by the demanding range and penetration requirements of the strategic role, the bomber enthusiasts felt that the manned bomber could still find a niche in a conventional or limited war. Similarly, those who favoured a dedicated and operationally effective strategic deterrent system suddenly had their horizons widened as to the range of possible systems, now that no heed was required to be paid to the needs of imperial policing. This group turned their attention to a project that had been slowly evolving for some time, the Blue Streak intermediate range ballistic missile (IRBM).

4.2.2 The Ministry of Supply

The Ministry of Supply had been involved with what eventually became Blue Streak for nearly ten years before the project was finally adopted as the follow-on deterrent system. The concept of a strategic missile system had first been examined in 1947. Both the Army and the Air Force were enthusiastic about the prospect of such a weapon and a study was begun under the code name of 'Menace'. However, the Ministry of Supply considered this to be over ambitious and Menace was dropped.[4]

By 1952, however, the Ministry began to have second thoughts about the necessity for a strategic ballistic missile. The Low Altitude Bomber project, amongst others, was already highlighting to the Ministry the spectre of the oncoming change necessary in the procurement system and this, coupled with mounting criticism of their performance in the project management field,

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[4] Twigge, S.R., (1993) *The Early Development of Guided Weapons in the United Kingdom,*

left the Ministry of Supply feeling extremely vulnerable. The situation was worsened by the dissolution of the Ministry's guided weapons Progress Committee in August 1951.[5] The guided weapons programme was one of the two most important defence projects being undertaken in Britain at the time, being on a par with the nuclear programme.

Much criticism had been directed at the Ministry's handling of the guided weapons programme, and effective control of it had been lost to a Cabinet committee, the Defence Research Policy Committee, under Sir Frederick Brundrett of the Ministry of Defence.[6] In political terms, this was a very serious blow to the Ministry of Supply and something would have to be done by the Ministry in order to regain at least part of their power over the programme. It appears that the Ministry of Supply planned a simple outflanking move in order to achieve that end. This was facilitated by the fact that the Defence Research Policy Committee had upheld the priorities formulated by the Ministry of Supply's own rationalisation of the guided weapons programme. For the purposes of bureaucratic politics, these could now be regarded as the Defence Research Policy Committee's own priorities and hence the committee could be berated for any weakness in them.

The principal perceptible weakness of the guided weapons programme's prioritisation was its total concentration on defensive systems. It was obvious that guided weapons technology could also be used to create highly effective offensive systems. The most potentially powerful of these was the strategic surface-to-surface ballistic nuclear missile. Almost totally unstoppable once launched, missiles such as this threatened to revolutionise military strategy. Unfortunately they would be extremely expensive to develop, which was why the Ministry of Supply had originally cut them from the programme.[7] However, the technology was now maturing and it was clear that, before long, somebody, either the Russians or the Americans, would make major progress

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1940-1960, Chur: Harwood Academic Press, p. 188.

[5] Twigge, S.R., (1993) *The Early Development of Guided Weapons in the United Kingdom, 1940-1960*, Chur: Harwood Academic Press, p. 86.

[6] *Ibid.* p. 166.

[7] Twigge, S.R., (1993) *The Early Development of Guided Weapons in the United Kingdom,*

in this field. The time finally seemed ripe for the ballistic missile.

Developing such a weapon could be seen to serve the Ministry of Supply's purposes in a number of ways. It was a brand new technology with which British industry had no experience and therefore there would be no option but for the Ministry of Supply research institutes to have a major directing role. Also, a project as large as that, involving a new technology, could not conceivably be run 'in house' by one company. It would, therefore, require much co-ordination and control by the Ministry of Supply. As the Ministry's prospective missile was a strategic nuclear system, far more complex than the small anti-aircraft weapons currently being developed, it could expect to receive first priority in the allocation of scarce manpower and raw materials. Control of these would wrench the rest of the guided weapons programme back into the Ministry's control. As the prime strategic system, it would also give greater control over the nuclear programme. A firm grip on both of Britain's premier defence projects would enhance the Ministry's standing enormously.

4.2.3 Political Interest

There was another interest group at work behind the selection of Blue Streak, one that had been almost entirely absent from decision-making regarding the Low Altitude Bomber and Avro 730; that of mainstream politics.

Blue Streak rapidly assumed a political dimension that was to both drive it forwards and, eventually, contribute heavily to its demise. In contrast, the Low Altitude Bomber had not attracted the notice of Ministers until it was cancelled and the Avro 730 had also been almost entirely governed by internal Air Staff and Ministry of Supply decision-making. Political interest in what became Blue Streak can largely be seen as springing from the defence reviews that followed Sir Anthony Eden's arrival at Number 10. In the light of

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1940-1960, Chur: Harwood Academic Press, p. 186.

subsequent events, it is worth noting that Harold Macmillan's rapid switch from Supply to Defence to the Treasury via the Foreign Office gave him particularly strong views on the role that the deterrent played in foreign policy but even more particularly on the need to tie defence expenditure to 'economic viability'. This meant drastically reducing the armed forces' manpower and training requirements. Greater reliance on guided missiles and nuclear deterrence was a strategy that would enable this.

Once Macmillan became Prime Minister, he chose Duncan Sandys to be his Minister of Defence. This was particularly fortunate for the Ministry of Supply as Sandys had not only been a Minister of Supply but he had been a 'rocket enthusiast' long before Blue Streak was mooted. Sandys' awareness of the potential of guided weapons dated from his involvement in experimental missile work during the Second World War. Significantly, it was this experience that gave Sandys his first big break in politics, when he engaged in a hard-fought battle against Lord Cherwell to convince Winston Churchill, Sandys father-in-law, that the Germans were actually developing a strategic rocket.[8] His victory over Cherwell had given a huge boost to his early political career.

Now that Sandys was in his most challenging job yet, as Defence Minister, it seemed that missiles might yet again provide him with a winning card. Unfortunately Sandys personal 'brittleness', his membership of the Churchill 'inner clique', and the sheer contentiousness of his brief at the Ministry of Defence were to win him few friends either within the defence establishment or within his own party in the later years of the 1950s. Blue Streak became almost inextricably linked with Duncan Sandys and, in any examination of the project, the manner in which the rise and fall of the missile paralleled the political fortunes of Sandys himself should not be ignored amongst the greater political machinations surrounding the project.

The politics of the High Policy regarding Blue Streak have been exhaustively

[8] Irving, D., (1985) *The Mares Nest*, London: Panther, p. 45.

and ably dealt with by both orthodox and revisionist historians and this study does not intend to recover that ground, at least not in its entirety.[9] Certain specific issues with regard to the politics of the policy elite will be dealt with later in the chapter but, for now, it will only be noted that from a political point of view Blue Streak was the first of the V-bomber replacement projects to have a 'political profile': its adoption was seen as a means of attaining economic viability in defence and it became synonymous with a politician whose future career prospects were unpredictable to say the least.

4.3 Historiographical Interpretations of Missile Technology

Unlike the three projects examined in the preceding chapters, Blue Streak has been the subject of an extensive academic literature as already described. Whilst, as might be expected, this has produced differing interpretations of the policy surrounding the weapon, it is perhaps surprising that interpretations of the weapon's technological characteristics have also differed widely. It is necessary, therefore, to come to grips with the technological aspects of the Blue Streak programme.

It is important to note both what this technology implies for the weapon's operational effectiveness and, perhaps even more importantly, what it does not imply. There are three areas that tend to be repeatedly misunderstood in the historiography. Firstly, the question of the operational effectiveness of liquid-fuelled missiles, secondly, the developmental relationship between Blue Streak and its silo and, finally, the vulnerability of silo-based missiles. The reason for these misunderstandings is heavily linked to the evolution of the historiography.

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[9] For example Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press; Clark, I., (1994) *Nuclear Diplomacy and the Special Relationship: Britain's Deterrent and America 1957-62*, Oxford: Clarendon Press; Groom, A.J.R., (1974) *British Thinking about Nuclear Weapons*, London: Francis Pinter; Pierre, A., (1972) *Nuclear Politics: The British Experience with an Independent Strategic Force 1939-70* Oxford: Oxford University Press.

4.3.1 *Liquid Fuel and Obsolescence*

As the cancellation of Blue Streak has been attributed to vulnerability, this has been directly equated to some kind of incipient obsolescence. Blue Streak's liquid fuelled propulsion system has been mentioned by virtually every writer as a major contributing factor to the project's failure. Some, including Peter Nailor, have named it as the prime reason for the cancellation.[10] The inference appears to be that Blue Streak was only suitable for surface basing due to its liquid fuelled design. The cancellation is blamed on the premise that when the vulnerability of such basing was realised, it also became apparent that silo basing was technically too difficult and expensive. The rationale behind this interpretation is interesting. As the cancellation was due to questions of vulnerability, obviously Blue Streak was not intended to be silo based, as silo based missiles were not feasibly threatened by the type of missile threat either extant or imaginable in 1960. Although Duncan Sandys mentioned the silo basing of Blue Streak to Parliament in 1959,[11] it proved to be impractical on either cost or technical grounds and the missile had to be cancelled.

Thus a strong argument developed that the cancellation was largely due to Treasury pressure, which emphasised a bureaucratic politics explanation for the Blue Streak saga. This perspective relied on there being a developmental dislocation between the missile and the silo. However, the release of the British Nuclear Deterrent Study Group's final report by the Public Records Office in 1991 showed that Blue Streak was regarded as vulnerable whether or not it was silo based.[12] It was a 'first strike' weapon and was therefore incompatible with contemporary nuclear strategy. This tied in well with the

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[10] Nailor, P., (1988) *The Nassau Connection: The Organisation and Management of the British Polaris Project*, London: HMSO, p. 7.
[11] Wynn, H., (1994) *The RAF Nuclear Deterrent Forces: their Origins, Roles, and Deployment 1946-69*, London: HMSO, p. 388.
[12] DEFE /13/788 Final Report of the BNDSG, 31 December 1959.

newly emerging 'strategic' perspective on British defence policy.

This interpretation of Blue Streak, however, was based on a premise that silo based missiles were actually perceived as vulnerable in 1960, something that earlier writers had not considered. It might be imagined that the physical reality of the Blue Streak missile and its development programme were the most stark, solid and unambiguous components of the whole story. In fact, the technology of Blue Streak has proved to be an entirely 'plastic' entity that has been re-invented at least three times in order to fit the theoretical basis of the emerging historiography. This necessitates an attempt to define Blue Streak's physical reality.

The fact that Blue Streak was a liquid fuelled rocket with a response time of seven minutes has been repeatedly pointed to as proof of its vulnerability. However, this both underestimates the operational flexibility of the liquid fuelled missile and misinterprets the significance of 'response time' to a silo based missile. The design response times of liquid fuelled missiles were generally greater than either a manned aircraft or a solid fuelled rocket. Operational experience, though, with both the RAF's Thor and the USAF's Atlas had proved, by the time of Blue Streak's cancellation, that a significant proportion of a liquid fuelled missile force could be held for a considerable period at response time superior to that of a manned bomber and only marginally inferior to that of a solid fuelled weapon. Blue Streak had the capability to be held at 30 seconds from launch for up to ten hours, after which it would need to be stood down for three hours. It could be held indefinitely at seven minutes from launch.[13]

This does, however, tend to obscure the fact that response time does not have the same significance for a second-strike hardened system as it does for a bomber or an unhardened 'fire on warning' system such as Thor. These rely upon response time as protection against pre-emption, whereas the silo provides a silo-based missile with its defence against pre-emption.

[13] AIR19/998 Annex to D60, 8 December 1959.

Despite the emphasis that many commentators have placed on 'reaction time'. the major shortcomings of a liquid fuelled, silo-based IRBM, compared with a solid fuelled one, related to support and infrastructure costs. There were discrepancies in several areas. Firstly, the silos would have to be far more complex, housing, as they would, the missile's fuel plant. Secondly, the missiles would require far more maintenance, contributing to both higher manpower demands and a larger force size. Finally, the fact that only a proportion of the force could be held at maximum readiness at any one time would also require a larger force. Due to this, it has been assumed by some writers that Blue Streak was either overtaken by the unforeseen emergence of solid fuel for missiles or that Britain was technologically incapable of producing a solid fuelled weapon. In fact, the decision to develop Blue Streak as a liquid fuelled weapon, as opposed to a solid fuel system, was taken quite deliberately after analysis of several factors.

Treasury restraints were the principal motivation behind Blue Streak's emergence as a liquid fuelled weapon. Whilst it is true that Britain had little manufacturing experience with the large solid fuelled motors, Thunderbird's sustainer being about the largest attempted in Britain, key aspects of the technology had been evolved in Britain. ICI's tape-winding motor case technique formed the basis of the United States' Aerojet Corporation solid fuel motor for Polaris.[14] The case for developing Blue Streak as a solid fuel missile was made at the time. The Wheeler Report into Blue Streak by the Ministry of Aviation tried to point out the Treasury's 'false economy'. It referring to what it considered to be the principal weakness of the project, which it claimed was that

> ...only the sure fire technical systems can be undertaken. Certain more ambitious but perhaps more hazardous propositions, which may be the winning solutions in two years time, cannot be tackled in parallel. Among these the most important is the staged solid propulsion system. It offers the almost overwhelming advantage of complete avoidance of liquid oxygen manufacturing, storage and filling at the firing

[14] DEFE13/193 *Wheeler Report*, 22 October 1957.

sites.[15]

Despite the report urging 'the prize is so large we ought to spend the money on the parallel project now', it was decided to develop Blue Streak as a liquid fuelled weapon. However, even the Wheeler Report conceded that the liquid fuelled rocket had one particular advantage:

> It would be rash to consider discarding the liquid propellant system because whatever its complications, it is the proved basis of both US and Russian long range rockets and nobody can presume to see through all the hazards of developing even larger solid motors with still higher energy propellant, and even greater charge weight ratio than now.[16]

Developing Blue Streak as a solid fuelled weapon would have been a gamble. The massive strides in solid fuel technology made by the United States between 1955-60 were not even matched by the Soviet Union for over a decade. Perfecting Minuteman was to be a long and costly process, even for the United States. Therefore, by opting for Blue Streak, the British government had saved itself enormous development costs and avoided the risks that would attend the adoption of largely untried technology. The capability remained the same and there was more likelihood that the weapon would enter service on time, a major consideration given the previous record of the British procurement system. The costs were transferred to the force size, running costs and infrastructure expenditure. This is perhaps a significant point. Nicholas Hill has suggested that the timing of Blue Streak's maximum cost burden was a crucial issue with regard to the weapon's cancellation.[17] The liquid fuelled design allowed this to be delayed until the weapon was ready to enter service. It was then that the major costs kicked in. Whilst this was an attractive proposition in the early years of the project, it is notable that the expensive stage was fast approaching when the weapon was cancelled.

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[15] *Ibid.*
[16] *Ibid.*
[17] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press, p.114.

The liquid fuelled, silo-based strategic missile proved to be perfectly successful in service. The American Titan II and the Soviet SS9 and other missiles proved to be both viable and reliable components of their respective deterrent forces for over 25 years. Duncan Sandys' views on this aspect of Blue Streak were particularly salient:

> Militarily, rockets are not like aircraft, which are useless unless they are up-to-date: a rocket can be effective without being the most advanced available...Blue Streak is fully adequate for our purpose and there is no particular object in having anything better.[18]

However, as is illustrated by the urge that Sandys felt to make this comment, trying to sell technology that is not 'at the cutting edge' was problematic in twentieth century industrialised society. Although the fact that Blue Streak was a liquid-fuelled rocket had comparatively little adverse effect on its operational effectiveness, it was a major handicap to it politically. That Blue Streak did not represent the perceived cutting edge of missile technology was psychologically very significant, particularly given the largely totemic nature of the British nuclear deterrent. As has already been noted with regard to the Low Altitude Bomber, the Avro 730 and Blue Steel, a premium was placed on a certain quality in most fields of technical endeavour, whether or not it was entirely appropriate to the intended function of that technology. Invariably, it centred on a quality that was readily understandable to lay observers. How this effects the political aspects of weapons procurement can be quite crucial.

For Blue Streak, 'response time' and the superiority of solid fuelled missiles in this respect was soon grasped as a yardstick for measuring strategic missile technology. Blue Streak's supposed 'technical obsolescence' as a liquid fuelled rocket was to damn it in the eyes of many in the House of Commons and deprive it of much political support when it was needed. The repeated references to the obsolescence of Blue Streak's liquid fuelled rocket engine in the literature is evidence in itself of the prevalence of this largely culturally inspired view.

[18] DEFE13/193 Long-Range Rockets, Memorandum by Duncan Sandys.

The irony of this is that in three important respects, the design of the re-entry vehicle, the engine control system and the silo, Blue Streak was a world leader and served as a prototype for all subsequent American and British research. These factors were, however, secret as were many other aspects of ballistic missile design and, therefore, the somewhat less significant matter of 'response time' has become the means by which Blue Streak's capabilities were assessed.

The issue of the obsolescence of liquid fuelled rockets revolves around two issues, therefore. On the one hand, operational capability is not affected; the major cost of the system just being transferred from research and development to infrastructure and support. On the other hand, there are penalties to be paid for the negative cultural perceptions of high technology that is not of the most 'advanced'. In the case of Blue Streak, although it is a reason frequently quoted by writers such as Peter Nailor as an underlying cause of Blue Streak's cancellation, it can be argued that in fact the issue was not of prime significance.[19] The major stated reason for this was the mode of basing, rather than the missile itself. However, it must be acknowledged that the question of the obsolescence of liquid fuelled rockets was one of several factors regarding Blue Streak that its opponents found of some utility in undermining the system. Notwithstanding this, it is possible that the most damaging effect of this has been on the historiography.

4.3.2 The Silo

In terms of the historiography, the second significant question regarding the technology of Blue Streak concerns the relationship between the development of the missile and the evolution of the basing concept. As has been discussed, early writers on Blue Streak assumed that silo basing would have been regarded as invulnerable thus came to believe that such a basing plan could only have been considered at a late stage of the programme when it proved to be financially or technically impossible. To some extent, this attitude has lingered due to some rather ambivalent phrases in the primary documentation, such as Chilvers urging to Duncan Sandys: 'assuming we confirm, as I think we should, that we want underground sites'[20] as late as 9 June 1958.

The formal decision to base Blue Streak in silos was repeatedly deferred. However, this gives something of a false perspective to the issue as the delay in officially confirming the decision seems to have been entirely a ploy to placate the Treasury. The plan to silo base Blue Streak had already been mentioned in Parliament on two occasions prior to this.[21] However, from the point of view of the engineers, it had always been intended that Blue Streak

[19] Nailor, P., (1988) *The Nassau Connection: The Organisation and Management of the British Polaris Project*, London: HMSO, p. 7.
[20] DEFE13/193 Chilvers to Sandys, 9 June 1958.
[21] Wynn, H., (1994) *The RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 389.

would be silo-launched.

Although documentation is missing, it appears from circumstantial evidence that Britain might have begun to examine the feasibility of silos as early as 1954. Certainly, by the time the United States started a formal feasibility study into silo basing in December 1957, the RAE's Rocket Propulsion Department at Westcott were already undertaking trials with a 1/60th scale model, with a 1/6th version under construction.[22] The British work was sufficiently in advance of United States' silo technology for the Blue Streak silo design to be adopted for Titan II, the first American missile capable of 'hot launch'. This suggests that development work on the silo began at approximately the same time as that on the missile. Therefore, what has been regarded as one of the crucial policy decisions in the Blue Streak saga had already been taken at the weapons development level some three or four years before High Policy circles concurred.

Achieving a 'hot launch' silo-based capability with a ballistic missile creates a range of engineering problems. Blue Streak was the first missile system to be specifically designed to incorporate this capability and it proved one of the biggest challenges for the design team. In a 'hot launch', the missile is fired from the bottom of the silo. Major problems included resonance from the intense noise of the launch, concrete erosion from the heat and blast, and successfully venting the rocket exhaust. This in turn leads to problems of turbulence caused by both the massive flow of air through the silo due to the venting and also by the exhaust plume leaving the vent and creating problems for the missile when it emerges from the silo.

Of these problems, perhaps the most challenging was creating the acoustic lining for the silo. During the model trials, the noise of the launch inside the silo was found to be high enough to reduce aluminium camera mountings to dust. Therefore, to protect the missile, an 'acoustic lining' had to be developed. This is something that Convair and Martin failed to achieve with

[22] Underground Firing Site Report, December 1957 in Dommett, R., (1998) *Silos for Blue*

both Atlas and Titan. The early variants of Atlas could not be silo based at all; it was not until the Atlas F that any kind of silo basing became possible.[23] Due principally to their inability to solve the acoustic problems of 'hot launch', Convair had to adopt the 'silo lift' concept. This entailed elevating the missile out of the silo and firing it on the surface. This was not only complex but also caused guidance alignment problems and rendered the missile vulnerable to any incoming second wave of missiles. However, whilst operationally more simple and less vulnerable, 'hot launch' presented a formidable array of engineering problems, as previously related. The American Titan 1 was also forced to adopt the 'silo lift' approach and it was not until the development of Titan II and Minuteman that a hot launch capability was achieved, using the Blue Streak silo as a basis.[24]

This use of Blue Streak technology remained secret until the 1990s and the United States' problems in this field appear to have caused a general assumption that the first generation of liquid fuel rockets were incompatible with silo basing, which, ironically, may also have contributed to the confusion on this matter in the historiography of Blue Streak.

It is clear that, from an engineering perspective, the missile and the silo were developed as a system and little serious thought was given to basing Blue Streak above ground, although some of the programme's political opponents tried to moot it as cost-cutting alternative. Although the possibility of purchasing Thor with 'no strings attached' was also suggested, this became conditional on a silo system being developed for it.[25] The working party on Blue Streak emphasised this point:

Streak, Farnborough: Royal Aircraft Establishment, p. 6.
[23] Baker, D., (1978) *The History and Development of Rocket and Missile Technology*, London: New Cavendish Books, p.180.
[24] *Ibid.* p.180.
[25] DEFE 13/193 MoD to PM's Office, 28 May 1958.

> The accepted policy is that the British missile must be capable of being launched from underground sites.[26]

When challenged by the Treasury about the cost-effectiveness of Blue Streak's silo, the working party reiterated:

> The provision of underground launching facilities was an essential part of the Blue Streak Project.[27]

In the eventuality that Blue Streak, like Atlas, proved to be incapable of hot launch, a silo lift system was considered as an alternative. A letter from Harland, dated 7 March 1958, stated:

> There is a certain amount of argument (unofficially) about the relative merits of underground launching versus hide-underground-then-vertical-lift-and-launch.[28]

However, by the end of May 1958, the Ministry of Defence had informed the Prime Minister's office that:

> radical change to alternative plan (e.g. lift instead of a U-tube) unlikely.[29]

The use of the phrase 'radical change' is interesting in that it suggests that even a modification of the underground basing system would be a divergence from a well-established decision. By the autumn of that year, the third Six-Monthly Report stated that:

> The lift system is now considered to be of an insurance nature only since the acoustic problems associated with the U-tube seem capable of solution.[30]

The integral nature of the silo basing was also emphasised when efforts were made to speed up deliveries of the missile to the RAF:

> Programmes for the missile and the site are at present phased together. If the former

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[26] DEFE 13/193 Report WPBS, 6 June 1958.
[27] *Ibid.*
[28] Letter dated 7 March 1958 from Harland, in Dommett, R., (1998) *Silos for Blue Streak*, Farnborough: Royal Aircraft Establishment, p. 6.
[29] DEFE 13/193 Report WPBS, 6 June 1958.
[30] Dommett, R. (1998) *Silos for Blue Streak*, Farnborough: Royal Aircraft Establishment, p 12

is accelerated, the latter will have to be accelerated too.[31]

There is no evidence that any engineering studies were ever conducted concerning either a 'silo lift' system or an operational above ground site. Although politically there was a dislocation between the missile and its basing, this was largely illusory as none is apparent at the weapons development level. The significance given to this issue in the historiography is arguably misplaced although the overall cost of the silo system was used as a major argument against Blue Streak. Even this, however, seems to have had little basis in fact as the silo was only expected to cost £500,000 more per missile than a putative above ground site. Therefore, it can be seen that both the contemporary political debate and the subsequent historiography of Blue Streak have been based around a conception of the weapon that has little bearing on its actual 'physical reality'.

4.3.3 The Vulnerability of Silo Based Missiles

The third major question regarding the technology of Blue Streak relates to the concept of the vulnerability of the silo-based missile. The Blue Streak silo was intended to be invulnerable to megaton range bursts no nearer than half a nautical mile away. In this respect, it was fully comparable with both American and Soviet missile silos. Although Minuteman vulnerability became a major issue in the late 1960s, this was largely a political ploy to further the prospects of the Safeguard ABM system.[32] Silo based missiles did not become seriously challenged until the early 1980s when a whole range of basing options were proposed for the United States MX ICBM. However, silo based ICBM's have remained the core of both American and Soviet nuclear deterrent into the 1990s.

[31] DEFE 13/193 Report WPBS, 6 June 1958.
[32] Dunn, D.H., (1997) *The Politics of Threat: Minuteman Vulnerability and American National Security*, Basingstoke: Macmillan.

Despite this, the vulnerability of the silo-based missile did briefly become an issue in defence circles during the early 1960s. The silo was a new concept whose durability in the face of technological change was uncertain. Therefore, the possibility of using a mobile basing concept received serious study. The USAF attempted to have 10 *per cent* of its Minuteman force based on special trains, to provide a 'mobile' element.[33] This proved impractical and the entire Minuteman force was eventually silo based. However, the size of the force to be rail based, ten *per cent*, gives some indication of the significance of the issue. It was essentially an insurance of an insurance. Silo basing was still anticipated to be adequate for 90 *per cent* of the force.

For Britain, the issue was more acute if Blue Streak did, in fact, become the sole delivery system because, if it did become vulnerable, Blue Streak did not have the sea and airborne backup of the American ICBMs. The vulnerability of the system, however, depended on the size of the threat. In the days before multiple independently targeted re-entry vehicles (MIRV), an extremely large enemy counter-force capability was required before a silo-based system was remotely vulnerable. The possibility of 'MIRV-ing' ballistic missiles had not become apparent by the end of the 1950s. At the time, it appeared that silo-based missiles would have to be outnumbered, possibly half-a-dozen times over or more, by enemy delivery systems before they became at all vulnerable. With a ratio such as this and the acceptance that every country had a finite limit on the amount of resources that it could divert to defence, it can be seen that the advantage lay heavily with the use of silo-based missiles as a second strike deterrent. The only qualification to this was if missile accuracy increased dramatically.

Therefore, when assessing the vulnerability of a system like Blue Streak, the two principal determinants are enemy force size and accuracy. The body that was eventually given this task was the British Nuclear Deterrent Study Group (BNDSG). Their report was to have a decisive effect on the Blue Streak

[33] Baker, D., (1978) *The History and Development of Rocket and Missile Technology,*

project.[34] The way in which it assessed these two factors of force size and accuracy gives not only a revealing insight into the role of threat within the British nuclear weapons procurement process but also calls into question some of the prime assumptions of the present historiographical debate concerning Blue Streak.

4.4 The British Nuclear Deterrent Study Group and its Conception of Threat

The British Nuclear Deterrent Study Group (BNDSG) final report is not a straightforward document as it contains many curious statements, contradictions and errors. Those relating to strategy have been noted by John Baylis.[35] In *Ambiguity and Deterrence*, Baylis notes these 'ambiguities' of the BNDSG report as a strange but interesting example of 'confusion' regarding nuclear strategy in high official circles. It can be argued that there is much else in both the BNDSG's final report and its proceedings that is 'ambiguous' and that even a cursory study of these anomalies throws a very different light on our understanding of the rise and fall of Blue Streak.

London: New Cavendish Books, p.188.
[34] DEFE 7/1328 BNDSG Final Report, 31December 1959.
[35] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64,* Oxford: Clarendon Press, p.285.

4.4.1 The Report

The final report of the BNDSG on Blue Streak was issued on 31 December 1959. Paragraph 30 contains a concise resume of the Committee's view of the potential vulnerability of Blue Streak and the rationale that framed it:

> Before deciding to mount a pre-emptive attack, the Soviet Government would need to be certain that they could neutralise the bulk of the 60 Blue Streak sites with one swift blow, in order to prevent any substantial weight of counter attack. (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 (0.55nm) and that a warhead of at least 3MT would be available, 95% of the underground Blue Streak sites could be destroyed by between 300-400 Soviet missiles). Even allowing for the requirements of air defence weapons for the protection of the Soviet homeland, and for the need simultaneously to pose a serious threat to the United States, we have no doubt that the Soviet stockpile in 1967 would be sufficient to provide these warheads for an attack on the United Kingdom.[36]

This was the paragraph that killed Blue Streak.

An examination was made of the possibility of using Blue Streak as a 'fire first' weapon, which, as John Baylis notes, was very strange as certainly the Deputy Chiefs on the Committee, if not Sir Richard Powell himself, must have known that such a capability was completely at variance with the accepted nuclear strategy of the time.[37] This was that the design of the Blue Streak system, commenced five years earlier, was based around the necessity for it to be a second strike system, hence the silo. However, this did have the interesting effect of enabling the Chiefs of Staff to recommend the cancellation of Blue Streak on command and control grounds, without them directly having to concur with the threat analysis. This made the decision sound far more plausible than having to state that the 60 Blue Streaks were

[36] DEFE 7/1328 BNDSG Final Report, 31 December 1959.
[37] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p.285.

vulnerable to a 1200-megaton attack from 400 missiles.

This figure needs to be put into perspective. The total planned American ICBM force, of both Minuteman and Titan missiles – the core of US nuclear deterrent and exclusively aimed at the Soviet Union – had a combined yield of under 1260 megatons.[38] If 60 Blue Streaks, with their 60-megaton total yield, could actually tie down a 1200-megaton force, they would be making an astonishing contribution to Western defence.

Of course, bureaucratic politics is not the only candidate for the creation of such a bizarre threat analysis. The schizophrenic nature of Britain's entire rationale for possessing nuclear weapons at this time contributed heavily to this process. The BNSDG was given the task of finding the most suitable system to deter the Russians when, in fact, the deterrent's true purpose was to act as a diplomatic lever on the United States. Even if that is taken as given, at the time officialdom was unsure whether the best way to create such a lever was through 'independence' or 'interdependence'.[39] Due to this complete lack of integration between High Policy and Operational Planning, itis not surprising that there should be a whole gamut of inconsistencies in the BNDSG's report. Many of these 'inconsistencies', nonetheless, including the peculiar 'first strike weapon' argument outlined above, do not fit in with a simple confusion caused by Britain's ambiguous nuclear policy. However, the confused nature of Britain's nuclear ambitions did act to dislocate threat and make it even more susceptible to the 'pulling and hauling' of bureaucratic politics than would usually be the case in the weapons procurement process.

It is this process that appears to have been at work with regard to Blue Streak. Even a cursory examination of the BNDSG's final report reveals several aspects that throw doubt upon its reliability as an objective study of Blue Streak's capabilities.

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[38] Baker, D., (1978) *The History and Development of Rocket and Missile Technology*, London: New Cavendish Books, p.202.
[39] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford:

As has been discussed, the vulnerability of a silo-based missile system is dependent on enemy force size and missile accuracy. The BNDSG's assessment of force size is extremely surprising, being solely based on the potential fissile material stockpile without reference to likely force deployments or even economic capability let alone the strategic interests of either Russia or the United States. Also, no attempt is made in the report to compare this with the likely military and economic effort required to destroy 95 *per cent* of the rival systems.

Whilst this approach to threat analysis could merely be condemned for its crudeness, the assessment of Soviet missile accuracy bears a far more serious charge. Some of the figures quoted in the report seem to show definite signs of having been 'manipulated'. The figure of 0.55nm centre of error probability quoted is curious. It was leaked to several newspapers but equates to no known Western missile of this period, despite the inferences of Paragraph 30. It also exceeds, by at least 20 *per cent*, the best conceivable accuracy that the intelligence estimates used by the Ministry of Aviation could attribute to possible Soviet missiles by 1970.[40] What it appears to be is Blue Streak's circle of error probability (CEP) of 1.3nm at 2,500nm, divided by 2.5 to give the estimated CEP of a Soviet missile with a range of 1,000 miles.

However, this would represent a serious misunderstanding of the way in which CEP is calculated. CEP is not directly proportional to range. CEP represents the average circle of error within which 50 *per cent* of a particular missile strike might fall. It principally relates to targeting errors during the re-entry phase. These are largely caused by either mapping errors, the aerodynamic instability of the re-entry vehicle or adverse meteorological conditions over the target. Guidance problems during the boost phase tend to cause such extreme errors that the missile goes 'completely out of the ball park', this generally accounting for the 'missing' 50 *per cent*. The 'coast' phase is, of course, both ballistic and exo-atmospheric and, whilst susceptible to variations in the earth's gravitational field, the effects of this are not at all

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Clarendon Press, chapter 8.

proportional to range. Therefore CEP tends to relate to those missiles that actually arrive over the target and is mainly a measure of the accuracy of the re-entry vehicle. As most distance is made during the 'coast' phase, it can be seen that there is no direct proportional link between circle of error probability and range. Therefore, the accuracy of Soviet missiles would be greatly exaggerated using the BNDSG's formulation. That a misunderstanding should have arisen over this is strange because the Ministry of Aviation had answered Treasury enquiries on this matter only shortly before the BNDSG started to meet, presumably for the benefit of the Treasury representative, BD Fraser.[41]

There are other strange anomalies in the BNSDG report. One in particular seems to damn Blue Streak's silo with faint praise:

> ...to neutralise 60 surface sites the Soviet weight of attack would need to be only half that required to neutralise the same number of underground sites.[42]

In fact, as the Ministry of Aviation had pointed out to the Treasury a short while previously:

> Blue Streak on the surface is probably vulnerable to an overpressure of about 2psi i.e. a radius of 7 nautical miles from a 1 megaton burst. In order to allow for possible error the very optimistic figure of 5psi is assumed. This overpressure is achieved for a radius of 4 nautical miles from a 1megaton burst. The underground siting for Blue Streak is being designed to withstand a one-megaton burst at ½ nautical mile and an overpressure of 140psi. We have no reason to doubt that this would prove practical.[43]

A table was appended that illustrated the percentage of surface based missiles that would escape a 1 megaton explosion at varying distances compared with silo based ones at the same distance.

Figure 4.1 Relative Vulnerability of Blue Streak Launch Sites

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[40] AIR 20/10767 Note to Treasury, 22 April 1959.
[41] AIR 20/10767 Note to Treasury, 22 April 1959.
[42] DEFE 7/1328 BNDSG Final Report, 31 December 1959.
[43] AIR 20/10767 Note to Treasury, 22 April 1959.

	½ nm	1nm	2nm	3nm	4nm
Above Ground	0	0	6	29	50
Underground	50	84	96	98	99

> This table almost certainly understates the advantages of underground siting since it is based on the assumptions about overpressure set out in 3b.[44]

It can be seen that the figure is indeed 2:1 if the blast occurs 4nm away but at the inaccurate and overly pessimistic centre of error probability figure that the BNSDG were working to, ½ nm., the figure was actually 50:0 in favour of the silo-based missiles. At the Ministry of Aviation's 1nm estimate for best possible Soviet missile CEP, the figure climbed to 84:0 in favour. At Blue Streak's 1.3nm circle of error probability, the figure would be in the region of 44:1. This does not even take into account the Ministry of Aviation's over-optimistic figures for the surface survivability of Blue Streak. It is interesting that this 2:1 estimate of the ratio of survivability had surfaced earlier, mooted by the Treasury, and was disposed of by Chilvers of the Ministry of Defence:

> The vulnerability to blast differs not by 2:1 but by something like 20:1.[45]

It seems, however, that the Treasury preferred the estimate of 2:1, for reasons that are not hard to imagine.

The pessimistic tones used to describe Blue Streak's capabilities were not echoed by the language used to describe that of the V-Bomber force:

> Four minutes are at present required to enable the V-Bombers, when operating from the planned dispersal airfields, to take off and fly clear of a nuclear attack on their bases. Given 24hrs warning, the V-bomber force would be able to react in time to evade a pre-emptive attack made with missiles launched on a normal trajectory. If, however, the Soviets were to fire missiles at low trajectories from East Germany, the effective time for evasive action might be as low as three minutes. The Air Ministry believe that with improved techniques it should be possible to reduce V-bomber reaction time. But in any event the arrival of the Soviet missiles would inevitably be

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[44] AIR 20/10767 Note to Treasury, 22 April 1959.
[45] DEFE 13/193 Chilver to Minister, 5 September 1958.

> spread to some extent, and some of the bombers would probably be able to escape. Furthermore, for short periods, during times of tension, it would be possible to reduce this risk by maintaining a proportion of the force on standing patrol. In either event, the capability of the V-bomber force would be likely to exceed 50 per cent.[46]

Three statements in this paragraph stand out as markedly different in both tone and interpretation of threat to those that describe Blue Streak. Firstly, there is the matter of reaction time. No less than eight paragraphs of the report are dedicated to a detailed examination of possible weaknesses in Blue Streak's reaction procedure. As the silo provided Blue Streak's survivability against pre-emption, and that the Deputy Chiefs of Staff at least should have known that fire-on-warning was not acceptable, this was irrelevant. As reaction time provided the V-Force with its principal means of avoiding pre-emption, it is strange that in contrast the sole analysis of this factor, in which the bombers were known to be deficient, is the vague and bizarrely optimistic passage:

> The Air Ministry believe that with improved techniques it should be possible to reduce V-bomber reaction time. But in any event the arrival of the Soviet missiles would inevitably be spread to some extent, and some of the bombers would probably be able to escape.

In the analysis of Blue Streak, it is assumed the British missile will suffer from all manner of serviceability and technical problems, whilst the Soviet forces will operate at 100 *per cent*. When the V-Force is analysed, the reverse is assumed. Exactly what the 'improved techniques' were that would improve V-Bomber reaction time by 25 *per cent* is also questionable. V-Bomber

[46] DEFE 7/1328 BNDSG Final Report, 31 December 1959.

reaction time made no further improvements after technicians at RAF Wittering solved the problem of starting all four engines at the same time in 1958. In fact, after the introduction of the Blue Steel stand-off bomb, things got decidedly worse.[47] The statement that over 50 *per cent* of the V-force would survive a pre-emptive strike is also surprising. A contemporary Strategic Air Command assessment was that no more than 8 aircraft would survive.[48]

If the V-bomber carrier force got an 'easy ride' from the BNDSG, the Skybolt missile was also extremely fortunate with the way in which the committee assessed its capabilities. The rigid manner in which the committee had followed the JIC's dictum that Soviet missile capability should be regarded as identical to that of the West with regard to Blue Streak, was completely ignored in relation to Skybolt. Two assumptions were made that contravened the intelligence advice. Firstly, that the Soviet Union would confine itself to short-range point-defence surface-to-air missiles, when earlier in the year a USAF Bomarc missile had destroyed a supersonic target flying at a range of 500 miles.[49] If the Soviets attained an identical capability, and it was similarly deployed as a perimeter defence weapon, the ability of Skybolt carriers to close within firing range of their targets would be highly questionable. Secondly, the Committee announced that it did not believe that the Soviet Union would evolve an ABM system. This was despite the United States' effort being poured into the Nike Zeus/Spartan ABM system, that it was aiming to deploy by the end of the decade.[50] It was also in contravention of the intelligence assessments informing the Blue Streak development programme.

This led to a major advantage of Blue Streak over Skybolt, in respect of its survival in an ABM environment, not even being considered. The design philosophy of Blue Streak's re-entry vehicle was based around the necessity

[47] Wynn, H., (1994) *The RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment*, London: HMSO, p.411.
[48] *Ibid.* p. 352.
[49] Taylor, M.J.H. and Taylor, J.W.R., (1972) *Missiles of the World*, London: Allan, p.17.
[50] Baker, D., (1978) *The History and Development of Rocket and Missile Technology*,

to evade ABM defences. The resulting design formed the basis for all subsequent American and British work in this field. Polaris and particularly Chevaline, Blue Streak's successors, incorporated this technology and so the BNDSG's incredulity at the possibility of Soviet ABM defence is at complete variance with intelligence advice and procurement policy, both before and after Blue Streak's cancellation.[51] Skybolt was deficient with respect to penetrating ABM screens for two reasons. Firstly, due to the paramount need to reduce weight in airborne systems, not only was Skybolt forced to carry a lightweight O.5 MT warhead but there was also no possibility of it carrying decoys. In the United States, this was to put it at a definite disadvantage to Minuteman II and the Polaris A3, both of which had been originally intended to carry decoys.[52] Secondly, it had not been designed to engage well-defended primary targets. Skybolt was a defence suppression weapon, a precursor of the subsequent Short Range Attack Missile used by SAC from the early 1970s onwards. The USAF B52H Skybolt carriers would have used their missiles to 'clear a path' to the primary targets which they would then have attacked with multi-megaton free-fall bombs.

The RAF's intended use of it against primary countervalue targets was regarded as problematic within the Air Force, and it seemed likely that the rather inadequate, but more powerful, Blue Steel would have to be retained by some squadrons in order to deal with the bigger targets. The fact that targeting was also not considered by the Committee is not only odd, given its brief to assess operational efficiency, but similarly worked very effectively against Blue Streak. Blue Streak was not only more accurate than all the other systems considered, but its warhead was twice as powerful as that of Skybolt. Even in a 'city-busting' role this could make a major difference against a large target like Moscow, which, it was believed, required at least four accurately delivered 1MT weapons to ensure its destruction.[53]

London: New Cavendish Books p.178.

[51] Dommett, R., (1999) *A Brief Account of the Development of Blue Streak and Black Knight Reentry Heads*, RAE Farnborough, p. 6.

[52] Baker, D., (1978) *The History and Development of Rocket and Missile Technology*, London: New Cavendish Books, p.401.

[53] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment*, London: HMSO, p.320.

4.4.2 The Politics of Bureaucracy: its Arena, Ethos and Tactics

As the above examples illustrate, the BNDSG final report departed from being an impartial, objective analysis of the operational viability of Britain's strategic delivery system options on several counts. These include not only the complete lack of any systematic comparative analysis of the various systems but also the use of inaccurate or distorted data, the less than impartial use of vocabulary, an uneven depth of analysis and an incomplete and distorted set of analytical categories. This did not go unnoticed by some of the committee's members. The minutes of the eleventh meeting contain the following passage:

> Although the present draft of the report examined in considerable detail the vulnerability of Blue Steel Mk 2 and Blue Streak, there was no similar assessment of the two possible future mobile deterrent systems.[54]

This was not the only sign of disquiet with the proceedings. The threat analysis that was ultimately contained in paragraph 30 of the final report drew this incredulous and perceptive reaction from a section of the committee:

> Such an attack would not only obliterate this country, but would also inevitably result in a serious radio-active fallout hazard in large parts of Western Europe and the Soviet Union.[55]

These concerns were not heeded in the final report, however. How, therefore, did this state of affairs come to pass? It could be attributed to ignorance on the part of the committee members and gross incompetence on the part of the secretarial staff. This is frankly implausible given the informed nature of the interdepartmental correspondence between the committee members and the great experience of all involved. The real answer, it is

[54] AIR 19/998 BNDSG, 11th Meeting, 3 December 1959.
[55] AIR 19/998 BNDSG, 9th Meeting, 12 November 1959.

argued, is that it was impossible to expect that the BNDSG would produce any thing that was 'impartial' or 'objective'. These concepts were structurally excluded from the makeup of the 'interdepartmental committee'. This was an arena in which subjectivity and partisanship reigned supreme and were recognised as doing so by the participants.

Such battlegrounds of bureaucratic politics are generally notorious for the paucity of the primary sources they leave in their wake. This is largely true but what records they do leave behind can be extremely revealing. The Air Ministry's attitude and tactics with regard to the BNDSG are revealed by a small selection of briefing papers that survive in the Public Records Office collection.[56] These are some fragments of the personal briefing notes of Vice Chief of the Air Staff, Air Marshal Sir Edmund Huddleston, the Air Staff representative at the BNDSG, that were presumably mis-filed in an otherwise innocuous technical file. Although these post-date the cancellation of Blue Streak, referring as they do to the debate a year later concerning the relative merits of Polaris and Skybolt project, due to their rarity and frankness they are extremely valuable in illustrating the range of ploys that the Ministry utilised in the discussion.

The 'gamesmanship' inherent in the arena of the interdepartmental committee comes across from the Chief of the Air Staff's laconic instructions to the Vice Chief, Sir Edmund Huddleston:

> We should avoid tabling anything before we must. We should have smeared the Admiralty proposals enough to preclude their unthinking adoption. We should also be able to play this long.[57]

Within this broad framework, more detailed tactics and ploys were discussed. Figures and statistics were fair game for 'modification'. However, this had to be done within a certain framework. The way in which British defence projects were costed was then, and still is, highly inaccurate. The means by which these costings were constructed was, however, well enough known to

[56] AIR 19/998 VCAS to PS, 19 January 1962.

prevent major 'invention'. Accordingly, certain comparative figures had to be accepted:

> We have been disappointed in our hope that the airborne deterrent would prove substantially cheaper than the sea-borne deterrent.[58]

Fortunately for the Air Ministry, this made it a double-edged sword, as the cost of retaining the bomber force until Polaris was ready had to be incorporated in the Navy figures:

> We have now sent the Admiralty the bomber force figures to be taken into account in their Polaris case. We hope it will shock them severely.[59]

Whilst major figures were difficult to adapt, more minor ones could be manufactured with impunity, as the VCAS admitted when describing how he dealt with one interrogator:

> He questioned the adequacy of our missile float, and suggested that towards the end of the period there would be no margin left for servicing. I countered with the following arithmetic (although I must confess that some of it was made up on the spot).[60]

Several tactics were available for manipulating costings. One of the most popular was to try and find factors that could be used to inflate the opposition's cost analyses. This, however, required a thorough knowledge of

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[57] AIR 19/998 VCAS to PS, 19 January 1962.
[58] *Ibid.*
[59] *Ibid.*
[60] *Ibid.*

their operational procedures and criteria, and was therefore not always successful, as the following example illustrates:

> We tried to pursued the Treasury to say in a supplementary annex to the report that the Admiralty really need another submarine (and quota of missiles) to replace normal peacetime wastage. The conclusion now reached is that on the available statistical evidence of peacetime submarine losses, which is small-, they need another half submarine. I am afraid we cannot hope to make much of this.[61]

Apart from the degrading in the value of the statistical and financial information, certain other products of the inherent bureaucratic competition limited the effectiveness of the committee system.

Due to the necessity felt by each department to concentrate its attention on backing 'sure-fire' winners and to avoid compromising the structural integrity of their arguments, other possible options were often not revealed to an interdepartmental committee. With regard to the BNDSG, the Air Ministry was reluctant to reveal the possibility of 'stretching' the design of the existing V-Bombers as:

> ...to mention them will be regarded as a pathetic attempt to stay competitive by hanging on to basically obsolete aircraft.[62]

Another problem was that the competition could cause a 'drift' in the debate away from the realities of the operational requirement. This was because, in the battle to provide the best 'answer', it was sometimes worthwhile trying to change the 'question'. This was a tactic used by the Admiralty with regard to the BNDSG, by trying to have the deterrent's target list shortened, much to the chagrin of the Air Ministry, who complained:

> The picture is not entirely black if all Departments concerned were still directing their attention to providing the means to damage about 50% of 40 Russian cities.[63]

This could sometimes have the effect of creating totally implausible operational scenarios, something that the Air Ministry recognised had

[61] AIR 19/998 VCAS to PS, 19 January 1962.
[62] *Ibid.*

happened with regard to Skybolt. The Air Staff had been backed into proposing a continuous airborne alert, which both the Air Staff and the Admiralty knew was unnecessary and impractical. They could only hope, vainly as they knew:

> ...that reason dawned and it were agreed that under normal circumstances a continuous airborne alert was not necessary.[64]

However, once this situation occurred there was very little that could be done about it. The participants were as much prisoners of the process as the decision they would finally produce. Although, as has been noted, this material post-dates the demise of Blue Streak by almost a year, it does give an extremely valuable insight into the ethos of such inter-departmental committees. The attitude displayed by the Air Staff in the document towards its submissions to the committee leaves little doubt that it would be extremely unwise to take the debate within it at face value.

In fairness to the BNSDG, it must be acknowledged that even without the intrigues of bureaucratic politics the task it was facing was extremely onerous. All the systems that they were considering had yet to enter operational service and many of the problems associated with each system would not become apparent until this time. Finding realistic ways of making comparison between these systems was therefore extremely difficult and the committee was left with trying to make judgements based on those factors that were already apparent.

The different technologies of each system displayed their strengths and weaknesses to varying degrees depending on their stage of development. The principal problem for Blue Streak in this respect was not its level of

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[63] *Ibid.*
[64] AIR 19/998 VCAS to PS, 19 January 1962.

vulnerability but that its vulnerability was crudely calculable. The airborne deterrent was, very probably, far more vulnerable but calculating this was subject to so many variables that it became like 'the Dance of the Seven Veils' always leaving something to the imagination.

However, whilst this can seen as an extenuating explanation for the quality of the analysis within the final report, it is not sufficient to justify the discrepancies in this document in its totality. If the BNDSG's report is as compromised as it appears and the committee is such an arena for bureaucratic politics, then the unanimity of the Chiefs of Staff regarding Blue Streak suddenly seems extremely suspicious. One or more of them would surely have cried foul if they had been truly committed to Blue Streak. Even Harold Macmillan expressed mild surprise at the Chiefs of Staff's concurrence regarding the redundancy of the missile, which he noted was, 'presented with a unanimity hitherto not achieved.'[65]

The use of such subterfuges as are found in the BNDSG report strongly suggests hidden motives. As in 'Murder on the Orient Express', it seems Blue Streak was 'done away with' by everyone on board. Having raised the possibility that almost all of the bureaucratic actors might have had something to gain from the demise of Blue Streak, it becomes necessary to postulate what this might have been.

4.5 The Actors and their Motives

Although there were six Ministries represented on the BNDSG, only two can be considered as having 'hidden agendas' as far as Blue Streak was concerned and only one of these manifested itself. With one exception, the other four Ministries had quite open objections. The Admiralty would, in

[65] Macmillan, H., (1972) *Pointing the Way 1959-61*, London, Macmillan, p. 251.

general, have preferred a naval operated deterrent based on Polaris but, as will be discussed in the next chapter, there was some opposition within the Navy to this that limited the Admiralty's freedom of manoeuvre. The Army would have preferred the money to be spent on conventional forces but was generally resigned to the improbability of this occurring. The Home Office was greatly exercised by the civil defence issues raised by the basing of Blue Streak but this was strictly in accord with its responsibilities. The same can be said for the Treasury. Although it was an extremely strong and vocal opponent of the project on the grounds of cost, this was, in most respects, only as it should be. There is some slight evidence of it colluding in some bureaucratic politics ploys, particularly with regard to denigrating the survivability of Blue Streak's silo, as has been described, but this is minor in comparison with the politicking of, for instance, the Air Staff.

In comparison to the others, the Ministry of Defence was a strong supporter of the project, although this diminished with the demotion of Sandys to Minister for Aviation. However, its influence was still slight at this stage, apart from the quite considerable influence of the Chief Scientist. However, the Chief Scientists generally held quite strong opinions of their own that only rarely resembled that of the Ministry. The situation pertaining during the prime Blue Streak years can be seen as fairly typical, with a pro-Blue Streak Minister and Ministry often being represented by a Chief Scientist, Sir Frederick Brundrett, who much favoured Polaris.[66]

The two actors whose attitude towards Blue Streak was not all what they seemed were the Ministry of Supply and the Air Staff. Their positions will now be described, along with those of another group who were not represented on the BNDSG but who nonetheless established the committee and could be described as holding its chairman in sway. This was the political establishment who, despite wishing to be 'advised' by the BNDSG, already had their own particular agendas with regard to Blue Streak, as will now be related.

[66] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford:

4.5.1 The Politicians

That the BNDSG would find against Blue Streak was almost certainly no surprise to Duncan Sandys. He had been suspicious of the Powell Committee from the very beginning. In the early days of June 1959, just before the committee formed, Sandys' private secretary sent this memorandum to Sir Richard Powell:

> The Minister discussed with you this afternoon the proposed Study Group on the British deterrent. He felt that we had only recently reached our conclusions on the need and form of the British contribution to the nuclear deterrent. Little further information would be available, and in his view, the time was not yet ripe for a further study of this problem. He asked that if this matter was raised in your coming meeting at Chequers, you should say that he was considering setting up a Study Group, and you should try to leave this matter open. You agreed to discuss this further with the Minister after discussing it with Sir Frederick Brundrett and after your visit to Chequers.[67]

Such 'study groups' and 'working parties' were birds of ill omen for any project. They were viewed as a traditional means of procrastination and project assassination, as has been seen with regard to the Low Altitude Bomber. In this respect, Sir Richard's summons to Chequers ahead of the formation of the Study Group must have seemed particularly ominous to Sandys.

Political objections to Blue Streak were based on several factors. Some of these were very openly articulated, such as the economic objections to the missile, whilst others remained less obvious. For example, it is highly likely the missile's association with Sandys did not help it in some circles. However, perhaps the most decisive objection to Blue Streak was a growing antipathy to the idea of basing the deterrent on British soil. Perhaps

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Clarendon Press, p. 219.

surprisingly, it was based on both practical political and strategic considerations. Its significance has been somewhat overlooked in the subsequent historiographical debate but was widely recognised at the time in official circles. For example, a year after the cancellation of Blue Streak, Sir Robert Cockcroft, the former Controler of Guided Weapons and Electronics (CGWL), wrote to Sir Solly Zuckerman:

> Blue Streak was cancelled because it was not politically viable rather than because it could be pre-empted. The scale of pre-emption was admitted to be of the order of 3,000 megatons. Supporters of the system argued that this was so excessive that pre-emption could be ignored in practice. The argument was not accepted and vulnerability was advanced as the main reason for cancellation. The real reasons were more fundamental although still not clearly appreciated. I suggest no British statesman could visualise exploiting a deterrent threat which if mishandled could only lead to the annihilation of the whole country; nor could he believe that a threat involving such consequences would be taken seriously by an opponent.[68]

The full implications of this have tended to be lost in the debate between the economics-driven orthodox account and the strategic primacy of the revisionist approach. The revisionist argument has been greatly strengthened by many statements in a superficially similar vein. For instance, Harold Macmillan gave his own opinion of the cause of the cancellation in his memoirs:

> It was not the financial considerations which swayed the Defence Committee, including the new Minister of Defence, Harold Watkinson. It was the almost irresistible case put by the Chiefs of Staff in favour of replacing weapons fired from a stationary position with a missile delivered a mobile firing point, now such a method seems practical.[69]

Whilst this seems a fairly categorical rejection of the orthodox argument regarding the primacy of financial considerations in favour of the revisionist strategic rationale, there is an element of ambiguity regarding one certain aspect of it. What exactly was the advantage of such mobile systems? The

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[67] DEFE13/617 Sabatini to Powell, 4 June 1959.
[68] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press, p. 115.

revisionist perspective was informed by the minutes of the Defence Committee meeting, which made it plain that Chiefs of Staff thought that the issue was that of the vulnerability of the system. Macmillan's memoirs confirm that some kind of vulnerability is the issue, as they state:

> Nevertheless, it was difficult to resist the pressure which was beginning to grow in many quarters against the concept of ballistic rockets fired from a fixed-and therefore vulnerable-site.[70]

However, there is reason to believe that the vulnerability that weighed on Macmillan's mind, at least, was not that of the system itself. He was to state in his report to the Queen regarding Blue Streak:

> Moreover for political and moral reasons I am very anxious to get rid of these fixed rockets. This is a very small country, and to put these installations near the large centres of population - where they would have to be - would cause increasing anxiety to Your Majesty's subjects.[71]

By 'moral reasons', Macmillan was almost certainly referring to the vulnerability of the civil population to fallout from a pre-emptive strike that had so preoccupied the Home Office with regard to the siting of Blue Streak. The reference to Britain as a 'very small country' is a recurring theme in political commentary regarding nuclear issues in Britain, as is witnessed by Thorneycroft's later remarks about 'this small island'.[72] Again, this appears to confirm the prevalence of the 'unique vulnerability' perspective amongst the political elite as well as the various strata of the military establishment in Britain at this time. However, it would appear that the 'political' aspect was actually more of a concern to the Prime Minister. He contrasted the 'increasing anxiety' that Blue Streak would cause with the fact that:

> ...a bomber is somehow accepted on its bombing field and a mobile weapon, either on a truck or better still a submarine is out of sight.[73]

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[69] Macmillan, H., (1972) *Pointing the Way*, London, Macmillan, p. 251.
[70] Macmillan, H., (1972) *Pointing the Way*, London, Macmillan, p. 251
[71] *Ibid.* p. 259.
[72] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64,* Oxford: Clarendon Press, p. 303.
[73] Macmillan, H., (1972) *Pointing the Way*, London, Macmillan, p. 259.

This makes it clear that more than just 'nuclear vulnerability' issues were behind the unease felt by Ministers regarding basing. A further illustration of this comes from a memo written by Peter Thorneycroft's private Secretary to the Chief of the Air Staff:

> It may be helpful if I were to add that in SoS's view attention should be focused on primary considerations affecting the choice of sites. Among these he would include the political acceptability of certain areas (as already recorded in the file). He is not, however, inclined to attach the same importance to the fall out argument which does not appear to be relevant in the deterrent context.[74]

This makes it clear that the political sensitivity of the sites was not synonymous with the vulnerability of the population to nuclear fallout. The particular groups who it was feared would make Blue Streak politically unacceptable are identified in a memorandum from the Under Secretary for Air's Private Secretary in July 1959, which enquired:

> ...what difficulties are likely to be encountered with Local Authorities and Landowners?[75]

This is emphasised by the VCAS' comments which were forwarded to the Private Secretary to the Secretary for Air in December. VCAS thought:

> ...the redeployment to other areas, particularly where non-governmental land is involved may incur major political problems.[76]

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[74] AIR 20/10122 PS (SoS) to CAS, 23 December 1959 (emphasis in the original).
[75] AIR 20/10122 PS/US of S to DUS (I), 21 July 1959.
[76] AIR20/10122 PS/VCAS to PS/SoS, 4 December 1959.

It can be imagined that there was great political sensitivity against alienating powerful and traditional Tory supporters, losing marginal constituencies and local authorities and possibly even getting embroiled in an unseemly fracas with left wing councils. In addition to this, CND activism was reaching the first of its great highs and the prospect of having to permanently police 60 or more scattered Blue Streak silos would not have seemed attractive, either to the government or local authorities.

It might be argued that CND was not the only source of anti-nuclear opinion that could have afflicted Blue Streak. For a variety of reasons, there was a definite body of opinion within official circles that greatly doubted the utility of the independent deterrent and there is reason to believe they were not un-represented within the BNDSG. The issue surfaced in discussion more than once and the Treasury, the Home Office, the Army and the Navy all had their doubters. The Foreign Office believed that the nuclear deterrent was a 'wasting asset'.[77] The Air Staff was in no doubt that such a coalition existed, with members at the very highest level within the defence establishment. Its worry for the decisive Defence Committee meeting regarding Blue Streak was that:

> It is to be hoped that nobody at the Defence Committee will revive the suggestion, in the context of tomorrow's discussion, that the deterrent is too expensive on any hypothesis.[78]

Objections to the concept of the nuclear deterrent within the British defence establishment had a long pedigree, from Sir Henry Tizard onwards. It was also manifest in the political arena. Even the Conservative party had its sceptics, notably Reginald Maudling, in the period under discussion.[79] The influence of such a coalition can be found concealed within paragraph 39 of

[77] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Role and Deployment 1946-69*, London: HMSO, p. 421.
[78] AIR19/998 Brief for SoS (Air) & CAS, 24 June 1960.
[79] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 278.

the BNDSG final report:

> None of the three weapons systems is thus operationally or technologically valid in the sense that it could in all circumstances be certain of inflicting the target level of damage on the Soviet Union. None would have other than a limited retaliation capability. But before embarking on a pre-emptive attack on the United Kingdom alone, the Soviet Leaders would need to be satisfied that they could discount the possibility of retaliation from the United States, whose bases the Soviet union could not neutralise by pre-emptive attack.[80]

The evolution of this passage and the message it contained can be found in the minutes of the ninth meeting of the BNDSG on 19 November 1959. The prospect of the 1200 MT pre-emptive strike that the BNDSG postulated against Blue Streak gave rise to the following observation:

> ...in such circumstances the United States would be bound to react. For this reason it was surely unrealistic to assume that the Soviet leadership would contemplate an attack of this magnitude on the United Kingdom alone.[81]

This led to the conclusion that:

> If the credibility as a deterrent of the British nuclear forces depended to this extent on the existence of the United States deterrent forces it could be argued that it was unnecessary for the United Kingdom to provide any nuclear deterrent forces.[82]

At this point the Chairman, Sir Richard Powell, intervened in an attempt to curtail this line of reasoning. He stated:

> The political purposes for which the British nuclear forces were required formed part of the current wider studies of future United Kingdom policy, and it is undesirable that the study group should attempt to duplicate that examination.[83]

During the eleventh meeting, an attempt was made to expunge the anti-deterrent comments from the provisional report, into which they had been automatically placed by the secretaries. The minute keepers were instructed

[80] DEFE7/1328 BNDSG Final Report, 31 December 1959.
[81] AIR 19/998 BNDSG 9th meeting 12 November 1959.
[82] *Ibid.*

that:

> ...the paragraphs assessing the effectiveness of Blue Streak in the deterrent role should be limited to a summary of the technical advantages and disadvantages of the weapon. The political arguments, which were not strictly relevant to the study groups enquiry, should be omitted.[84]

The manner in which the minutes were recorded unfortunately precludes the identification of those behind the 'anti-deterrent' statements but there is evidence to suggest that this particular advocacy coalition was a fairly powerful grouping. The objections of those who felt that Blue Streak's threat analysis was unrealistic had their views removed from the final report. The anti-deterrent coalition, on the other hand, were sufficiently powerful to have their views incorporated in the final report, against the opposition of the Chairman, even if they were encoded as:

> Soviet leaders would need to be satisfied that they could discount the possibility of retaliation from the United States.[85]

Decoded, this read essentially that the British deterrent was a needless duplication of American effort. It was a view that was to persist in the BNDSG, almost inevitably, it might be argued. The ambiguities of British nuclear policy were made obvious in a uniquely vivid manner to the BNDSG by the dichotomy between their terms of reference and the actual political purpose of the deterrent. Two years later, the BNDSG's new chairman, Sir Robert Scott, was to put the matter even more forcefully:

> The time has come to consider giving up the independent control of the British nuclear forces and their delivery systems, and we should negotiate the best terms

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[83] *Ibid.*
[84] AIR 19/998 BNDSG 11th Meeting, 3 December 1959.
[85] AIR 19/998 BNDSG Final Report, 31 December 1959.

possible with the Americans to hand over control to them.[86]

The Cabinet did not concur, and the BNDSG was eventually disbanded.

How the anti-nuclear coalition combined with the other coalitions and interest groups in the BNDSG is not clear, although it can be imagined that it would find much common cause with those who did not want the deterrent basing on British soil. Due to this, the exact configuration of the political opposition to Blue Streak is not entirely clear, but nonetheless it is probably true to argue that resistance to the basing of missiles on British soil best defines the axis of the decisive political advocacy coalition against Blue Streak. The Home Office worries about the effects of fallout on cities from an attack on the Blue Streak sites were not universally seen as relevant but allying this with fears of political unpopularity in those constituencies where the missile would be based, particularly ones where no nuclear installations already existed, seems to have drawn quite a wide political coalition within the Government.

This purely political advocacy coalition differs from those described in the revisionist literature, which comprise of both military and political members and focused on the operational vulnerability of the weapon system. The significance of this particular line of political opposition was that though Treasury pressure was, of course, intense, it could not have been decisive if the military backing behind Blue Streak had been solid and the attitude of the rest of the political establishment merely ambivalent. However, against both a hostile military and political establishment Blue Streak could not survive.

The chief significance of the political objections to Blue Streak is that they led to the creation of an arena in which Blue Streak could be disposed of, namely the BNDSG. The two other essential prerequisites for Blue Streak's demise

[86] DEFE 13/3/11 Scott to Watkinson, 7 July 1961, quoted in Clark, I., (1994) *Nuclear Diplomacy and the Special Relationship: Britain's Deterrent and America 1957-62*, Oxford: Clarendon Press, p. 377.

were the complicity of the Ministry of Supply and the Air Staff in providing a convincing justification for its cancellation. As will be described, although the reasons that caused the Air Staff to turn on Blue Streak are fairly discernible, the ineffectual nature of the Ministry of Supply's defence of Blue Streak is less explicable.

4.5.2 The Ministry of Supply

The poor showing made by the Ministry of Supply in attempting to defend Blue Streak within the BNDSG is one of the more perplexing aspects of the cancellation story. Junior officials within the Ministry can be seen attempting to refute the misinformation being circulated regarding the missile[87] and Duncan Sandys, the Minister of Aviation, was to make strenuous efforts within the Cabinet to save the Blue Streak. However, the performance of the Ministry of Supply's representative on the BNDSG, Sir William Strath, was almost totally lacking in effect; several very damaging pieces of misinformation circulating within the Powell Committee went completely unchallenged. No concrete reason can be given for this, although two observations can be made. It should be noted that these are both purely conjectural, although they do have some explanatory power with regard to an issue that is otherwise a mystery.

As has been suggested, the very fact the BNDSG came into being can itself be seen as evidence of a desire within the government to be rid of Blue Streak and, as such, the choice of membership of the committee is a matter of some interest. With regard to the Ministry of Supply, it is notable that Sir Richard Powell invited Sir William Strath to be their representative. Sir William was author of the Strath Report. As John Baylis notes:

> ...in this latter Report, the devastating consequences of thermonuclear war for a small

[87] AIR 20/10767 MoAv note to Treasury, 22 April 1959.

densely populated island like Britain were spelled out for Ministers in graphic detail.[88]

This gave more definite form to the vague notion of Britain's unique vulnerability to atomic attack and worsened the consequences many times over by its consideration of the use of thermonuclear weapons.

The report had great impact on the strategic debate in Britain.[89] It is not unreasonable to assume that the implications of his own report would weigh heavily on Sir William's mind. Given that one of the major advocacy coalitions against Blue Streak was principally opposed to the basing of the deterrent on British soil, at least partly due to the consequences for the civil population of a pre-emptive strike against it, the fact that the Ministry of Supply failed so notably to refute the disinformation circulated within the BNDSG may not seem so surprising. This can only be conjecture, however, but there are few other explanations for this failure.

One other observation might be made regarding the Ministry of Supply and Blue Streak, in that at the time the project was cancelled, the great bulk of the Ministry's task concerning it had already been completed. Virtually all design work on both the weapon and the silo had been finished and the major infrastructure for trials, testing and production was largely complete. Aside from trials themselves, which subsequently went almost flawlessly, only the supervision of the production of both the weapon and the silo by the major sub-contractors remained. It is interesting to note that the TSR 2 project reached almost exactly the same stage of completion before it, too, was cancelled. It might be that the Ministry of Supply, seeing that the writing was on the wall for the project and that there was little more that the Ministry could gain from it, insulated itself against any backlash by not obstructing those interests that opposed it. Aside from pure incompetence, which is a somewhat hackneyed accusation with regard to the Ministry of Supply, it is otherwise difficult to understand why the Ministry did not make more of a fight of it within the BNDSG. By not doing so, they gave an easy ride to the

[88] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p.361.

Government and the Air Staff in their attempts to dispose of Blue Streak.

4.5.3 The Air Staff

On the 9 February 1960, the Minister of Defence, Harold Watkinson wrote to Duncan Sandys

> The Chiefs of Staff have been considering their attitude to Blue Streak and have now given me their unanimous advice that they find Blue Streak, as a fire first weapon, unacceptable. I am afraid Dermot sold the pass here to begin with.[90]

'Dermot' was Dermot Boyle, Chief of the Air Staff, and Watkinson's allegation that it was he who was primarily responsible for the Chiefs of Staff rejection of Blue Streak is at complete variance with almost all existing accounts of Blue Streak's cancellation. Whilst this correspondence between Watkinson and Sandys remained unavailable to historians until the early 1990s, there was at least one hint of the nature of the Air Staff's involvement in the demise of Blue Streak in the public domain at an earlier date.

Richard Neustadt, in his classic *Report to the President* regarding the Nassau conference, described to President Kennedy his belief that the most salient features of the bureaucratic politics of Blue Streak were:

> ...mounting costs plus RAF distaste for 'sitting in silos.'[91]

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[89] *Ibid.* p. 362.
[90] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press, p. 108.
[91] Neustadt, R., *Report to the President: Skybolt and Nassau*, Aberystwyth Nuclear History Archive (copy), p. 7.

This contemporary recognition of the part played by the Air Staff's bureaucratic politics in the cancellation of Blue Streak has passed unnoticed in the historiography of the subject, despite the prominence of Neustadt's report as a primary source in such studies.[92] In some ways, this is unsurprising in that it does not accord with either orthodox or revisionist perceptions of the cancellation. However, it was also true that there was little or no other supporting documentary evidence available to support this, as is almost always the case with bureaucratic politics. It is a matter of great good fortune, therefore, that the last Air Staff Blue Streak file 'retained by department' – the VCAS's personal Blue Streak file AIR 20/10122 – was finally released in 2000, somewhat redressing this situation.

One of its contents is a memorandum entitled *Future Bombing Policy*, which outlines possible Air Staff bureaucratic politics strategies. As has been stated, such explicit documentation is rare in the extreme with regards bureaucratic politics, the only other examples encountered being the misfiled VCAS briefing papers of AIR 19/998. Though the *Future Bombing Policy* paper, both unfortunately and intriguingly, is unsigned and has no circulation list, it does fairly unambiguously describe the Air Staff's bureaucratic politics objectives concerning Blue Streak.[93] One of its main themes is the difficulty of framing threat analyses so that they meet the requirements of all the Air Staff's bureaucratic politics agendas. Its conclusions regarding this matter reveal the main Air Staff bureaucratic politics agendas. It states:

> ...where the analyses have produced results of importance they tend to produce a set of interlocking incompatibilities. For example, the V-Force, whilst on the ground in the UK, turns out to be very vulnerable to SRBM attack, but if we use this information to support an extensive deployment of Blue Streak we damage the financial prospects for a successor to Blue Streak. If, to counter this, we foresee a time when the Blue Streak underground site becomes vulnerable to enemy attack, and when defences against ballistic missile attack begin to appear, then we raise serious doubts about the

[92] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon; Clark, I., (1994) *Nuclear Diplomacy and the Special Relationship: Britain's Deterrent and America 1957-62*, Oxford: Clarendon Press, p. 377.

[93] As it was in Sir Edmund Huddleston's personal file and appears to be a draft, the VCAS would seem to be the most logical author. Intended distribution beyond CAS, DCAS and possibly ACAS would seem unlikely due to its content.

> deployment of Blue Streak. If, on the other hand, we agree that Blue Streak will remain invulnerable into the indefinite future, we gain the case for its deployment but lose the cases for both for a successor and for Air Defence.[94]

The nature of the 'successor' is made abundantly clear later in the document when the principal object of its recommendations is defined as being to 'improve the prospects for any future manned bomber found to be necessary.'[95] It is also extremely significant that the secondary objective is described as offering the RAF 'more freedom of balance between global and limited war.'[96]

The document also confirms that the Air Staffs own investigations found the V-Force to be vulnerable to pre-emptive missile strike but not Blue Streak, exactly the reverse of what the Air Staff argued in the BNDSG.

It is clear from this that the Air Staff were not interested in possessing Blue Streak as a system in its own right. Blue Streak was seen only as a means to attaining two other ends. These were the retention of the manned fighter and the re-introduction of the manned bomber. The ideal scenario was that Blue Streak would be deployed but found to be vulnerable to conventional air attack, therefore requiring a rejuvenated Fighter Command to protect it. It would then fade from the scene as the introduction of the ABM made some form of manned bomber the only viable strategic delivery systems. Blue Streak was therefore both a peg to hang Fighter Command on and also a stopgap to retain the deterrent for the RAF until what the Air Staff fondly hoped was the transient era of the ballistic missile was over.

Evidence for both these objectives can be found in other Air Staff reports.

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[94] AIR20/10122 Memo Future Bombing Policy, 7 July 1959.
[95] *Ibid.*
[96] *Ibid.*

One of the most explicit in terms of revealing bureaucratic politics agendas is that detailing the case for the retention of Fighter Command. This is contained in another AIR20/101 document, *Report by the Air Ministry Working Party to Consider the Defence of Blue Streak Sites.*[97] Like the *Future Bombing Policy* document, this was one of a number of reports commissioned in June and July of 1959 almost certainly to prime the Air Staff representatives at the BNDSG.

The case put forward by the report was that Blue Streak would not be vulnerable to missile attack until at least 1970. However, until this time, it would be vulnerable to a bomber attack of the following nature. Firstly, there would be an attack by low altitude bombers on coastal radar sites and surface to air missile batteries. These targets having been destroyed, a large force of some 400 high altitude medium bombers would then attack the Blue Streak silos, low altitude bombers being unable to do this due to problems in both navigating over land and identifying the targets.

If this scenario is examined in detail, it can be seen that its argument was very carefully constructed being based on several premises that all inexorably led to the need to retain a powerful manned fighter force. Firstly, the assessment that Blue Streak would not be vulnerable to missile attack until after 1970 put it beyond the remit of the Powell Committee and left a window open for the utility of fighter defence. Secondly, it assumes the destruction of the radar and missile sites by low altitude bombers.

It was at this point that the contrived nature of this threat analysis becomes glaringly apparent. In order to create the opportunity for a large powerful radar-equipped fighter to jump centre stage, the low altitude bombers have to be induced to turn round and head for home. This is because low altitude bombers at this stage could not be tracked by radar or engaged by missiles or fighters, which was not conducive to the retention of Fighter Command. The report contrives this by stating that low altitude bombers would not be able to

[97] AIR20/10122 *Report by the Air Ministry Working Party to consider the Defence of Blue*

get a navigation fix on anything other than a coastal target. This was despite the fact that the Air Staff was developing TSR2, intended to enter service at exactly the same time as Blue Streak and which was to be equipped with a navigation system that would ensure an accuracy that could be counted in yards against any target, day or night, at low-level. Instead of the low-level bombers ignoring the radar and surface to air missile sites and attacking the Blue Streak sites themselves, the report envisaged the job being attempted instead by a large force of high altitude bombers, which, due to the attentions of the low altitude bombers, have not now been destroyed by surface-to-air missiles. Here, finally, comes a threat against which Fighter Command can leap to the rescue.

Documents such as the *Future Bombing Policy* paper and the *Report by the Air Ministry Working Party to Consider the Defence of Blue Streak Sites* demonstrate clearly the extent to which Blue Streak was assailed by the Air Staff's bureaucratic politics agendas. The problem remains, however, directly linking these agendas to the type of bureaucratic politics tactics described earlier in this chapter. Fortunately, there is some evidence that perhaps the most effective piece of disinformation used to disparage Blue Streak, the suggestion it was only suitable for use as a launch on warning weapon, did actually originate in the Air Staff camp. This is contained in a note attached to the *Report by the Air Ministry Working Party to Consider the Defence of Blue Streak Sites.* The note gives the following two conclusions that it was felt could be taken from the report:

> There is little doubt that in the time-scale under discussion the enemy <u>theoretically</u> will have the ability in terms of accuracy of delivery, yield and numbers of weapons to destroy a large proportion of the 'Blue Streak' force, unless:
>
> (a) a <u>realistic</u> active defence system is provided;
> (b) a politico/military decision-making organisation is set up which can match the very short reaction time of 'Blue Streak and which is capable of giving the order to launch before the force can be destroyed on the ground, *i.e.*

Streak Sites, 18 June 1959.

before the impact of the first enemy weapon.[98]

Section (b) of this conclusion is extremely significant with regard to the bureaucratic politics of Blue Streak, as it may indicate the origins of the accusation that Blue Streak had a poor 'reaction time' and was only suitable for 'launch on warning'. The phrase 'launch on warning' became synonymous with Blue Streak both in its final days and afterwards. It was used as a pejorative term to denote the systems strategic obsolescence, supposedly based on the weapon's poor 'reaction time'.

How this arose is one of the great mysteries of the cancellation. As the investigation earlier in this chapter has shown, Blue Streak was a fully survivable second strike system for which the question of reaction time had no relevance and, in any case, its putative reaction time was, in fact, excellent. The very provision of a hardened silo would not have been required if the system had been intended for 'launch on warning'. Explanations as to how this persisted in the historiography have been discussed, but how it arose at the time should now be examined. Despite the manipulation of the 'launch on warning' concept providing perhaps the most visible evidence of a bureaucratic politics agenda at work, identifying which actual one is problematic.

On the face of it, the suggestion that a special politico-military organisation be formed so that Blue Streak could be launched on warning can be seen as a very crude bureaucratic politics ploy. Retaining Fighter Command was something that would be deeply resisted by the Treasury and the Ministry of Defence. Duncan Sandys saw the abolition of the Command as one of the principal financial benefits that could be accrued from the 1957 Defence White Paper. In order to make the retention of Fighter Command seem more palatable, the rather outlandish suggestion to have a new and constitutionally suspect body to 'launch on warning' was put as the only other alternative.

This may, in fact, be all there is to 'alternative (b)'. However there are several

[98] AIR 20/10122 Note re *Air Defence of 'Blue Streak*, 21 June 1959 (emphasis in the original).

puzzling aspects of both the suggestion and the Blue Streak project itself that could indicate otherwise.

Firstly, it is notable that in this case, Blue Streak's reaction time is described as being 'very short', rather than the 'slow' that usually forms the rationale for the 'launch on warning' hypothesis. The fact that this suggestion is therefore built around the strengths of the system, advocating as it does that a command and control system be set up that can 'match the very short reaction time of Blue Streak' is at odds with the usually negative basis of most bureaucratic politics ploys. This gives an impression that the idea was not concocted specifically for the Air Defence paper but had some other origin as a positive proposal for exploiting the capabilities of the system. Certainly it seems a far too striking and unconventional suggestion to suddenly 'pull out of the hat' at the end of an otherwise fairly predictable report on Air Defence, indicating perhaps that the idea had already had some exposure in Air Staff circles.

What, however, would be the purpose of actively advocating 'launch on warning' as a positive strength of the system to the extent that a specific 'politico/military decision-making organisation' would be required? The clues to this may lie in several inexplicable 'loose ends' relating to the targeting of Blue Streak.

One particularly intriguing aspect of the Blue Streak project was the targeting for the system. As far as the national unilateral response was concerned, the original 40 nuclear bomber airfields had been swapped for an arbitrary 40 cities when counterforce targeting was abandoned. In the early 1960s, this was reduced to an equally arbitrary 15 cities as Britain's strategic capability dwindled. With the abandoning of counterforce targeting, with its specific military objectives, quantifying the exact scale of the necessary countervalue retaliation that could be expected to deter the enemy in the first place could only be done in arbitrary terms. However, it appears Blue Streak's targets would not be the standard 40 cities, but a far more specific 33 city target set.[99]

Such a specific number smacks of a definite warfighting strategy with particular objectives. This begs the question as to what kind of a warfighting strategy this could be? Britain's previous warfighting strategy had been a counterforce strike against the 40 Russian nuclear bomber bases which directly threatened Britain. This had been abandoned with the advent of the ballistic missile and the massive proliferation that this brought to the number of military targets threatening Britain. Therefore, due to the forces available any warfighting strategy proposed must focus on something other than raw military potential. Arguably the best candidate for this would be a political decapitation strategy targeted at the 25 Soviet republic capitals and the bigger cities of Russia.

A decapitation strategy would certainly fit with the composition of the advocacy coalition behind Blue Streak. As has been discussed, this can be seen as comprising of those who believed in a dedicated and operationally effective deterrent, as opposed to those who wanted a symbolic deterrent principally optimised for limited war. Underlying the quest for an operationally effective deterrent was the desire for 'active defence' against Britain's nuclear vulnerability, which materialised as the counterforce strike strategy. As has been stated, however, a pure counterforce strike against military threats was no longer viable by the mid-1950s. It has generally been accepted that the end of counterforce strike marked the end of the quest for an active defence against nuclear attack. That such a powerful interest group should totally evaporate without seeking options seems, however, somewhat unlikely. A decapitation strategy would be the most likely alternative given the size of Britain's nuclear strike capability at the time. Some consideration had been given to a decapitative strategy in the late-1940s when the counterforce argument was first evolving. In July 1949, a Joint Planning Staff paper outlined the need to destroy 'Soviet state power' in the following terms:

> ...the complete removal of the Soviet regime will be an essential requirement for

[99] Air 20/10122 Report by the Air Ministry Working Party to consider the Defence of Blue Streak Sites, 18 June 1959.

> achieving allied war aims...We considered that effective air attacks upon the towns, which are centres of control - political and administrative - is the best method of creating conditions in which the Communist party and the administrators could not control and the secret police could not suppress. When control is disrupted the armed forces will not be able to fight effectively.[100]

A prime link between the 'launch on warning' concept and a 'warfighting' measure such as decapitative strike was the fact that the effectiveness of such measures was really dependent upon speed at which they could be undertaken before Britain was destroyed. This was well appreciated in the early debates in Britain on nuclear strategy. As John Baylis has pointed out:

> ...the requirement to strike the first blow at Soviet capabilities was to be stated with ever increasing candour in the papers of the Chiefs of Staff in the late 1940s and early 1950s.[101]

The proposal to create a politico/military organisation to expedite the launching of the Blue Streak force was therefore in line, for instance, with plan GALLOPER of March 1950 which 'emphasised the vital importance of launching the strategic bomber offensive as soon as possible after hostilities begin'.[102]

The phrase 'politico/military decision-making organisation' infers something more elaborate than just a straight-forwards pre-delegation of authority to enable launch on radar early warning. However, in the circumstances in which a decapitative strike might be necessary, such a politico/military institution would be essential in promptly deciding exactly what constituted both 'hostilities' and 'warning'.

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[100] DEFE4/22 JP(48) 59 (Final 2nd Revise), 20 July 1949: Quoted in Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 91.
[101] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon, p. 95.
[102] *Ibid.*

The intriguing possibility therefore arises that at the root of the 'launch on warning' accusation against Blue Streak may lie an attempt by some of the systems supporters to sustain an active defence strategy after the demise of counterforce targeting. This might well have generated extra antagonism towards the system and given additional significance to the epithet 'launch on warning' used to denigrate Blue Streak. Although this is entirely conjectural, it can be seen at least that the origins of the 'launch on warning' accusation, whether merely traced back to the *Air Defence of Blue Streak* paper or to a source that pre-exists that, does not contain the allegation that Blue Streak had a 'poor reaction time'. In fact the reverse is stated. Therefore, at some subsequent stage, this concept must have been 'modified' by opponents of the weapon to make it appear far more negative. As the concept originated in the Air Staff, and the Air Staff did nothing to correct its distortion, it can well be argued that it was they who were responsible for that distortion.

Despite the energy being expended by the Air Staff on fighting a bureaucratic politics offensive to maintain its 'institutional essence', there were already those within it for whom the problems caused by the complexity of the Air Staff's bureaucratic politics agendas were becoming increasingly apparent. One of these was the unknown author of the Future Bombing Policy paper. As has been noted, this officer was particularly concerned by the increasing difficulties encountered in finding a cohesive logic with which to construct threat assessments that could accommodate all the Air Staff's agendas. The future Bombing Policy report underlined both the cause and consequences of this:

> It may be that the difficulties are not in logic but in policy. As things stand, the RAF is endeavouring to hold single-handed the whole strategic offensive front at all points against all comers. In this situation no weaknesses can be admitted either to the other Services or to the Treasury. As we get further in time and techniques from the last war, the plans for ten or fifteen years ahead get hazier and less reliable, and the RAF monopoly gets more difficult to defend.

It then went on to make a startling suggestion:

We might instead consider a different approach in which the need for a mixed strategic offensive force is a primary and starting assumption...The new features of this situation would probably be the admission of the Royal Navy to the strategic offensive club with the RAF as senior member. This could have considerable advantages.[103]

This demonstrates an awareness by at least some within the Air Staff that the 'dog in a manger' attitude of many of their colleagues towards both the possession of the deterrent and the determination of the force's exact nature were in danger of backfiring seriously. The reliance upon bureaucratic politics stratagems to maintain the service's institutional essence was both harmful to the combat effectiveness of the armed services, individually and as a whole, and, in any case, would be unsustainable in future. Its detrimental effect on weapons procurement decisions was acknowledged by the recognition that without bureaucratic rivalry:

[the] strengths and weaknessess of the various weapons could then be examined and stated objectively, and choices made to give a moderate compromise between the military effectiveness of the combination of weapons...and the financial allocations.[104]

Even if bureaucratic rivalry was not abandoned it would soon become impractical due to the changing nature and growing expense of new technology. A united and inter-service approach would be needed to make possible:

...solutions to some of the problems we can already see ahead of us in the applications of space research. For example, satellite navigation (already planned by the Americans for 1961) and reconnaissance schemes may well be both very important and very expensive. A joint interest in such developments might be essential to any action at all.[105]

Unfortunately for the Air Staff, this candid recognition of the perils of its bureaucratic politicking was not heeded and the chaos that was to ensue from its unravelling was only just around the corner.

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[103] AIR20/10122 Report *Future Bombing Policy*, 7 July 1959.
[104] *Ibid.*
[105] *Ibid*

There was seemingly little warning of the Air Staff's bureaucratic politics strategy coming adrift. This was largely because the alliance within the Air Staff supporting Blue Streak had seemed very strong indeed. Whereas Blue Steel Marks 1 and 2 had been dogged by dispute between the various Air Staff factions between 1957 and 1959, during the same period the Blue Streak project, though beset by the hostility of the Treasury, had been untroubled by dissent within the Air Staff camp. This was in fact, not surprising. It was the lynch-pin of almost all the Air Staff's bureaucratic politics agendas. It was crucial to attempts to save Fighter Command, it was essential for retaining the deterrent for the RAF until the manned bomber could be re-invented in some form. It had no limited war capability, ensuring that the entire East of Suez role was left to TSR2 and the manned bomber lobby.

The emergence of Skybolt in 1958 weakened this all to a certain extent, as it promised at least a partial rejuvenation of the manned bomber concept, but the truce held for another year after that. This was probably because Blue Streak was serving its purpose sufficiently well to make it not worth while upsetting the apple-cart over an American missile whose future was always regarded as dubious. The crisis that some of the most powerful bureaucratic politics groupings in the Air Staff found themselves facing by the spring of 1959 changed the situation completely.

On the face of it, the crisis had nothing to do with Blue Streak. In fact, it solely concerned the other, limited war, component of the Air Staff's 'bomber strategy', TSR2. Due to the interlocking nature of the Air Staff's bureaucratic politics objectives, however, what spelt trouble for TSR 2 spelt doom for Blue Streak. This crisis will described in detail in the next chapter but, for now, need only be acknowledged as the cause of the collapse and transformation that overtook the Air Staff's bureaucratic politics agendas.

The dramatic change that the Air Staff's strategy faced, however, did not make itself immediately obvious. In some respects, its implications were too serious to be exposed in the usual manner to mercies of the Air Staff's internal factions. What was needed was a discrete arena in which the newly emerging problems could be dealt with. It was not until the beginning of June that the prospect of the Powell Committee emerged, largely to fulfil other political agendas that were working against Blue Streak, as has been described. This would provide exactly the sort of discreet arena in which the crisis could be resolved.

The extent to which the BNDSG successfully provided this arena can be gauged by the fact that the final outcome of the committee's deliberations were not at all apparent to those outside it, even those who due to their seniority and centrality in the procurement process might be assumed to be well informed. For example, as late as the week before the BNDSG's final meeting regarding Blue Streak, Christmas Eve 1959, the Private Secretary to the Secretary of State for Air was to circulate this note to his collegues:

> It seems, however, that Sir Richard Powell's study group may be reporting fairly shortly and SoS considers it desirable that when this happens the Air Ministry should have its ideas clear on the deployment of the weapon. He would therefore like to hold a meeting as soon as possible with the addressees of this minute to discuss it. Perhaps you would let me know whether 3pm on the 1st of January 1960 will be convenient.[106]

The meeting was never held, as the implications of the BNDSG report issued the day before spelt cancellation for Blue Streak, and although this was not announced until the following March, it was essentially 'all over by Christmas'.

4.6 Conclusion

It can be seen that the cancellation of Blue Streak relied upon a mechanism with three components. These were a hostile political establishment that

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[106] AIR20/10122 PS/SoS to PS/CAS, 23 January 1959.

could provide the opportunity and arena in which to cancel the weapon, a crisis ridden Air Staff to provide the justification to do it and a strangely impotent Ministry of Supply to ensure that no opposition was offer to either.

Of these three factors, it is that of the Air Staff's opposition to Blue Streak that is perhaps most at variance with the views of the existing historiography. However, even without the revelations of the VCAS's personal files, in many respects the Air Staff's behaviour in the BNDSG is quite enough to demonstrate their hostility towards Blue Streak. Even though the system was very definitely 'theirs' and the Air Staff might therefore have been expected to spent their time promoting it, in fact the RAF representatives at the BNDSG spent most of their time blatantly promoting Skybolt and denigrating Blue Streak. That this was not a simple 'seeing of the light' with regard to the virtues of a plainly superior system is demonstrated by the fact that the Air Staff's own studies had shown that the V-Force's vulnerability to pre-emption was much higher than had been imagined.[107] Why the Air Staff actually preferred Skybolt and how this equates to problems with TSR2 forms the subject of the next chapter.

[107] AIR20/10122 Report *Future Bombing Policy*, 7 July 1959.

TSR 2

5.1 Introduction

Despite not being a strategic system, TSR2 is of great importance to this study in that it is the missing link that explains both the fall of Blue Streak and the rise of Skybolt. It does this by virtue of its centrality to the Air Staff's bomber strategy, of which nuclear deterrence was but one component part. By 1959, this strategy was dependent upon the maintenance of a coalition of interest groups within the Air Staff, conflict between which had undermined all the Air Staff's previous attempts to produce a replacement bomber system. From the cancellation of the Avro 730 in 1957 to the middle of 1959, this coalition held firm. It was then shattered as one of its two supporting pillars suddenly failed.

The two pillars of the Air Staff's internal alliance were Blue Streak and TSR2. Quite unexpectedly, it was the coalition around TSR2 that collapsed. Blue Streak then became victim to both the general chaos within the Air Staff's internal politics and to the ambitions of the factions for whom its deterrent role suddenly became of vital importance. The reason for the collapse of the coalition around TSR2 was the dawning realisation that the Air Staff had seriously miscalculated in its belief that TSR2 could fulfil its limited war requirements 'East of Suez'. This had two separate implications. Firstly, maintaining the institutional essence of the RAF in the post-Sandys era was dependent upon the possession of an aircraft exactly like TSR2, as far as perhaps the most significant interest group in the Air Staff – the bomber lobby – was concerned. If TSR2 was no longer suitable for the East of Suez role then another role would have to be found for it. However, the other main supporters of TSR2 – the limited war/East of Suez lobby – were adamant that a limited war capability in the Far East role should be maintained regardless of TSR2 or any other bomber. Unfortunately, Sandys had allowed the RAF only one more new combat aircraft and, as the rest of the RAF were adamant that this had to be TSR2, how would the Far East capability be maintained? The key to solving both these problems became Skybolt and the first obstacle to obtaining it was Blue Streak. In order to understand this complex and inter-related series of issues, it is first necessary to examine why TSR2, almost overnight, became regarded as strategically and tactically obsolescent in the summer of 1959.

5.2 TSR2: Strategic and Tactical Obsolescence

The sudden inability of TSR2 to fulfil its intended role was due to imminent changes in both strategy and tactics appearing on the horizon almost immediately after the definition of the project had taken place. The Air Staff had originally intended that the TSR2 strike aircraft would provide the RAF with all it required for 'East of Suez' operations from the mid-1960s onwards but, even by 1959, the project was already threatened with strategic irrelevance. This was because its primary role was becoming increasingly open to question. Something that the existing literature rarely makes clear is the fact that TSR2 was not originally intended for use on NATO's central front but in the Eastern Mediterranean and Malaysia. Although the operational conversion unit and two operational squadrons would be based in Britain during peace-time, on the approach of war they were intended to be deployed with the rest of the force on Cyprus and at RAF Butterworth in Malaysia.[1] TSR2 was an entirely 'East of Suez' aircraft and, although any decision to withdraw from Britain's Eastern commitments was at this time unmentionable politically, there had been a growing awareness amongst the senior levels of the defence establishment, from at least 1958 onwards, that this, or something resembling it in all but name, was highly likely. With regard to TSR2, this prospect was being mooted as early as July 1958. The Chairman of the DRPC, Sir Frederick Brundrett, wrote to both the Minister of Defence and the Chief of the Air Staff expressing his concern about the entire concept

[1] AIR20/10732 Report *Deployment of TSR2 Force*, 24 June 1961.

of OR339, the original staff requirement for the TSR2.[2] Noting that the aircraft were intended to enter service by the mid-1960s, Brundrett wondered if the Air Staff were 'planning on a realistic basis' by assuming that Britain would still retain the bases and commitments that it did in 1958.[3] If it turned out that the eastern bases were to go then the RAF would only be requiring a relatively simple close support aircraft and not a highly sophisticated strike aircraft like TSR2. The political sensitivity of this topic, which precluded it being more openly ventilated, is made apparent by Sir Frederick's caution to both the Minister and the CAS regarding his note in which he stated that he "would be very glad if you would ensure that no quotation is ever made from it nor that its existence is ever known."[4]

Coupled to this danger of strategic irrelevance was an equal prospect of tactical obsolescence. This was due to prospective changes in the British approach to tactical nuclear warfare. During the mid to late 1950s, British strategy had favoured a strategic nuclear response to any Soviet incursions on the Central Front but to fight the Russians primarily with tactical nuclear weapons if war broke out only in the Middle or Far East. It was this role that TSR2 was specifically designed to undertake. With increasing pressure from the United States for what eventually became known as a 'flexible response' strategy in Europe, in which a Soviet invasion would first be opposed with conventional weapons before a graded escalation to tactical nuclear weapons, the widespread initial use of tactical nuclear weapons in the Far and Middle East would become untenable. What would be required, at least initially, was a more determined conventional response that in terms of air power would require a much greater emphasis on close support and air superiority missions.

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[2] Wynn, H., (1994) *The RAF Nuclear Deterrent Forces: their Orgins, Roles and Deployment 1946-69*, London: HMSO, p. 510.
[3] *Ibid.*
[4] *Ibid.*

Even if tactical nuclear strikes were to be required, they would now be of a different character to the tactical nuclear warfare envisaged in the mid-1950s for which TSR2 was optimised. Previously, tactical nuclear warfare had only differed from strategic nuclear warfare in terms of the geographical location of its targets. The same type of targets were to be attacked as in strategic warfare, such as cities, airfield, harbours, except that they would be located in the Soviet Union's satellite countries rather than in the Soviet Union itself. East Berlin, for instance, was regarded as a 'command centre' and would therefore receive a tactical strike comprising of two Thors and a one-megaton bomb delivered by a USAFE F100 Super Sabre, three megatons in total.[5] Both the British and Americans regarded a similar attack on the Soviet Union as strategic warfare, with Moscow being scheduled to receive four megatons from Bomber Command for example.[6] With the evolution of strategies designed to limit escalation, this crude distinction between tactical and strategic warfare was no longer feasible. Attacks on Warsaw Pact airfields in Eastern Europe would invite retaliation in kind against targets in Western Europe and, whereas the United States and the Soviet Union might regard this as tactical warfare, the United Kingdom would not regard a nuclear strike against British soil as warranting anything less than a strategic response.

This is why the British discounted the possibility of fighting that type of tactical nuclear warfare in Europe and saw the Middle and Far East as the only suitable venues for a strategy of that kind. However, from the mid-1950s the United States began to investigate alternative strategies. The concept of battlefield nuclear warfare received more attention, in which weapons would initially only be used in the immediate battlefield area, theoretically reducing the risk of escalation. Actual enemy combat units and their associated 'rear areas' would be predominately targeted in contrast to the rather general infrastructure targets of the preceding strategy. This required smaller nuclear weapons delivered by flexible short-range systems such as missiles, heavy

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[5] Scott, L. and Twigge, S.R., (1999) *Planning Armageddon: Britain, the United States and the Command of Western Nuclear Forces*, Amsterdam: Harwood Academic Press, p. 114.
[6] *Ibid.* p. 95 (n)

artillery or even mines. Air delivery could easily be accomplished by small tactical close support aircraft. Battlefield nuclear weapons had started to be introduced to Europe from October 1953 by the United States Army[7] and, despite a strong antipathy towards them in Britain, the British Army had received its first United States supplied Honest John missiles and nuclear capable 203mm howitzers by the end of 1960.[8] The imminent introduction of these weapons, coinciding with Brundrett's comments regarding the East of Suez commitment, cannot have gone unnoticed by even the most partisan of TSR2's supporters.

Due to the change in focus of tactical nuclear warfare strategy and the doubts concerning the nature of the 'East of Suez' commitment, the need for anything as large or complex as TSR2 steadily evaporated between 1958 and 1960. However, as early as 1959, the Air Staff, particularly the 'bomber lobby', had started a concerted campaign to save this aircraft. Why was this? More specifically, it begs the question as to why Sir Frederick Brundrett's advice was not taken in 1958 before the specification had become so fixed and any serious work done on the project. Why were the Air Staff so determined to have an aircraft with no conceivable role when they could easily have changed to one that would have fitted anticipated future requirements exactly? Sir Frank Cooper expressed surprise at this very matter at the RAF Historical Society witness seminar on TSR2 some 30 years later. He stated:

> One of the oddities was that throughout the eight year period the need for a Canberra replacement was never seriously questioned; the need for tactical reconnaissance aircraft for NATO, CENTO and SEATO was always accepted; and, despite Suez, in 1956, East of Suez did not become a crunch issue until 1965.[9]

The answer to this demonstrates that Air Staff procurement policy at this time cannot be regarded as a simple interaction between strategy and the laws of

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7 Scott, L. and Twigge, S.R., (1999) *Planning Armageddon: Britain, the United States and the Command of Western Nuclear Forces*, Amsterdam: Harwood Academic Press, p. 149
8 *Ibid.* p 157
9 Hunter, A.F.C., (ed.) (1998) *TSR2 with Hindsight*, London: Royal Air Force Historical Society, p. 37.

physics. The strategic assumptions that Sir Frederick had warned were flawed, in an assessment amply confirmed by subsequent events, just happened to provide a requirement for an aircraft as near as the British aircraft industry could build to being exactly the aircraft the RAF wanted to fly. TSR2 fitted the RAF's 'institutional essence' perfectly in terms of the Air Force's strategic culture and even career structure. The extent to which TSR2 was the RAF's 'social and cultural construction' is not only demonstrated by its emergence and survival for six years after its strategic and tactical irrelevance was first mooted, it is also manifest in the physical attributes bestowed upon it by the operational requirement.

5.3 TSR2: the Social Construction of a Combat Aircraft

It is striking that the term 'Canberra replacement' was almost universally used to describe the project that became TSR2, long before its role-descriptive designation – Tactical Strike and Reconnaissance 2 – was evolved. It has remained a constant appendage to any description of the aircraft ever since. This may seem unremarkable, in that it was certainly to replace the English Electric Canberra light bomber that TSR2 was developed. It is very important to note, though, that the institutional function of replacing the Canberra was fixed before the operational mission of the aircraft was decided, as the evolution of the aircraft's designation accurately reflects. This was to be a key factor in the problems that started to manifest themselves by July 1959. The term 'Canberra replacement' is doubly significant in this respect as both the Canberra and TSR2 had a fixed role with regard to their institutional importance to the service, to which their actual operational roles were secondary and subject to adjustment.

The Canberra was originally intended to be a high altitude bomber, essentially a 'mini V-bomber' able to undertake the shorter range V-bomber missions using conventional, and later, atomic weapons. As such, it would be able to immediately replace the RAF's obsolete piston-engined strategic bomber, the Avro Lincoln, and bridge the gap between the aircraft and the introduction of the V-force, which the Canberra would then supplement in both limited and global war roles. In this it was directly analogous to Bomber Command's use of the De Haviland Mosquito during the Second World War. However, perhaps its most crucial role would be to familiarise RAF squadrons with the new technology of its advanced electronic systems and jet propulsion in order to provide a sufficient pool of experience with which to form the V-Force.[10]

This original intention would not, however, be completely fulfilled. The Canberra did indeed serve its institutional function by replacing the piston-engined bombers in Bomber Command's squadrons but it did not do this by operation in the role originally envisaged. The advanced blind bombing and navigation system that the Canberra was to have shared with the V-Bombers, H2s Mk 9 with NBS, became so delayed that it was not even fully available when the V-Force initially entered service.[11] Therefore, the original variant of the Canberra, the Mk 1, was cancelled and had to be replaced by the Mk 2, which carried traditional visual bombing aids instead of the radar and NBS. This meant that the Canberra was unable to undertake high altitude all-weather bombing missions and was totally dependent on ground based navigation aids. The aircraft would have to bomb from well below its intended operational ceiling and only in good weather, thereby not at all fulfilling its intended role.[12]

It might be expected that this would cause the demise of the entire Canberra

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[10] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 67.
[11] *Ibid.* p. 67.
[12] *Ibid.* p. 68.

concept but this was not to be. Despite the AOC in C Bomber Command's warning of "the grave risks...being taken in replacing the Lincoln as a main force aeroplane with the Canberra" which was "too ill-equipped at present to perform its task", the aircraft was crucial in terms of training the future V-Force and giving Bomber Command the 'jet credibility' that its propeller-driven Lincolns so visibly lacked. Instead the role was scrapped and a new one found that was nearer to being within the aircraft's capabilities. The role found for the Canberra was essentially battlefield support, bombing transport and infrastructure targets within 250 miles of the battlefield under the aegis of SACEUR.[13] This was not the role that TSR2 was originally intended to fill. The expendability of strategy in the face of 'organisational essence' is noteworthy as is the fact that an extremely similar dilemma was to befall the TSR2 project some ten years later. There is strong evidence to suggest that TSR2's operational role, like that of the Canberra before it, was created to justify TSR2 in operational terms so that it could perform its function in maintaining the institutional essence of the RAF. This is shown by the fact that, although the need for a 'Canberra replacement' remained constant in the minds of the Air Staff, the actual operational role was modified four times.

Possibly the earliest examination of the need for a 'Canberra replacement' was OR16's *Tactical Air Force Requirements for 1959-65 – Tactical Bomber Requirements.*[14] This envisaged the aircraft as being primarily NATO committed. Its operational role was extremely specific and was based upon the recommendations of SACEUR's *Capabilities Plan 1957* (SHAPE/330/54). The requirements of that document were:

> ...to reduce, as quickly as possible, Soviet capability to deliver atomic weapons against NATO forces and other elements of the NATO war-making power. It also appreciated that, at best, active defence measures can only provide partial protection against the enemy threat, they cannot eliminate it. The Plan concludes therefore that

[13] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 69.
[14] AIR20/8573 OR16 Report *Tactical Air Force Requirements for 1958-65 – Tactical Bomber Requirements*, 24 August 1955.

> the only practical means of eliminating the enemy threat is to destroy it at source by counter-air bombardment.[15]

The aircraft specified to do this job bore little resemblance to TSR2. Instead of that aircraft's 1200 mile tactical radius, it was stipulated that the tactical radius need not exceed 750 miles and could be as low as 450 miles if the aircraft was capable of operating from small dispersed fields in the tactical area. This was because:

> ...to operate the force from bases outside the tactical area would reduce its effectiveness by lengthening sorties and by complicating command and control.[16]

This strongly infers that later Air Staff opinion requiring long range capability was not based upon strictly operational considerations.

As the aircraft's role was to be primarily nuclear strike against airfields and missile sites, it was to be optimised for that role and internal weapons stowage only needed to be provided for a single 2,000lb weapon. A large weight of conventional stores, if required, could be carried externally. It was anticipated that after the 1965 period the aircraft would be replaced in its primary role by a short-range ballistic missile. It can be seen that the requirement called far more for a strike fighter than a bomber, a 'nuclear Hunter' rather than a 'supersonic Canberra'. This was something that the report emphasised by recommending that either the projected OR329 interceptor or the 'thin wing' development of the Javelin all-weather fighter would provide a suitable basis for the new tactical bomber. This was an extremely prescient analysis of the requirement, to which both the much later Jaguar and Tornado conformed, as indeed did virtually all the tactical strike aircraft operated by NATO by the late 1960s and the 1970s. However, this role-based analysis of what was meant by the phrase 'Canberra replacement' had strangely disappeared by the time that the operational requirement OR339 was issued, even though it was to subsequently reappear as the role

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[15] AIR20/8573 OR16 Report *Tactical Air Force Requirements for 1958-65 – Tactical Bomber Requirements*, 24 August 1955.
[16] *Ibid.*

for TSR2's successors. The NATO role had been abandoned in favour of an East of Suez strike role. This required a much larger and more sophisticated aircraft, a true bomber. With regard to the switch from a NATO to a Far Eastern role, Sir John Barraclough, a former Director of Public Relations for the RAF later recalled that:

> ...the Air Ministry 'line' on that aircraft was 'remarkably and outstandingly feeble'... Journalists had had considerable difficulty with understanding what the TSR2 would do in the context of a 3-day war! TSR2's capabilities did not fit with any NATO strategy...it had then been necessary to go to the East of Suez and Island strategies which resulted in confrontation with the Royal Navy and the aircraft carrier programme.[17]

Putting the 'cart before the horse' in this manner by determining an aircraft's characteristics before determining its role is a definitive suggestion that those characteristics had a purpose whose significance was the main motivation behind the project. As they were obviously not connected with its operational role, it must be assumed that these characteristics instead performed some essential institutional function.

When looking for signs of 'social engineering' with regard to TSR2, it is perhaps easy to miss the most obvious manifestation of its social and cultural construction. This was that first and foremost, the TSR2 was unmistakably a bomber. It can be argued that this was at the core of what was meant by the phrase 'Canberra replacement', rather than any specific role. To be a bomber, TSR2 needed to be large, have at least two engines, an internal bomb bay and a crew comprising of a navigator as well as a pilot. In this, it fitted almost exactly with the technological lineage of its predecessors, the Canberra, Mosquito and Blenheim. However, why should this be a sign of anything other than a sound tactically and strategically based operational

[17] Hunter, A.F.C., (ed.) (1998) *TSR2 with Hindsight*, London: Royal Air Force Historical Society, p. 66.

policy? In terms of 'institutional essence', it is interesting to compare the British penchant for the classical multi-seat, multi-engined bomber to the American practice in Tactical Air Command. Although the USAAF (as it was) had made great use of a number of tactical bomber types during the Second World War, such as the B25 Mitchell, B26 Marauder, A20 Havoc and A26 Invader, it was a category that rapidly fell by the wayside during the 1950s. Although B45 and B66 multi-engined, multi-seat tactical bombers were deployed to NATO, they were rapidly relegated to reconnaissance or electronic warfare roles whilst the USAF's refined Canberra variant, the B57, was used purely for night interdiction.[18] This was largely due to the USAF's combat experience in Korea, which led to a number of new approaches to the problems of conducting tactical air operations in the jet age. In terms of equipment, this was marked by a shift to exploiting the growing size and capability of the new generation of large single-seat fighters to undertake most of the roles formerly undertaken by multi-seat bombers. Thus by the end of the 1950s, the type of strike role undertaken by the three-seat, twin-engined Canberra bomber in the RAF was being done by the single-engined, single-seat F84 Thunderstreak, F105 Thunderchief or F100 Super Sabre fighter in Tactical Air Command. It must be noted that this rigid division in the RAF between the role of the bomber and that of the fighter was as much to do with attitude of the 'fighter lobby' as it was the 'bomber lobby'. Aviation writer Arthur Reed wrote of the struggle to get the RAF to accept the strike fighter concept:

> Its developers had to overcome a faction within the Royal Air Foce which was suspicious and even downright hostile towards the concept. The faction contained officers who, at the time the concept was being developed, had achieved middle and senior rank, but whose mind set was still wedded to doing 'upward Charlies' at 45,000 feet.[19]

Fighter Command had just as fixed an idea about what constituted a fighter

[18] *Encyclopaedia of Aviation* (1982) London: Orbis, vol. 17, p. 3966.
[19] Reed, A., (1982) *SEPECAT Jaguar*, London: Ian Allen, p. 5.

and its gainful employment as Bomber Command had with regard to bombers. This refusal to exploit the possibilities of the large tactical strike fighter caused great frustration within the British aircraft industry, which had lost sales due to the popularity of the F84F and F100 with foreign air forces. This culminated in an attempt by Sir Sydney Camm, the chief designer of Hawker Siddely, to force the Air Staff's hand by building a large single-seat strike fighter, the Hawker P1121, as a private venture.[20] This was fully comparable with the American F105 and essentially the 'nuclear Hunter' implicit in the original 1955 OR 16 'Canberra replacement' study, which may well have informed Camm's proposal.

The speculative development of an aircraft as complex as this was unheard of in the post-war world. It reflected the confidence of Camm, perhaps Britain's most politically influential aircraft designer, that the Air Staff could not possibly fail to see the light so forcefully revealed to them and also his frustration that they had not done so earlier. It is a testimony to the power of the Air Staff 'bomber lobby' that Camm was forced to abandon his project incomplete due to total Air Staff indifference. It is notable that when this design was resubmitted to the Air Staff to be reconsidered for the TSR2 requirement as the P1129, Camm had added a navigator, another engine and an internal bomb bay to turn his tactical fighter unmistakably into a bomber.[21] It was not until after the cancellation of TSR2 that the RAF finally adopted the now NATO-wide concept of the single-seat strike fighter when its intended two-seat supersonic trainer was reborn as the Jaguar single-seat tactical strike fighter. This was in 1974, some 20 years after the first American tactical strike fighter units had deployed to the Central Front.

The technology selection for TSR2 was also subject to the influence of as many varied interest as its operational role. TSR2 represented both a rebirth of the Low Altitude Bomber and the Avro 730 in its operational concept. In terms of technology, it provides yet another example of 'project afterlife'. The

[20] Lewis, P., (1974) *The British Fighter since 1912*, London: Putnam, p. 370.
[21] Sturtivant, R., (1990) *British Research and Development Aircraft: Seventy Years at the Leading Edge,* London: Haynes Publishing Group, p. 199.

research at the RAE and RRE leading to the complex attack and navigation system at the heart of the project was essentially a continuation of that done for the LAB. The paradox of this was that after TSR2 was cancelled, elements of the system were adapted once again for the Tornado, finally entering service in 1982 almost 30 years after work on it was first instigated.[22]

TSR2 was essentially a scaled down Low Altitude Bomber but with an additional conventional capability, the lack of which had so damned the LAB in the eyes of the Air Staff. Grafted onto this was the high altitude reconnaissance capability and supersonic performance of the Avro 730. The link between the Avro 730 OR330 bomber and TSR2 has been inferred by Sir Michael Beetham, who has commented:

> OR330 had just been cancelled, therefore the Air Staff would probably have been concerned to build in as good a high level performance as could be achieved.[23]

In attempting to combine these two concepts, requiring as they did that the aircraft operate in two utterly different flight regimes, an already very demanding project was made incomparably more difficult and expensive. As cost and development delay contributed heavily to the demise of TSR2, the reason for this questionable fusion of the most difficult elements of both the Low Altitude Bomber and the Avro 730 in the operational requirement should be examined. Not only does this throw further light on the eventual failure of the TSR2 project, but it also highlights a further evolutionary stage in the bureaucratic politics of the V-Bomber replacement saga.

The incorporation of the requirement for high altitude supersonic performance was one of several aspects of the requirement that puzzled many involved in the project. The chief test pilot, Wing Commander Roland Beamont, declared that:

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[22] Agar, J. and Hughes, J., 'Open Systems in a Closed World' in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press, p. 240.
[23] Hunter, A., (ed.) (1998) *TSR2 with Hindsight*, Royal Air Force Historical Society, p. 27.

> ...he had never understood why a speed of Mach 2.25 had been called for. The aircraft was intended to be a low-level transonic penetrator. The requirement for a sustained performance of Mach 2.25 at high level could only have led to a far more costly engine development.[24]

Marshall of the Royal Air Force Sir Michael Beetham wrote the original draft specification for TSR2 as a Squadron Leader in the Air Staff Operational Requirements Branch. His explanation for the high speed required of the aircraft was that:

> ...the OR staff had to look well ahead and could know what developments might be made by 'the other side'. The staff could not be faulted if they 'asked for the best'. Suggestions of, say, a Mach 2.25 performance tended, therefore, to 'creep into the OR'. There was always great enthusiasm to appear positive and never say 'no'. The danger, therefore, was to over-egg the OR.[25]

This is a good definition of what the Americans call the 'candy store' approach to weapons procurement. However, it is highly noticeable that the Air Staff was in fact extremely choosy about which technological novelties it would allow itself to be lured by. They proved quite capable of persistently saying 'no' to a number of significant innovations, such as vertical take-off and variable geometry wings, in the 1950s.[26] The only thing that there was always 'great enthusiasm' for was anything that provided additional high altitude supersonic performance.

Sir Michael added a further justification for TSR2's supersonic capability:

> It was important in writing an OR not to be confined to one flight regime especially if the aircraft is not due to come into service for some years. If the enemy had solved the problems of defence at low level, the aircraft might be driven to operate at higher levels.[27]

Two comments might be made regarding this statement. Firstly, the reason that TSR2 was operating at low altitude in the first place was because the

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[24] Hunter, A., (ed.) (1998) *TSR2 with Hindsight*, Royal Air Force Historical Society, p. 26.
[25] *Ibid.* p. 27.
[26] Gunston, W., (1982) *Harrier*, Oceala: Speciality Press, p. 13.

enemy had already 'solved' the problems of defence at high altitude. Therefore, a switch back to high altitude missions was never a possibility for TSR2 and this was quite obvious from the beginning. A 'stealthy' successor to TSR2 might have been able to reclaim the stratosphere but TSR2 itself, with its huge air intakes, could never be described as stealthy.[28] The second comment that could be made is that there was never any requirement for an aircraft optimised for high altitude supersonic performance to incorporate an alternative low altitude capability in the event of a change in enemy tactics. The RAF, in fact, had no problem at all with an aircraft being 'confined to one flight regime' as long as that flight regime was the high altitude supersonic one.

The rationale for TSR2's supersonic performance had three different manifestations in the project's lifetime. The original reason given for supersonic performance in the 1955 OR16 report was twofold. Firstly, it was not believed possible to create a low-level all-weather navigation system and so some alternative form of attack would be needed at night and in bad weather. That alternative was high altitude supersonic penetration, which would be viable over the battlefield as it was not believed that a mobile surface-to-air missile system was likely and a speed in excess of Mach 1.7 would be sufficient to render fighter interception difficult.[29] However, it was rapidly realised that an all-weather low altitude navigation system was a viable proposition after all, as such a system had been under development for the Low Altitude Bomber. Simultaneously with the switch to the East of Suez role embodied in OR339, which ensured that the aircraft was still very definitely a bomber, came an additional requirement that the aircraft should be able to perform medium altitude reconnaissance. This acted to ensure the aircraft was also very definitely supersonic, necessitating as it did exactly the same speed and altitude to penetrate as the previous requirement but this time in order to undertake photographic reconnaissance, which it was stated could not be done at low altitude. However, it is important to note that one of

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[27] Hunter, A., (ed.) *TSR2 with Hindsight* Royal Air Force Historical Society, p. 27.
[28] *Ibid.* p. 182.

the most advanced pieces of equipment specified for the aircraft was an optical linescan system that would enable reconnaissance to be undertaken at low altitude, rendering suspect the claims that the aircraft would need high altitude supersonic performance to undertake the reconnaissance role once in service.[30] Once OR339 was replaced in May 1959 by OR343, with its emphasis on rough-field operations, it was then claimed that the supersonic performance was merely a bonus brought about by the massive thrust of the engines required to meet the short take-off requirement.[31] Although even the reconnaissance capability only required Mach 1.7, OR 343 upped the design speed to Mach 2.25.

Far from being an incidental 'cost free' bonus of other aspects of the requirement, in fact this unnecessary further increase in speed bought severe airframe heating problems whose solution was to cause extra costs and complications for the aircraft.[32] Sir Michael Beetham attributes this in part to the promises of increased performance offered by each of the aircraft manufacturers competing for what was assumed to be the last ever military aircraft contract.[33] However, it can be argued that other factors were also at work.

Two underlying reasons can be discerned as to why TSR2 acquired the conflicting and unnecessary requirements for both high and low altitude capability. Firstly, there were issues of political expediency amongst the supporters of the manned bomber lobby. The bureaucratic politics of the TSR2 specification demonstrates the unstable nature of advocacy coalitions within the Air Staff. These coalitions were formed in the usual way from various strands of opinion, coalescing around issues of mutual advantage. However, due to the rapid technological, tactical and strategic change being

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[29] AIR20/8573 OR16 Report *Tactical Air Force Requirements for 1958-65 – Tactical Bomber Requirements*, 24 August 1955.
[30] Putley, E., 'Thermal Radiation and its Applications' in Budd, R. and Gummett, P., (eds.) (1999) *Cold War Hot Science: Applied Research in Britain's Defence Laboratories 1945-1990*, Amsterdam: Harwood Academic Press, p. 200.
[31] Hunter, A., (ed.) *TSR2 with Hindsight*, Royal Air Force Historical Society, p. 15.
[32] *Ibid.* p. 15.
[33] *Ibid.* p. 21

undergone at this time, new issues were constantly emerging and therefore new coalition advocacy configurations were having to be formed requiring totally fresh negotiations and compromise amongst actors.

As has been illustrated, prominent in Air Staff procurement debates were dichotomies in attitudes to both strategy and tactics. The four strands of opinion produced recombined in several configurations at various times. The strategists were divided on 'deterrence only' and 'warfighting' lines. Those who were more concerned about tactics and favoured the manned bomber were split between those who favoured high-altitude operations and those who favoured low-altitude operations. Between 1951-4, with regard to the Low Altitude Bomber, the high altitude enthusiasts had sided with proponents of 'deterrence only' and the low altitude group had joined the 'war-fighting' coalition. This had fluctuated briefly throughout the debate regarding the Avro 730, but when the 'war-fighting' strategy coalition's espousal of the concept of ballistic missiles alienated the low altitude bomber enthusiasts, the two halves of the bomber interest group were forced together again in order to define TSR2. As this was not an issue that was of interest to any other group, no decisive alliances could be formed and the two sides were forced to compromise, the result partially being TSR2's 'schizophrenic' specification.

However, it can also be argued that another factor can be seen to be at work, one that in certain respects had also affected the decision making regarding the Avro 730. This was the symbolic significance of the technology.

Culturally, the prevalence of the 'higher faster' ethos in aviation development has been commented on with regard to the Avro 730. By the late 1950s, this tendency was at its peak. Supersonic performance was demanded from almost every category of aircraft that was remotely capable of attaining it, whether its role required this or not. The supersonic aircraft had attained the same cachet as the original jet aircraft had possessed at the start of the decade. Possession of such aircraft was taken as an essential indicator of 'first rank' status. Julian Amery's comment that TSR2 was 'a world class aircraft for a world class airforce' possibly encapsulates what was required of TSR2 almost as well as the expression 'Canberra replacement'.[34] Certainly no aircraft would have been viewed as 'world class' in the late 1950s and early 1960s if it were not supersonic.

The level to which this obsession with supersonic speed was taken is indicated by the fact that the USAF were even introducing a supersonic training aircraft into service at this time, the T38 Talon. Whilst it might be thought that this was en entirely logical move, given the prevalence of supersonic aircraft, in fact the training syllabus only included a single supersonic sortie and even that was essentially an 'end of course celebration'[35]. Nonetheless, other air forces, including the RAF, included supersonic performance in their requirement for new training aircraft as a matter of course. The 'faddish' nature of this is illustrated by the fact that this euphoria for the supersonic had largely evaporated by the end of the 1960s and no other supersonic training aircraft have entered service since the T38, the RAF's aircraft eventually metamorphasised as the Jaguar strike fighter.

However, just as in 1952 when the Air Staff would not countenance a propeller-driven low altitude bomber as a replacement for the V-Bombers, no matter how efficient it was, by 1959, they would not countenance anything other than a supersonic replacement for the Canberra. The Canberra was now passé and Bomber Command's credibility could only be restored by evidence of supersonic capability. There is a parallel between this and the desire to get the operationally inadequate but, crucially, jet-propelled Canberra into service in 1951 to replace the RAF's propeller-driven bombers. One of the principal charges laid by the Air Staff against the Naval NA39 Buccaneer strike aircraft, mooted as an alternative to TSR2, was its lack of supersonic performance, a 'fundamental drawback',[36] although it was never explained how this would benefit the Buccaneer's impressive penetration capability. It is interesting to note that the obsession with supersonic

[34] Hunter, A., (ed.) *TSR2 with Hindsight,* Royal Air Force Historical Society, p. 67.
[35] *Encyclopaedia of Aircraft* (1982) London: Orbis, p. 466.

performance did not seem to infect the world's naval air arms. Neither the Buccaneer nor the US Navy's Grumman A6 Intruder low-level strike aircraft, both under development at the same time as the TSR2, had any pretensions towards supersonic performance. Both were highly successful in service, the Intruder having both the best bombing accuracy and crucially the lowest loss rate of any American aircraft in Vietnam.[37]

It can be seen that by the time that the concept of a 'Canberra Replacement' had solidified into OR339 it had acquired a disparate set of characteristics, all of which can be seen as explicitly furthering a clutch of bureaucratic politics agendas having little connection with either operational effectiveness or strategy. Optimising TSR2 for the East of Suez role rather than the NATO mission ensured that the range requirement would be too great for a strike fighter. Including the reconnaissance mission as well would ensure that it would have to be supersonic, which was symbolically desirable and would also rule out consideration of the naval Buccaneer. It was also noticeable that a very stringent bombing accuracy requirement was incorporated in OR339. This effectively ruled out the use of a ballistic missile, which the original OR16 report into the 'Canberra Replacement' had considered would be the ultimate solution to fulfilling the perceived role.[38] All of this was endangered by the threatened changes in both tactical nuclear warfare and the erosion of the East of Suez commitment. The future needs of that commitment would require a very different aircraft if the RAF was to retain its role in the Far East. Unfortunately, this was rendered difficult by the fact that preserving TSR2 as the aircraft it was became as important for many in the Air Staff as preserving its nominal role. However, preserving both was the Air Staff's preferred option and it was to that end that their efforts were devoted by the end of 1958.

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[36] Wynn, H., (1994) *The RAF Strategic Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-1969*, London: HMSO, p. 508.
[37] *Encyclopaedia of Aircraft* (1982) London: Orbis, pp. 43-44.
[38] AIR20/8573 OR16 Report *Tactical Air Force Requirements for 1958-65 – Tactical Bomber Requirements*, 24 August 1955.

5.4 The Search for an Alternative Role

As can be seen, the TSR2 became the basket into which an alarming array of bureaucratic politics' 'eggs' had been placed. This was largely due to the fact that it was the only and, as far as Duncan Sandys had been concerned, the last manned system under development. It meant that vigorous efforts would be made on a broad front to preserve it. These efforts formed themselves into two prongs; one that sought to make the aircraft more relevant to its intended role and the other that sought to find it an alternative role.

The attempt to adapt TSR2 to the possibility of changed strategic and tactical circumstances in its existing role manifested itself in February 1959. The original TSR2 requirement OR339 was superseded by OR343, which placed far greater emphasis on conventional close support capability and 'rough field' operations away from a permanent base, in line with the anticipated move away from permanent bases and nuclear strike. However, like the insistence on Mach 2 performance, the attempt to turn TSR2 into a close support aircraft had little plausibility to many involved in the project. ATF Simmons, a member of English Electric's design team, commented that:

> ...no one in his right mind would have dreamed of exposing a multi-million pound engineering jewel like the TSR2 to the hazards of light anti-aircraft and small arms fire at close range.[39]

The undercarriage design required by the short take-off/rough field requirement was extremely troublesome on the prototype aircraft and, in any case, did not solve the fundamental problem of operating and maintaining an aircraft as complex as TSR2 away from a well-equipped base.[40] Wing Commander Dell, one of the aircraft's first test pilots admits that he had always been:

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[39] Hunter, A., (ed.) *TSR2 with Hindsight,* Royal Air Force Historical Society, p. 109.
[40] *Ibid.* p. 29.

> ...puzzled with the requirement for '650 knots out of a semi-prepared strip'. Who, he asked, would have flown the aircraft into such a strip in the first place, let alone provided the sort of logistic support necessary for such a sophisticated aircraft?[41]

Group Captain Mears, who had been a junior officer in the Operational Requirements Staff was also very sceptical regarding the wisdom of trying to operate TSR2 from a 'rough field'. Obtaining that type of capability out of TSR2 could only escalate cost and complexity even further, as both were only really practical with an aircraft at least half the size of TSR2 and one that was far less complex. Mears commented

> The engine installation was totally incompatible with field operations. It had to be inserted into a 25ft long tunnel with a clearance of only 0.1 ins. The RAF specification for an engine change to ground run was 3 hours in the field; the average of the best 3 engine changes achieved by BAC was 68 hours in a hangar![42]

It seemed extremely obvious to those involved in the project that the additional requirements of OR343 were politically motivated in some way. Professor Heath commented that 'it appeared to many that the Army Sortie was specified in an attempt to win Army support for the project.'[43]

This indeed may have an element of truth to this but the principal cause was almost certainly the need to adapt to the changing needs of the East of Suez role. The strike bomber was desperately attempting to undertake the role of a tactical fighter one third of its size, in anticipation of the loss of bases East of Suez and a re-emphasis on conventional warfare. This added complications to the TSR2 requirement that had an adverse effect on the cost factor causing rapid price escalation. As TSR2 did not have the same level of immunity to Treasury pressure as a deterrent system, it was therefore extremely vulnerable to cancellation on cost grounds. Even by December 1959, the estimated cost of the project had escalated from £35 million to £90 million prompting the comment from the Treasury that had the current estimates 'been before the Minister a year ago' it seemed 'not impossible that

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[41] *Ibid.* p. 29.
[42] *Ibid.* p. 29.
[43] Hunter, A., (ed.) *TSR2 with Hindsight,* Royal Air Force Historical Society, p. 87.

the question of meeting RAF requirement with a version of the NA39 (Buccaneer) would have been more strongly pressed'.[44] The costs continued to spiral and it became readily apparent to those in the Air Ministry that additional justification would need to be found for the TSR2.

In February 1960, RC Kent, AUS(A), sent this note to the CAS:

> Since in certain quarters in the MoD there appears to be a tendency to tie the future of this aircraft almost entirely to limited war, it might perhaps be useful to remind CAS that in our plans the TSR2 also features in Bomber Command, where it is required in due course to replace the tactical Valiants assigned to Saceur and in RAF Germany where in due course it is required to replace Canberra B(I)6/B(I)8 and reconnaissance squadrons.[45]

The CAS must indeed have required 'reminding' of this, as both men would

[44] Wynn, H., (1994) *The RAF Strategic Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-1969*, London: HMSO, p. 519.
[45] *Ibid.* p. 519.

have been well aware that the deployment plans for the nine TSR2 units excluded the use of the aircraft in Europe, and besides the prospect of any replacement of the Saceur Valiant force was slim. The high operating costs of the Valiants, in relation to the Canberras that they had recently replaced, had meant a force reduction from 64 Canberras to 24 Valiants.[46] Although this had been partially justified to Saceur on the grounds that the Valiant was more capable, having the range, weapons load and navigation systems to strike two targets, in fact the force size was determined by the need to limit spending to the same level as the existing force. As this deployment seemed to be based on a notion of 'fixed costs' it is to be wondered just how many of the vastly more complex and expensive TSR2s the Air Staff anticipated would replace the 24 Valiants. The question of the Saceur Valiant force also throws an interesting light on the Air Staff's attitude to NATO commitments, which does seem to be remarkably similar to its attitude to the deterrent. The substitution of the Saceur Canberras by Valiants had not been done at Saceur's request but had originated as an Air Staff initiative to find a way of employing surplus Valiants. The Canberras they replaced, Mk 6s, could be usefully redeployed to the Middle East to replace the rapidly ageing and less capable Mk 2s.[47] The commitment of the Valiants to NATO provided another two squadrons of medium bombers that could be withdrawn to meet 'national commitments' whenever needed. It should be noted that the frequency with which Britain withdrew forces from NATO for such purposes was a major bone of contention between Saceur and the British government.

It does seem that the Air Staff saw the NATO commitment as a means of maintaining subsidised limited war forces for use East of Suez in much the same way that they saw the deterrent as a way of maintaining such forces. The attempt to give TSR2 some relevance to the Central Front was entirely artificial and did not appear in the deployment plans prepared by the Air Staff for TSR2, which concentrated the type at bases in Cyprus and Malaya.[48] As such, the Air Staff rapidly reached the conclusion that yet again something

[46] Wynn, H., (1994) *The RAF Strategic Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-1969*, London: HMSO, p. 365.
[47] *Ibid.* p. 365.

more convincing was needed to justify TSR2's continuing existence. What followed was a bizarre attempt to give the aircraft a strategic role, which can be seen as having a suspicious synchronicity with the cancellation of Blue Streak and the confirmation of TSR2's production order.

The investigation into providing TSR2 with a strategic role had nothing to do with any gap in the deterrent, as Blue Streak's 'insurance' project, Skybolt, was virtually certain to replace the IRBM once it was cancelled. The suggestion appeared to come from Harold Watkinson, the Defence Minister, who wrote a note to the Chief of the Defence Staff stating that he was 'attracted by the idea' of giving TSR2 a strategic role and wanted the Air Staff to undertake a study.[49] Although Watkinson stated that he was motivated by the desire to gain extra capability from the 'high cost' of the TSR2 force, both the proposal and the Air Staff's reaction to it are strange. As has been discussed, the Vulcan/Skybolt combination adequately provided for the needs of the deterrent, both from an operational point of view and from the RAF's institutional perspective. The TSR2 force, whose size was already expected to be restricted by the very high cost of the aircraft, should not have had the 'excess capacity' to undertake additional roles if the force had been properly planned.

One might expect, therefore, that the Air Staff would have strongly objected to the concept of 'strategic TSR2', threatening as it did both the funding for the continuation of the V-Force and, in particular, the RAF's ability to carry out whatever vital role it was for which TSR2 was so expensively being developed. In fact, there is no sign of such a protest and the Air Staff seem to have jumped to the task with alacrity. This leads to suspicions that the idea may well have originally found its way to Watkinson's ear from the Air Staff and be operating in their interests. Certainly the fact that the Air Staff made no protest about such a profound change in the aircraft's role underscores the fact that in saying TSR2 was vital to the future of the Air Force, what the Air

[48] AIR20/10732 Report *Deployment of TSR2 Force*, 24 June 1961.
[49] Wynn, H., (1994) *The RAF Strategic Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-1969*, London: HMSO, p. 521.

Staff meant was that the aircraft itself was vital, not the performance of its role.

Unfortunately for the Air Staff, the outcome of its extensive investigation of Watkinson's 'whim' failed to find a plausible way of utilising TSR2 in the deterrent role. TSR2 did not have the necessary range to attack Moscow, so some kind of missile would be necessary in order for it to do so. BAC proposed fitting it with what were ostensibly two of the Army's Blue Water missiles, although in fact the weapon would be similar to Blue Water only to the extent of having a common guidance package.[50] In the end, even this subterfuge was to no avail as it transpired that with the extra drag of externally mounted weapons, the overall range of the aircraft/missile combination was actually 300 miles shorter than that of the aircraft with an internally mounted bomb.[51] Various configurations of a specially designed internally carried missile were proposed by the RAE, but the cost and necessary time-scale of its development ruled this out.[52]

Also considered was the concept of the 'one-way' mission. This was being adopted by the French Force de Frappe as a solution to the range problems of the Mirage IV strategic bomber, an aircraft of roughly comparable size and performance to TSR2. In its most extreme form, the strategy demanded that two Mirages operate together, one configured as a tanker and one carrying the bomb. Halfway to the target, the bomb carrier would completely drain the tanker of fuel and carry on to the target. After delivering the bomb, the crew of the second Mirage, now exhausted of all fuel supplies, would eject and theoretically return to France on foot.[53] The adoption of a similar strategy by Britain, however, was thwarted by two factors. Firstly, there was the lack of a suitable megaton-range weapon for TSR2, which as it was specifically designed to attack at low-level required a specifically designed 'lay down' weapon. The obvious, if rather extreme, solution to this problem was articulated by an unknown but presumably senior Air Staff figure in the

[50] AVIA65/780 Minutes of Meeting to discuss TSR2's Strategic Capability, 25 July 1960.
[51] *Ibid.*
[52] *Ibid.*

marginalia of the report regarding the provision of the lay-down weapon: 'Why not lay down the aircraft, KAMIKAZE?'[54] Fortunately for the morale of the RAF, the entire subject was at this stage dropped from discussion. This was due to the Chairman's comment that any one-way missions could only be specifically authorised by the government and were outside the committee's terms of reference.[55] This represented a second and more enduring obstacle to the scheme, which does not seem to have raised again. There have been persistent rumours, however, that at least one of the V-Force's targets was a no-return mission. The fact that it was even known that the government regarded the authorisation of such missions as its prerogative is suggestive of the fact that the prospect of such a policy had been raised before and not necessarily discounted.

The desperation evinced by such remarks is perhaps only matched by what became the final proposal to create a strategic rationale for TSR2. This envisaged the mounting of a Skybolt missile on a pylon above the aircraft, the only way that Skybolt could be carried on TSR2 due to the missile's length. To launch Skybolt, TSR2 would zoom-climb from low altitude to a height where the missile's star-tracking navigation system would be able to work, then roll on its back to drop the missile. The sheer implausibility of this when compared to the ease of carrying two Skybolts on a Vulcan only served to underline the contrived nature of the proposal.

The last attempt to find an alternative role for the aircraft came in December 1963 with the 'Thorneycroft proposals' for the contentious NATO Multi-Lateral Force. These offered the commitment of the TSR2 force to a mixed-manned nuclear strike force under Saceur.[56] These proposals were an extremely creative, though doomed, attempt to settle in one stroke some of the most trying problems in both international and bureaucratic politics facing British defence and foreign policy. Scott and Twigge describe its advantages as:

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[53] *Encyclopaedia of Aircraft* (1982) London: Orbis, p. 539.
[54] AVIA65/780 Minutes of Meeting to discuss TSR2's Strategic Capability, 25 July 1960 (emphasis in the original).
[55] *Ibid.*

> First, as the force comprised existing weapons systems, the overall cost would be greatly reduced. Second, exclusion of the Polaris submarines enabled Britain to retain its commitment to an independent deterrent. Third, the absence of a fleet component deflected criticism from the Admiralty whilst inclusion of the TSR2 pacified the RAF who were anxious to acquire Government support for a project whose future seemed in some doubt.[57]

By now some of the doubt at least was coming from within the Air Staff. For many, the East of Suez role was more than just a suitable excuse for a 'proper' bomber. Within the Air Staff was a significant element, part of the traditional 'eastern' strain of British strategic culture, that saw the likelihood of war in Europe as remote, but thought that subversion and more direct action was highly likely in the Middle and Far East. Therefore, any advocacy coalition between the manned bomber enthusiasts and the 'easterners' would have come under extreme strain as TSR2's unsuitability for its original role became apparent.

5.5 Cancellation

Evidence that the Air Staff's support for TSR2 was under threat can be seen as early as 1961 in the issue of a new Air Staff Target for an aircraft to supplant TSR2 as quickly as possible.[58] Air Staff Target 355 provides a valuable insight into the Air Staff's 'double guessing' of what the Government's position on the East of Suez question would be by the time that TSR2 was available in numbers. This AST is perhaps the firmest evidence of the Air Staff's awareness of TSR2's unsuitability for the East of Suez role. From the requirement, it seems that that Air Staff believed that the Government would not renounce the commitment but would withdraw support for the infrastructure necessary to maintain it. Therefore the armed services

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[56] Scott, L. and Twigge, S.R., (1999) *Planning Armageddon: Britain, the United States and the Command of Western Nuclear Forces*, Amsterdam: Harwood Academic Press, p. 191.
[57] *Ibid.* p. 191.
[58] AIR20/11086 Air Staff Target No OR 355 *Tactical Strike/Reconnaissance/Interceptor Aircraft*, 21 August 1961.

would be asked to do a virtually impossible job, one with no room at all for a 'symbolic' or 'political' weapons system if they were to succeed. The aircraft detailed by the requirement was to be primarily for use on the NATO Central Front, although operations East of Suez were still envisaged. However, the use of permanent bases there was largely discounted and the aircraft was to be principally optimised for conventional operations including air defence.[59] This resulted in a requirement for a much smaller and cheaper aircraft than TSR2, equipped with variable geometry wings to enable operation from short temporary strips and the decks of aircraft carriers, and configured for both air defence and ground attack roles. This requirement eventually led, via the abortive AFVG, to the Panavia Tornado, and it is interesting to note in this context that one of the scenarios envisaged by the requirement was an Iraqi invasion of Kuwait.

It was intended that TSR2, now described as 'interim equipment', should be rapidly retired and replaced by the new aircraft in 1975. Even at this stage, largely due to the heightened hostility between the two services, the Air Staff were still not prepared to contemplate cancelling TSR2 in favour of the naval Buccaneer, no matter how 'interim' the hugely expensive TSR2 had become. In terms of 'institutional essence', the extent to which even the AST 355 requirement was dedicated to obtaining something as much like a bomber as possible, whilst still fulfilling future operational needs, should be noted. This can still be discerned in the eventual manifestation of the Tornado whose contemporaries, such as the F15, F16, F18 and the Mirage 2000, were all essentially single-seat air superiority fighters with additional ground attack/strike capability. The Tornado, however, was still very much a two seat bomber and, despite being initially designated a Multi Role Combat Aircraft in line with the concept expressed in AST355, could never be described as an air superiority fighter and needed great modification to operate even in the interceptor role.[60]

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[59] AIR20/11086 Air Staff Target No OR 355 *Tactical Strike /Reconnaissance /Interceptor Aircraft*, 21 August 1961.
[60] Hunter, A., (1998) (ed.) *TSR2 with Hindsight*, Royal Air Force Historical Society, p. 183.

There is possibly no greater testament to the strength of the bomber lobby within the Air Staff than TSR2's survival for six years with such an obviously gaping hole where its strategic and tactical rationale should have been. In the end, it was the type's enormous cost that was to condemn it even in the eyes of its greatest supporters. The cost and time overruns were partially due to constant upgrading of the specification in order to fit the aircraft into the RAF's institutional requirements. However the poor management of the project caused by the Ministry of Aviation's industrial strategy and project management techniques were the other prime contributor. The TSR2 contract was used by the Ministry of Supply to explicitly 'force amalgamation on the industry', it being recognised by the mid-1950s that smaller, stronger industrial groupings were needed than the existing ten design groups.[61] The use of the TSR2 contract to do this was 'quite simply a blackmail',[62] as English Electric Company's Chief Executive, Sir Frederick Page, put it and, even in the opinion of the civil servant charged with its execution, 'this was a fundamental mistake which later played a very major part in the decision to cancel the aircraft.'[63]

Vickers-Armstrong were merged with English Electric to build TSR2 but regardless of the necessity for this 'shotgun wedding' with regards to industrial strategy, it was entirely counterproductive in terms of individual project management. The resulting working relationship between Vickers-Armstrong and English Electric was described by an engineer on the project as 'quite shocking'.[64] He added, "the engineers approached almost every problem from a different angle and seldom agreed on anything." This engineer had spent the last 25 years on European collaborative projects and had never experienced anything as difficult – or as acrimonious – as the relationship between Vickers and English Electric.[65] In the view of ACM Sir Patrick Hine, a senior staff officer in the Air Staff during the mid-1960s:

[61] *Ibid.* p. 117.
[62] *Ibid.* p. 123.
[63] *Ibid.* p. 117.
[64] Hunter, A., (ed.) (1998) *TSR2 with Hindsight*, Royal Air Force Historical Society, p. 118.
[65] *Ibid.* p. 118.

> Merging companies of different cultures and managing a very sophisticated programme ... probably made it impossible to have maintained what should have been more rigid cost control.[66]

Essentially, at the project management level, TSR2 brought back all the problems of the Low Altitude Bomber and added a further layer. Although, by now, the appointing of a Prime Contractor in 'Weapons System Management' style was unavoidable, in many respects it was merely a courtesy title. With regard to the crucial matter of controlling the subcontractor's development of equipment for the project:

> ...each of these equipments had an equipment director (a Ministry man) who had to report [to D(RAF)A] on any matter where he believed that Vickers-Armstrong was not doing the right thing at the right time. In short, although Vickers had been appointed prime contractor, the firm had not been allowed to exercise the authority implicit in such an appointment.[67]

The result of both the cost overruns and the delay resulting from the bizarre operational requirement and poor management was that, by the autumn of 1964, the Chief of the Air Staff, Marshall of the Royal Air Force Sir Charles Elworthy, had come to the conclusion that TSR2's cost escalation had gone too far. Air Commodore Henry Probert of the Air Historical Branch was later told by Elworthy that:

> ...he personally had accepted cancellation as CAS. Costs were escalating rapidly, the numbers purchased were steadily being cut and he feared that it would run the whole RAF budget dry.[68]

Probert later became aware that 'CAS (Elworthy) had recommended to Hugh Fraser (Minister for Air) before the 1964 General Election the cancellation of TSR2'.[69] Elworthy's private secretary, Sir Michael Quinlan, recalls that Sir Charles had suggested the substitute purchase of the American F111 to the Minister but Fraser declined to forward the idea to Peter Thorneycroft.[70]

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[66] *Ibid.* p. 118.
[67] *Ibid.* pp. 121-2.
[68] Hunter, A., (ed.) (1998) *TSR2 with Hindsight*, Royal Air Force Historical Society, p. 66.
[69] *Ibid.* p. 66.
[70] *Ibid.* p. 66.

However, Probert suspected that 'had another Conservative government been elected in 1964, TSR2 would still have been cancelled.'[71]

It was ironic that particular sensitivities to the implications of the worsening situation in Aden amongst some senior members of the new Labour government meant that TSR2's putative, but improbable, East of Suez role nearly saved the aircraft. Both the Minister of Defence Denis Healey and James Callaghan at the Treasury were supporters of Britain's East of Suez commitment and were concerned that the cancellation of TSR2 would be seen as a message indicating imminent withdrawal.[72] It was a double irony, therefore, that Healey found the solution to this dilemma in Elworthy's suggestion that TSR2 be cancelled in favour of the F111. This ensured not only the demise of TSR2 but also, paradoxically, the survival of the role that had been specifically tailored to fit it.

This is evinced in an exchange between Healey and the opposition MP, Julian Risdale, during Healey's speech announcing the cancellation of TSR2.[73] Risdale challenged Healey:

> Surely the only circumstances in which he can envisage the RAF without a strike aircraft would be the complete withdrawal of our forces from the Far East, Middle East and Cyprus. Is this the government's policy?[74]

Healey replied:

> No, I myself think it most unlikely that these hypotheses will be fulfilled. They would, indeed, require such a radical change in our commitments as to imply tremendous changes not only in the RAF weapons programme but the weapons programme for the whole of our forces. In order to make quite certain that, whatever happens, our services will have appropriate aircraft in sufficient numbers, Her Majesty's government have secured from the United States government an option on the F111A aircraft at a

[71] *Ibid.* p. 66.
[72] *Ibid.* pp. 41-2.
[73] Wynn, H., (1994) *The RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 502.
[74] Wynn, H., (1994) *The RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 502.

> price per aircraft which, even on a full scale programme, would represent less than half the estimated total TSR2 research, development and production cost.[75]

Seven years earlier, with the likelihood of further strategic retrenchment a distinct possibility, the East of Suez strike role had seemed, to Sir Frederick Brundrett at least, as something to avoid. Now that the brink of that retrenchment had been reached, it brought the political necessity to cling onto the symbols of that commitment as tightly as possible. Almost inevitably, the F111 order was later cancelled but not until after the last British troops had left Aden.

Why did the Chief of the Air Staff ignore Sir Frederick Brundrett's advice, given at such an early stage, when it would still have been possible to abandon the specification and adopt something more suitable? The simple answer seems to be that the original specification provided the RAF with exactly the type of aircraft that it wanted to fly; a large, impressive supersonic multi-seat bomber. The Air Staff's approach to the replacement specification, AST 355, only attempted once the writing for TSR2 was more conclusively on the wall, went down a substantially similar path, though constrained by the new realties of the situation. This rather shows that it was simply a case of the Air Staff not being able to imagine any other kind of aircraft.

In some respects, TSR2 became 'Noah's Ark' for all the most cherished capabilities of the manned aircraft in the face of the devastation to the air development programme unleashed by Sandys' 1957 White Paper. Without the 1957 Defence Review, there would not have been such an urge to 'over egg the pudding' with regard to the OR, as Sir Michael Beetham put it.[76] In the opinion of Sir John Barraclough, 'TSR2 was the phoenix rising from [Sandy's] ashes.'[77]

However, it is clear that this did not in fact substantially alter the Air Staff's existing approach to the project. The abandonment of the requirement for a

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[75] *Ibid.* p. 502.
[76] Hunter, A., (ed.) (1998) *TSR2 with Hindsight*, Royal Air Force Historical Society, p. 7.

NATO strike fighter in favour of a SEATO/CENTO bomber occurred a year before publication of Sandys' White Paper. This early abandonment of the aircraft that Air Staff research had shown to be operationally necessary, in favour of one that RAF opinion had thought was institutionally required, set an agenda for the development of TSR2 which the 1957 Defence Review merely strengthened and confirmed. The issue of 'TSR2 replacement' AST355 as early as 1961 showed both the awareness within the Air Staff of the tactical and strategic chasm that had opened beneath the aircraft and the power of the East of Suez interest group. However, the fact that the project continued suggests that strategic interest groups were less powerful than organisational interest groups. It also further confirms that, in the Air Staff's eyes the aircraft itself and the interests it represented were far more important than any specific role.

Does this mean that considerations of strategy played no part in the evolution of the aircraft? In the accepted sense, that individual systems should be optimised for roles that form part of a cohesive overall strategy, the answer would be 'no'. For TSR2, roles were optimised to fit the needs of the aircraft. The switch to the East of Suez role, combined with the reconnaissance role, ensured that the operational requirement would provide the aircraft that the Air Staff required by excluding all other options. The range required was too great for a strike fighter, the speed and altitude required were both too great for the Buccaneer and the bombing accuracy was too precise for a ballistic missile.

The accommodation of such a range of bureaucratic politics agendas within the rationale behind TSR2 was fatal for Blue Streak. The opposition from the Treasury, the Admiralty and the Home Office could all potentially be weathered but if the weapon could not rely on the support of its principal backer it was finished. Air Staff support for Blue Streak was based upon the particular function that the weapon had in supporting its principal bureaucratic politics agendas, as the Future Bombing Policy document so frankly stated.

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[77] *Ibid.* p. 66.

As has been demonstrated, TSR2 was also primarily a vessel for bureaucratic politics agendas. Blue Streak and TSR2 were the two essential pillars of a coalition between the Air Staff's previously warring factions. Once TSR2 came under threat from early 1959 onwards, this carefully constructed alliance between the various interest groups collapsed. The search for both alternative roles for TSR2 and ways of maintaining the East of Suez role required the freeing up of the deterrent role and therefore the demise of Blue Streak. The weapon that would potentially solve the East of Suez dilemma and give fresh life to a manned bomber force that could not now totally rely on its continuation with TSR2 was Skybolt. The role of this weapon in the cancellation of Blue Streak and the further light that its adoption throws on the Air Staff's attitude with regard to the deterrent will now be examined.

Skybolt

6.1 Introduction

Other than for reasons of completeness, the Skybolt project may seem an incongruous subject for inclusion in this study. It was an American designed and developed weapon and it was cancelled by American decision-makers. Surely this must be the one system that was immune to bureaucratic influence at the levels examined in this study? This, however, is not the case and there are indeed three important questions that need to be asked with regard to the Skybolt project if the bureaucratic politics of the Air Staff with regard to the deterrent are to be understood. Firstly, why was Skybolt seen as a solution to the problems caused by the collapse of the coalition between the Air Staff's various interest groups? Secondly, why did the Air Staff risk loosing the deterrent to the Navy by abandoning their own Blue Streak and opening the field to American systems? Finally, why did they fail to heed the repeated warning of the project's bleak technological and political prospects?

6.1 Why Skybolt?

The doubts regarding TSR2's operational capabilities, the cancellation of Blue Streak and the adoption of Skybolt are all concurrent events. What connects them is the East of Suez question. TSR2 had been designed to take on this role, only for it to be realised that the change both in the conduct of tactical nuclear warfare and the potential loss of permanent bases would render it obsolete. This created two new bureaucratic political agendas, one to find a new role for TSR2 and the other to find an alternative means of 'doing' East of Suez. Both of these had terminal consequences for Blue Streak as both at one stage or another were to require the 'freeing up' of the deterrent role. Although attempts to fit TSR2 into the deterrent role were ultimately fruitless, replacing Blue Streak with Skybolt, somewhat surprisingly, provided a possible solution to the East of Suez problem.

The Skybolt project's conventional capability and its application to the East of Suez problem is something that has not been examined previously. It can be argued that a major part of the attraction of Skybolt to the Air Staff was that it promised to enable the RAF to acquire a system capable of taking part in out-of-area operations in a limited war situation. This had nothing to do with the missile itself but the Air Staff's preferred carrier for the weapon, the Vickers VC10. Although the Air Staff inferred to the BNDSG, and therefore the Treasury, that the Skybolt VC10s would be minimum-charge variants of the VC10 transports that the RAF had already ordered, in fact, the aircraft would have a completely re-designed fuselage incorporating a blind bombing radar and an internal weapons bay.[1] The VC10 offered the possibility of adopting either of the two possible approaches to the provision of close air support at long ranges. TSR2 had fallen neatly between these two stools. Too large, unmanoeuvrable and expensive to be used as a traditional close support aircraft, despite the strictures of OR343, TSR2 was nonetheless also too small to have either the range or the conventional weapon load necessary for effective area bombardment in the manner of the 'Arc Light' sorties that USAF B52s subsequently carried out in Vietnam.

Conversely and somewhat surprisingly, the VC10 could potentially do both. The aircraft's wing hard-points could not only carry a total of six Skybolt missiles. As an alternative, either a large pod on each pylon, carrying a heavy load of conventional bombs, or, more intriguingly, a flight of six Folland Gnat lightweight fighters could be carried under the VC10s wings, turning the erstwhile transport into a flying aircraft carrier capable of projecting conventional air power deep into areas thousands of miles from a British base.[2] With the bomb pods attached, the VC10 would become a long-range conventional bomber with a performance similar to a B52, capable of performing limited war missions similar to Arc Light. Unfortunately for the Air

[1] AIR20/11086 ACAS (Ops) to DOR(A), 23 August 1961.

Staff, the intense competition with the Navy over the deterrent and the decisiveness of any Treasury intervention on behalf of one side or the other, led to the paring back of the project to the barest outlay possible. This meant retaining the V-Bombers as Skybolt's carrier vehicle and the abandonment of the VC10 in anything other than a transport role. However, the 'flying aircraft carrier' concept lingered as studies were prepared of a Vulcan carrying three Folland Gnats.[3] The Air Staff, however, did not give up on the VC10 proposal, subsequently proposing it as a replacement carrier for Skybolt from the early 1970s onwards when the Vulcan would be due for retirement. Even without the VC10, however, Skybolt would ensure the maintenance of some kind of long-range limited war conventional capability in the Far East. Just as importantly, it would offer continued employment for RAF bomber crews, reuniting the twin benefits that had been perceived as accruing from the employment of TSR2.

The manner in which Blue Streak was disposed of in order to facilitate the acquisition of Skybolt was discussed in the preceding chapter. However, the switch illustrates the failure of the Air Staff to appreciate the changed political landscape in which they were operating and the extent to which their grand design nearly backfired. The cancellation of both the LAB and the Avro 730 had been undertaken by the Air Staff and the Ministry of Supply and merely rubber-stamped by Ministerial authority. However, the debate regarding Blue Streak had now brought the question of the follow-on deterrent system firmly into the political spotlight. The Air Staff could no longer choose its own deterrent systems, indeed it could no longer assume that it would retain responsibility for the deterrent. In promoting an American system as Britain's 'independent' deterrent, the Air Staff were also opening the door to the Polaris system and Naval control of the deterrent. Whether this might actually have come to pass in 1960 has been a source of considerable debate. However, at the time, Richard Neustadt, special advisor to the

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[2] AIR20/11086 ACAS (Ops) to DOR(A), 23 August 1961.
[3] Woods, D., (1986) *Project Cancelled: the Disaster of Britain's Abandoned Aircraft Projects*, London: Janes, p. 76.

Kennedy administration, was convinced that it could have done. In his Report to the President, Neustadt claims:

> Considerable testimony, some of it from Watkinson, suggests that at Camp David in March 1960, when we agreed to British purchases of Skybolt, Gates and Watkinson alike would have been pleased had the other shown strong preference for a British share, instead, in Polaris.[4]

Of course, all concerned might well have been indulging in a little 'justification after the fact' for this major policy blunder but, on the face of it, there seems little reason why the United States would favour one system over the other at that particular time. Britain already possessed the technology to create the carrier systems, strategic bombers and nuclear submarines, for both missiles and the technology of the weapons themselves was almost identical. If anything, Skybolt was the more advanced application of that technology, so if there had been technology transfer concerns, it should have been Skybolt to which they were most attached.

The situation at Nassau was different in that system longevity became an issue. This was due to the increased influence of the State Department's desire to see an end to Britain's independent deterrent compared with the policy of the Eisenhower administration. Both Skybolt and Polaris were advanced systems with a long prospective operational lifespan. With Skybolt out of the way, its revival being an option that the British were unlikely to be able to afford, the opportunity arose to limit the longevity of the British deterrent by getting them to accept a system such as Hound Dog, which would rapidly become obsolete. If the mistake of offering to provide a replacement system was not repeated, the Americans could both fulfil their existing obligation and see the British deterrent rapidly wither on the vine. Therefore, ensuring that the British did not get hold of Polaris with 'no strings attached' had an importance at Nassau that was absent when the original agreement was made. In 1960, Britain would not have bought anything other

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[4] Neustadt, R., Report to the President "Skybolt and Nassau" (facsimile Aberystwyth Nuclear History Archive) p. 7.

than an advanced system. By 1962, they may conceivably have taken whatever they were given. It would therefore seem that the decision to proceed with Skybolt as opposed to Polaris in 1960 was almost entirely a British one. How did the Air Staff achieve this? The big clue to this perhaps is also given by Neustadt, who commented:

> ...the Skybolt project started as it were to end, with transatlantic reticence from minister to minister occasioned by the intimacy of their Air Forces.[5]

The strength of the RAF's transatlantic advocacy coalition with the USAF and the strength of the USAF's political influence within the United States almost certainly gave the Air Staff the confidence to take what otherwise would have been a great gamble in abandoning a system that was squarely under their control, for one that they might not get at all. This might well also have been conditioned by knowledge that the Royal Navy was not universally in favour of Polaris.

Although the Admiralty was to campaign for the supplanting of Skybolt by Polaris throughout the airborne weapon project's brief existence, its efforts to achieve this were not successful. This was partly due to the greater political influence of the RAF, whose existing possession of the deterrent conferred a greater voice to. However it was also due to conflict within the Admiralty over the desirability of operating the deterrent. John Baylis has described the strategic dilemma in which the Admiralty found itself.[6] As the Navy had been opposed to the value of the deterrent for so long, a new found enthusiasm for it now that a suitable sea-born system had been evolved would be open to derision. Baylis believes the Navy had to play a waiting game with regard to achieving possession of the deterrent.

However, despite the enthusiasm of Mountbatten and a few other senior officers, in general the rest of the Navy was not enraptured by the prospect of

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[5] Neustadt, R., Report to the President "Skybolt and Nassau" (facsimile Aberystwyth Nuclear History Archive) p. 7.

[6] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 283.

Polaris. This was due to several factors. Firstly, Mountbatten did not have a universal following in the Admiralty. A controversial figure, his views were not universally held and he was personally disliked by many in the service.[7] Secondly, Polaris was regarded as yet another attempt by the submarine branch to usurp the role of the heavy surface ship, a particularly sensitive subject by 1960. Although it was the ambition of virtually every naval officer to command a capital ship, the scrapping in 1960 of HMS Vanguard, the last Royal Navy battleship, and steady reduction in the Navy's carrier fleet rendered this an increasingly impossible dream for most. Finally, as well as this antipathy towards indulging the pretensions of the traditionally oil-smeared and unshaven submarine service and their submarine 'boats', the Navy was somewhat ambivalent toward nuclear warfare. The Royal Navy's attitude to nuclear weapons was basically similar to that of the Army; a few were necessary for prestige but they were operationally not the 'be-all and end-all' that the Air Force believed them to be. One or two nuclear weapons might be a suitably modern adornment to the capabilities of a large surface capital ship like an aircraft carrier but anything more would drain resources away from conventional capability.[8] The use of land attack nuclear weapons was also not in line with the Royal Navy's strategic culture. This was epitomised by the observation of Watkinson when he stated that the Navy wanted to sink ships not bomb cities.[9]

Perhaps the best indication of the strains within the Navy regarding the

[7] Ziegler, P., (1985) *Mountbatten: The Official Biography*, London: Collins, p. 214.
[8] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 223.
[9] Neustadt, R., Report to the President "Skybolt and Nassau" (facsimile Aberystwyth Nuclear History Archive) p. 69.

deterrent was evinced by the concept of the 'composite' submarine, which the Royal Navy vigorously put forward as an alternative to Skybolt.[10] The composite submarine was essentially a standard nuclear attack submarine with a small four-tube missile section added amidships. The rationale was that instead of having a few, dedicated, large 16-missile strategic boats, the missiles should be distributed amongst an enlarged attack submarine force, which could then undertake dual-role missions. The scheme was flawed by the fact that strategic submarine operations and conventional attack operations were completely incompatible by nature. The type of patrol area that an attack submarine would operate in would be one that deliberately drew it into maximum contact with enemy forces. The successful operation of the strategic mission largely depended on the submarine totally avoiding contact with enemy units.

This rather makes it obvious that, like the Air Staff, at this stage the Admiralty largely saw operation of the deterrent as a means of acquiring an enhanced conventional capability. Unlike the Air Staff, however, the Admiralty seemingly went to few lengths to disguise this. It could be argued that this was due to the greater difficulty of concealing the conventional emphasis of the composite submarines as opposed to the Skybolt carriers but a little imagination and a few downright lies could surely have helped matters, as the Air Staff usually found. The Admiralty, then, was either being exceedingly honest and extremely naïve or, more likely, had its room to manoeuvre curtailed by the need to maintain cohesion within the naval staff regarding the deterrent. In order to do this, it could be argued that the conventional slant of the composite system had to be manifest in order to placate the deterrent sceptics within the naval staff. Unfortunately, the manifest emphasis on conventional capability and utter implausibility of the scheme totally undermined the Navy's case and left the door open for the favoured Air Staff project.

[10] AIR119/998 Kent to Huddlestone, 19 January 1962.

With a lack of wholehearted Naval opposition, therefore, Skybolt became the obvious replacement for Blue Streak, particularly as it had already been earmarked as the 'insurance' system for Blue Streak. The insurance project had originally been Blue Steel Mark 2 but, by 1959, this had been superseded by the emerging Skybolt project. Although officially only to be procured if Blue Streak failed, it seems from the nature of the Air Staff's commitment to the project that they were always virtually certain that the weapon would enter service with the RAF. Certainly the USAF was never given the impression that the system would only be required if Blue Streak failed and RAF requirements were built into the weapon from the very beginning. Whether this reflects a confidence by the Air Staff that Sir Frederick Brundrett's dictum requiring that only one delivery system be deployed for the deterrent could be successfully overturned, or whether they never really believed that Blue Streak would enter service, is unclear. However, it certainly gave the project sufficient momentum to be almost automatically adopted after Blue Streak's cancellation.

The substitution of both Blue Steel Mark 2 and Blue Streak by Skybolt may mark another factor in the American weapon's favour as far as the Air Staff were concerned. This is the fact that it was not a British system. The Air Staff very possibly hoped to avoid the performance shortfalls, cost over-runs and late delivery that had, perhaps unfairly, become synonymous with British weapons systems as far as the RAF were concerned. Such was the poor reputation of the British procurement system by the time Blue Streak was cancelled throughout both government and the defence establishment that despite the fact that the use of American nuclear systems and the debate regarding the integration of British nuclear forces into NATO were heavily connected due to the MLF proposals, justifying the selection of an American system to the government in the face of criticism from the aircraft industry was seen to be quite straightforward. Air Marshall Walker, the head of the Air Ministry public relations, stated:

> The Beaverbrook press and vested UK manufacturing interests are to the fore in the 'buy British' element and there is understandably a reluctance in some quarters to

> accept the necessity for the order for the missile to be placed in America. The facts concerning the fulfilment of the Thor programme gives support to the justification for the order being given to the Douglas Corporation and the associated subcontractors. A further strengthening of the case is provided by a comparison between the times of operational availability of the Hound Dog and Blue Steel Mark 1 weapons system. I do not think we can exploit this latter factor outside government circles because of the reflection on the capabilities of the British aircraft industry; but I consider that if these facts could be made available they could well be used if necessary in any ministerial discussions.[11]

The shadow that Blue Steel had cast over British aerospace capability in the minds of Whitehall is made obvious by Walker's comments. By the beginning of the 1960s, the products of the British aircraft industry were being viewed with particular jaundice throughout Whitehall. Although it was the troubled gestation of Blue Steel that had brought the matter into the ministerial spotlight, almost all the government sponsored operators of British aircraft were of much the same opinion. The state-owned national airline, BOAC, had a marked preference for the products of the Boeing company after the Comet disasters and the problems experienced with the development of the Britannia and the Tudor.[12] The Admiralty were adamant that the American McDonald Douglas Phantom would be their next fighter after long delays with both the Seahawk and the Scimitar had rendered them both virtually obsolete before they entered service.[13]

The Air Staff were not just disillusioned with strategic systems. The Hunter/Swift project had been very badly handled at all levels and had prompted a major review of all procurement procedures,[14] whilst the CAS had hoped an arrangement might be reached whereby the RAF be given

[11] AIR 20/10829 CIO to PS to SoS, 28 June 1960.
[12] *Encyclopaedia of Aircraft* (1982) London: Orbis, p. 2624.
[13] Gunston, W., (1982) *Harrier*, Oceala: Speciality Press, p. 32.
[14] AIR20/8573 OR16 Report *Lessons from the Histories of the Swift and Hunter*, September 1955.

American F106 fighters in exchange for giving the USAF the right to base Thor missiles in Britain, due to the inadequacy of both the Javelin and the Lightning in the all-weather fighter role.[15] Even the most successful projects and design teams were not above serious criticism, a Ministry of Supply official stating, "we have no reason to have particular confidence in English Electric's design ability...the Canberra had one particular serious weakness which no approved firm should have made."[16]

In many respects, the 'don't buy British' attitude that had began to make itself felt was unjustified. Many of the problems encountered by these projects were the product of ill-defined requirements and bad planning at Ministry level and even the technological problems were mirrored in similar programmes in other countries. Although the United States could boast many successful projects, particularly Polaris, Hound Dog and the F86 Sabre, which were often used in Air Staff documents to cast unfavourable light on British projects, it had its share of failure too. The Cutlass, Skyray and Demon naval fighters had all suffered a troubled gestation[17] and the Electra airliner had suffered from a series of fatal crashes due to engine problems.[18] The Convair 880 and 990 series airliners had such a troubled development that the Convair company sustained the biggest corporate losses every experienced at that time.[19] Convair's F102 all-weather interceptor had also required complete redesign due to aerodynamic problems.[20]

The Russians had their share of problems as well, the vitally important Mya 4 (Bison) inter-continental bomber failing to meet requirements is but one example.[21] Also, despite the French Super Mystere being the first European

[15] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 251.
[16] AVIA54/121H of S to PRD(A), 21 April 1953.
[17] Angelucci, E. and Bowers, P., (1987) *The American Fighter*, Yeovil: Haynes, p. 189, p. 304, p. 448.
[18] *Encyclopaedia of Aircraft* (1982) London: Orbis, p. 2604.
[19] *Ibid.* p. 2641.
[20] *Ibid.* p. 3806.
[21] *Ibid.* p. 3066.

supersonic fighter to enter service, its predecessor the Mystere II had been withdrawn from service after only a few months due to structural failures.[22]

Be this as it may, however, in Whitehall the mood was very much against entrusting any further major projects to the British aircraft industry or, for that matter, the Ministry of Aviation, whose future was beginning to look increasingly insecure. Two advanced British missile projects, the English Electric P10D and the Bristol X12 Pandora received scant consideration either at the time of Blue Streak's cancellation or after the abandonment of Skybolt.[23]

Given that the Air Staff were seemingly predisposed to reducing the possibility of delays and cost over-runs, it is therefore strange that they chose a weapon such as Skybolt, even if it was to be built by Americans. The air-launched ballistic missile was by far the most demanding of all strategic missile concepts from a technological perspective. The two principal difficulties regarded weight and accuracy. Such a weapon had only been made possible by the recent development of suitable lightweight solid fuel rocket motors, which had also made Polaris feasible. However, the weight and size constraints on Polaris to enable it to be carried by a submarine were nothing compared to those facing Skybolt to enable it to be carried by an aircraft. The long range necessary to enable the carrier aircraft to evade air defences could only be achieved by drastically reducing the size of the warhead and eliminating the decoys that both the Polaris A3 and Minuteman 3 programmes deemed necessary if the weapon was to evade anticipated Soviet ABM systems. Even then, there was considerable doubt that the weapon could achieve the desired range. Avro produced a study showing that the Douglas Company's figures were dubious in the extreme and, although Avro certainly had a vested interest in doing so, many aerospace

[22] *Encyclopaedia of Aircraft* (1982) London: Orbis, p. 4702.
[23] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 293.

analysts remain sceptical to this day regarding the performance claimed for Skybolt.[24]

Even more problematic than meeting the size and weight requirements was ensuring the necessary accuracy. Ballistic missiles, because of their enormous speed and long range, are prone to large accuracy errors through even minor mapping errors regarding the launch point,. Launching a ballistic missile from a moving object, particularly one that has already travelled a long distance and therefore whose own position is already subject to error, complicates the process greatly. Launching Polaris accurately from a 30 knot nuclear submarine had proved to be enough of a challenge, launching Skybolt from a 600mph bomber and getting it to hit the target was exponentially more difficult. Given the many problems that the Air Staff were already encountering with far more simple systems such as Blue Steel, their choice of Skybolt seems incomprehensible.

6.3 Cancellation

Understanding the Air Staff's choice of such a technologically fraught project as Skybolt is also heavily connected with why the Air Staff failed to respond to a variety of indications that the Skybolt project was in trouble. Although this matter has been dealt with at length regarding high policy-makers, it should also be investigated with regard to the Air Staff. Such a question raises several issues, not only linked to the obtaining of 'early warning' of American intentions during the second half of 1962. In this respect, the Air Staff can be accused of being possibly even more culpable than high policy-makers as, due to the direct involvement of RAF officers in the project, they should have been the primary conduit for any information involving Skybolt. Instead, they appear to have been the main source of what John Baylis has called 'the wishful thinking which characterised British policy towards Skybolt.'[25]

[24] Interview with Professor John Allen, 25 August 2000.
[25] Baylis, J., (1995) *Ambiguity and Deterrence: British Nuclear Strategy 1945-64*, Oxford: Clarendon Press, p. 312.

Whilst this 'wishful thinking' has been attributed to a naïve faith that the Americans 'could get things done', it can be argued that it was instead due to the fact that the Air Staff's attitude toward the operational effectiveness of strategic nuclear systems was at total variance to that of the USAF.

As the preceding chapters of this study have argued, due to the perception that Britain was uniquely vulnerable to nuclear attack, the Air Staff had contained from the very beginning of the nuclear programme a strong faction that believed that nuclear deterrence should be symbolic only and that strategic systems should actually be optimised for limited warfare. With the demise of Blue Streak, the opposition to this view finally collapsed and Skybolt was procured principally for reasons connected with the contribution to 'institutional essence' and limited warfare that its carrier aircraft could make.

This was in direct contrast to Strategic Air Command's view of deterrence, which involved an array of sophisticated war-fighting strategies and extremely demanding operational capability requirements for its equipment. At the time, Richard Neustadt noted 'this difference between British purposes and ours'[26] and believed it was at the core at the misunderstandings between the two governments regarding Skybolt.[27] He commented:

> Zuckerman, to be sure, among other scientific advisors had been scathing in his comments about Skybolt for years past, and warned repeatedly of comparable sentiments across the water. But his very tone and terms – and repetition – misled his non-scientific colleagues. His bete noir was the weapons guidance system:

[26] Neustadt, R., Report to the President "Skybolt and Nassau" (facsimile Aberystwyth Nuclear History Archive) p. 39.
[27] *Ibid.* p. 38.

> accordingly his warnings seemed more technical than fiscal. And technically he sounded hypercritical: for British purposes Skybolt's 'effectiveness' required only that the Soviets should fear it might hit somewhere in a city. No more was wanted from the weapon than a threat of primary attack which would sustain the British claim to have a nuclear deterrent.[28]

The unpleasant surprise the British were to receive when McNamara unilaterally cancelled the Skybolt programme in December 1962 because of technological dificulties and cost over-runs was also due to the totally different expectations the British had of the procurement system when compared to the Americans. This was underlined by Peter Thorneycroft's comments to McNamara when pleading with the Americans to reconsider their decision:

> ...but most missiles slip their schedules. Most of these projects cost more...Many of them are less accurate than they might be desired to be.[29]

As Neustadt commented:

> In 1962, 'cost-effectiveness' was not a term of art yet known to the British...McNamara's reasoning was scarcely understood; his words of warning had fallen on deaf ears.[30]

6.4 Conclusion

Despite Thorneycroft's pleadings, the Skybolt project ended in cancellation. With this, the nuclear deterrent, which the RAF had virtually made its *raison d'etre*, slipped out of the Air Staff's hands following ten years of failure to find a suitable follow-on system. It is noteworthy, however, that this particular procurement decision was the only one concerning the various V-Bomber replacement projects that can unambiguously be attributed to the makers of high policy. Even more noteworthy, perhaps, is the fact that this decisive

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[28] Neustadt, R., Report to the President "Skybolt and Nassau" (facsimile Aberystwyth Nuclear History Archive). p. 38.
[29] *Ibid.* p. 64.
[30] *Ibid.* p. 38.

decision regarding the British nuclear deterrent was made in the United States. However, two major indigenous factors can be seen as influencing Britain's role in the Skybolt saga.

Firstly, the debate regarding the continuation of Britain's East of Suez commitment was a major influence on the project. It affected Skybolt in two ways. Primarily, it helped to render the entire strategic rationale for TSR2 dubious, which was a major cause of the cancellation of Blue Streak. Secondly, this in turn brought about the requirement for a limited war power projection system that greatly influenced the selection of Skybolt as the replacement for Blue Streak.

The second indigenous factor influencing the programme was the Air Staff's attitude towards the deterrent. In many respects, Skybolt can be seen as the perfect embodiment of the now dominant attitudes in the Air Staff's internal debate regarding the deterrent. With a smaller warhead than was required, and without the decoys that were thought necessary at the time for successful penetration, Skybolt's ability to escape interception and do the required damage to the target was not as formidable as its 'visible' qualities would suggest, particularly with the large question-marks over its technological viability, especially with regard to the guidance system.

That the policy decisions regarding the project ignored these operational and technological deficiencies in favour of other considerations indicates that Skybolt was intended as a largely totemic deterrent. The very fact that it was a ballistic weapon ostensibly meant that it was at that talismanic 'cutting edge of technology' and also made it nominally uninterceptable. This latter capability would provide worrying threat analyses for the potential enemy. In those respects, it adequately fulfilled its nuclear deterrent role as far as the Air Staff were concerned. The fact that its carrier aircraft could provide both essential power projection capability in the limited war role and provide employment for the RAF's bomber crews was the real operational capability that the Air Staff were interested in. It was this attitude towards that deterrent, one diametrically opposed to the emphasis on operational effectiveness of Strategic Air Command, that was at the root of the Air Staff's failure to foresee the looming disaster of Nassau. There, after ten years and six different projects, the Air Staff's efforts to provide themselves with a replacement for the V-Force finally came to naught when Macmillan brought home Polaris for the Navy. Somewhat ironically the demise of Skybolt was perhaps not such a blow for the Air Staff. A note of the 28 December 1962, quoted by Wynn, simply stated:

> Most unfortunately Skybolt is gone. Attacking Polaris will not bring it back....(We) must accept that and turn all our energies to building up the Royal Air Force to fill a "limited war" role.[31]

It could be argued that the bureaucratic politics agendas of the past 10 years had finally been legitimised.

[31] Wynn, H., (1994) *RAF Nuclear Deterrent Forces: their Origins, Roles and Deployment 1946-69*, London: HMSO, p. 422.

Conclusion

Having examined the various attempts by the Air Staff to replace the V bomber fleet, it must now be asked what new light this study has thrown upon such a massive procurement failure? Firstly, the effectiveness of the methodology must be assessed. Has the study of the threat analyses and the evolution of the technology proved effective in uncovering evidence of the use of threat as a legitimising language for bureaucratic politics agendas? It can strongly be argued that it has, particularly with regard to Blue Streak and Blue Steel.

The Role of Threat

As outlined in the introduction, in terms of threat this study focuses on conceptions of military/technological threat at the operational level, rather than the grand strategic threat that generally informs high policy. However, it can be argued that conceptions of threat at the operational level affecting the deterrent could also be highly influential with regard to high policy and were therefore prime targets for manipulation in furtherance of bureaucratic politics agendas. Considerable evidence of this activity can be observed with regard to the projects under study.

During the whole twelve-year saga of the V bomber replacement project the basic threat analysis remained fairly constant. The main threat was posed by Soviet surface-to-air missiles and evading these was the primary requirement of all the specifications in terms of threat. A secondary requirement emerged around 1957, and that was the ability to escape pre-emption by Soviet ballistic missiles. It might be imagined, therefore, that the basic performance requirements would remain fairly constant from project to project. This, however, was not the case. The performance requirements demanded by each succeeding specification were different and in a number of cases totally contradictory. The Low Altitude Bomber (LAB) heralded the demise of the high altitude bomber, only to be replaced by a high altitude bomber. The Blue Streak specification demanded a one-megaton warhead and decoys; its successor had a half-megaton warhead and no decoys. Blue Steel's range requirement was inadequate for its intended mission, forcing, as it did, the missile's carrier aircraft to close within range of the defences of some of the most important targets, largely negating the effectiveness of Blue Steel missile. This strongly suggests that instead of the needs of the threat analysis creating the various weapons systems, considerations such as the technology's need of an application tended to create the operational justification.

At times, unwanted systems were disposed of by a reverse logic, in which threat was manipulated in order to make a system's capabilities look like liabilities. A striking example of this is with regard to Blue Streak. The 'launch on warning' argument used to prove the missiles unsuitability due to its poor reaction time had originally been mooted as a way of exploiting what was regarded as an excellent reaction time. This is a clear example of a threat analysis being distorted to enable the fulfilment of a bureaucratic politics agenda. Indeed, almost the entire BNDSG discussion of Blue Streak comprised of threat analyses that had been distorted in a variety of ways by various different parties. The concept of 'technological viability' is also used in a similar manner but by a far more limited group, as can be seen with regard to the cancellation of the LAB.

This distortion of threat raises four questions. Firstly, who was responsible? Answering this question requires the identification of the principal bureaucratic politics actors, a task that may seem simple but that has been a subject of much confusion in previous works. Secondly, what was the actor's motive? This question is intrinsically linked with the first, and answering it provides half of the rationale for the study of threat manipulation with regard to these projects. Thirdly, what were the actor's tactics? This provides the other half of the rationale for the study of threat manipulation. Finally, what effect did this have on the projects? Addressing this question requires the assessment of the influence of bureaucratic politics agendas in comparison with structural and other factors.

Who and Why?

The first two questions raised are so inter-linked as to require answering together. Three major institutional actors can be seen at work, each with their own agendas. There were also several advocacy coalitions and, indeed, individuals who had considerable influence on events.

The Air Staff and 'Bomber Policy'

Whilst the Chiefs of Staff debates chronicled by Clark, Wheeler and Navias[1] show the Air Staff's belief in the efficacy of the deterrent to be almost total, a very different picture emerges from examination of the Air Staff's internal discussions. Although it is certainly true to say that many senior figures, such as Slessor, did genuinely see the advent of nuclear weapons as causing a revolution in strategy and warfare, the thinking that governed the procurement of the strategic delivery systems was anything but revolutionary. In some respects, this was due to the pre-nuclear origins of the V-Bombers, which led to the infusion of an anachronistic operational lineage into the concept of the new force. The V-Bombers were not the dedicated nuclear deterrent system that they are often portrayed as being. Conceptually, they were merely a

[1] Clark, I. and Wheeler, N.J., (1989) *The British Origins of Nuclear Strategy 1945-55*, Oxford: Clarendon; Navias, M.S., (1991) *Nuclear Weapons and British Strategic Planning 1955-58*, Oxford: Clarendon.

replacement for the wartime generation of heavy bombers, utilising the new technologies that had evolved at the end of that war. The carriage of weapons of mass destruction was largely a technological response to the smaller fleet size and lower sortie rates that the vastly more complex and expensive new aircraft would bring about. It was this that was principally behind the Air Staff's enthusiasm for Britain's acquisition of nuclear weapons, rather than a belief in a new strategic vision brought about by the Manhattan project. The Air Staff's strategic vision remained strongly Trenchardian, and it is Trenchard's concept of the bomber as a weapon suitable for use at all levels of conflict that is the key to understanding the Air Staff's attitude towards the deterrent.

The long-range heavy bomber gave air power the flexibility and strategic reach that guaranteed the independence of the air arm. The necessity of using the heavy bomber in all roles was not essentially due to its effectiveness but due to its ability to enable the air arm to remain independent of the other services in all roles. Therefore, when the RAF thought of any type of 'anti surface' operation, be it maritime strike, close support, long-range tactical interdiction or 'city busting', the heavy bomber would be first to be considered.

However, long-range strategic capability was an extremely expensive commodity by the mid-1950s. Its possession might enable the RAF to claim that it had the independent capability to undertake any number of roles. Unfortunately for the Air Staff, those roles were unlikely to be considered sufficient justification, in themselves, for the great expense of the strategic bomber. This was particularly true when either the Army or the Navy might well be able to claim the role amongst their traditional reemit and at a more cost-effective price. What the Air Staff required was a unique and essential role for the long-range bomber that would serve as a 'peg' to hang all the other capabilities that were required in order to compete with the other services for a slice of Britain's rapidly declining defence resources. Concepts of strategic bombing against cities as a general war deterrent or, if that failed, a war winning weapon, had served this purpose prior to the Second World War. Attempts to cash the promissory note of air power during that conflict did not bring the return hoped for but the fortuitous development of the atomic bomb threw a lifeline to the concept of Bomber Strategy. Not only did it solve the firepower problem of the new smaller fleets of advanced bombers, but also its overwhelming power lifted the doubts regarding the effectiveness of aerial bombardment. These practical difficulties solved, the concept of deterrence could be re-marketed, and a secure supporting justification was provided for the heavy bomber fleets.

Quester, Venables, and Ball, amongst others, have all stressed the extent to which nuclear strategy sprang from 'bomber strategy'.[2] However, what perhaps has not been made apparent is the durability of bomber strategy, and the fact that, during the period under study, the 1950s and early 60s, it was not at all superseded by any theory of nuclear deterrence in Britain. Instead, nuclear deterrence was merely regarded as an integral sub theorem of bomber strategy by the middle echelons of the Air Staff. The extent to which that was so is graphically illustrated by the degree to which procurement decisions regarding the nuclear deterrent were consistently subordinated to the fulfilling of the greater needs of the overall bomber doctrine.

Such considerations can be seen affecting the decisions to either procure or cancel all of the Air Staff's replacements for the V-Force. Firstly, the LAB began to wither on the vine from the moment the Air Staff realised it would have no conventional capability. Secondly, the adoption of the Avro 730 as the deterrent carrier, despite its already acknowledged failings as a strategic

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[2] Ball, S., (1991) *The Royal Air Force and British Nuclear Strategy 1945-49*, (unpublished Ph.D thesis, Cambridge University); Venables, M., (1985) *The Place of Air Power in Post-War British Defence Planning and its Influence on the Genesis and Development of the Theory of Nuclear Deterrence 1945-52*, (unpublished Ph.D thesis, Kings College, London), Quester, G.H., (1966) *Deterrence before Hiroshima: The Influence of Airpower on Modern Strategy*, New York: John Wiley.

penetration system, was entirely due to its fancied capabilities in limited warfare. When these proved illusory, it was cancelled. Blue Streak only saw the light of day due to the lack of any other option, the limited war functions of 'bomber strategy' being hived-off to TSR2. The moment TSR2's East of Suez role and tactical nuclear capability came under doubt, so did the RAF's commitment to Blue Streak. The fortunes of Skybolt, with its potential to revitalise the heavy bomber fleet began to rise at that very moment. As for Blue Steel, the inadequacy of its specified performance to fulfil its deterrent mission illustrates the largely symbolic importance attached by significant elements in the Air Staff to the deterrent role, also underlined by Skybolt's small warhead and lack of decoys.

Inadequacies in other 'invisible' areas, such as command and control, when contrasted with 'visible' factors such the demonstrations of operational efficiency given by Bomber Command's squadrons and the prominence given to the nuclear tests paint a picture of a deterrent that was by design 'all fur coat'. This tendency was not unopposed, and the internal bureaucratic struggle that resulted left its mark on several projects, most notably the Avro 730 and both marks of Blue Steel. It eventually evaporated as Britain's ability, both economically and technologically to follow any other course of action also vanished by the end of the 1950s.

Why the Air Staff held this position is unclear, but it is very probably the intensity of the struggle to both establish bomber strategy in the 1920s and defend it in the 1940s that caused it became so entrenched. These struggles were still very much within the memory of serving officers. Certainly it is notable that the decline of Strategic Air Command in the United States coincides with the retirement of the last senior Air Force officers who had served under Billy Mitchell.[3] The relatively recent inculcation of the RAF's 'strategic culture' meant that its influence was extremely strong.

The Ministry of Supply

The Ministry of Supply (MoS) was a Ministry under threat during the 1950s, a threat which materialised in its emasculation as the Ministry of Aviation and the eventual disappearance of even that organisation a decade later. Survival was an instinct that very much motivated the department at this time and led to a preoccupation with two issues that were intrinsically connected with that survival. The first was a resistance to the adoption of the new management practices that essentially robbed the Ministry of much of the rationale for its existence. The second was the attempt to create support for the Ministry amongst the aircraft industry as a counter to the hostility of the armed services and much of Whitehall.

The massive changes in aviation technology that characterised the early post war years led the rapid obsolescence of the essentially pre war concept and structure of the MoS. Geared to mass produce relatively simple aircraft that could easily develop along incremental lines, the MoS was now required to produce small numbers of highly sophisticated aircraft that required highly integrated development. In the USA, the adoption of the 'Weapons System Management Concept' had enabled the much larger US industry to successfully undertake a number of extremely advanced projects, overseen by a department of the USAF a fraction of the size of the gargantuan MoS. The Ministry's continual rearguard action against the adoption of the Weapons System approach to project management, with its implicit 'downsizing' of the Ministry's role, had a profound affect on many of the weapons projects discussed. The LAB was largely killed by this antipathy whilst the rise of the implausible Avro 730 was facilitated by it. The MoS's 'simulant' of Weapons Systems Management, the 'GWSP Project Management System' and its derivatives also damaged several projects. These caused severe delays and communications failures for both Blue

[3] Boyne, W., "Curtis LeMay" *Air Force Magazine*, March 1998 p. 67.

Streak and TSR 2. Their characteristic division of responsibilities was also to lead to very poor supervision of the Blue Steel project.

The other negative influence that the MoS inflicted on the various weapons projects due to its battle for survival was the primacy that it gave to its industrial strategy over the needs of the deterrent. Despite the national priority given to the nuclear deterrent by high policy makers, once the policy was passed to the policy implementation strata it became, in practice, subordinate to the priorities of that strata. Therefore, despite the organisational and technological challenge of the projects and the absolute necessity of getting them into service on time, the contacts were awarded in time honoured fashion. This was not to the most able contractor but to whichever of the Ministry's ten favoured design groups were in danger of running out of work, whether they necessarily had the experience or the facilities to undertake the task. The Avro company, for example, had to establish an entirely new department and hire new staff to undertake the Blue Steel project.[4] The placing of contracts with De Haviland Propellers and Rolls Royce for the airframe and engines for Blue Streak was also done despite the total lack of experience of either firm with the technology required.[5]

Even the Ministry itself admitted that other contractors, particularly English Electric, would have been more suitable.[6] The need to keep the industry happy was an important aspect of the Ministry's strategy for survival, and figured large in the internal discussions of the department. However, in some respects this primacy of industrial strategy over the needs of effective project management can be seen as an inevitable, structural consequence of the interposing of such a powerful industrial planning organisation into the procurement process, and such an argument formed the basis for the armed services opposition to the MoS. It should also not be imagined that the

[4] Interview with Professor John Allen 23 August 2001

[5] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press.

[6] DEFE7/2333 DCAS note 26/1/56 to SoS

primacy given to industrial strategy and the resistance to Weapon System Management went unopposed within the Ministry. Senior figures were well aware of the organisations shortcomings and were anxious to reform, but their efforts were continually thwarted by the power of the interest groups within the middle ranks of the organisation, who were determined to preserve the empires that they had built up during the war. The most powerful of these were the various government research establishments that operated within the MoS remit. Of these, one in particular was so powerful in aeronautical circles that it has to be regarded as a major actor in its own right. This was the Royal Aircraft Establishment, Farnborough

Farnborough

Despite the fact that in theory the RAE, Farnborough was a subsidiary component of the MoS, in reality it was one the major actors in the bureaucratic politics of defence procurement during the 1950s. It can be seen as having a decisive influence on the development of British post war aviation, over and above its intended role as Britain's principal aviation research establishment. This was largely due to the difficulties faced by the British aviation industry and indeed the other organs of the aerospace establishment in rising to the challenges of the revolution in aircraft performance caused by the advent of the jet age. Farnborough played a leading role in virtually every major aviation project undertaken in Britain during the period, often, as was the case with Lightning interceptor, Blue Steel and Concorde, having advocated the project to both the aircraft industry and its customers in the first place.

That Farnborough's advocacy role was necessary is probably beyond doubt, as the aircraft industry was at the limits of its ability to deal with the plethora of new technologies emerging at the end of the war. The radical manner in which the configuration, construction and propulsion of aircraft changed in the immediate post war years dealt a hefty blow to traditional British engineering empiricism. This made it imperative that the industry received assistance in order to modernise, and the RAE was the only institution capable of doing this.

It was not just industry, either, that was experiencing difficulties in adapting to the new technology. The Air Staff was also extremely dependent on the RAE. However, this dependency created a problem. This was not that the RAE was incapable of giving the necessary advice, as its staff represented the cream of British aeronautical science and in the immediate post war years were often at the forefront of international research. The difficulty lay in the structure and ethos of the organisation. The RAE was established as a pure research institution and in common with other British research institutions of the period, such as universities, the staff was encouraged to undertake pure research untrammelled by any thought of a definite application. Whilst this was ideal for fostering the development of exotic technologies that might not initially seem to have an obvious application it had serious repercussions from the point of view of the High Policy maker. Farnborough, in many respects, was the haunt of numerous technologies in search of an application, each one with an interest group of scientists behind it. There was a dangerous potential for those scientists to advocate their own favoured research interests as solutions to problems that would have been better served by other technologies.

This potential was realised on several occasions. The most notable was the advocacy of HTP as a solution for an extremely wide range of propulsion problems, very few of which were practicable or, indeed, the most efficient. The RAE's intense interest in high altitude supersonic flight did directly lead to the development of the Lightning interceptor, but it also contributed to the demise of the LAB, the pre occupation with the totally impractical Avro 730 and it very possibly also contributed to the delays affecting Blue Steel. In the civil field it also brought about the development of Concorde, perhaps the classic example of a technically excellent answer to a dubious commercial need.

Whilst there were mechanisms in place to familiarise RAE staff with the needs and requirements of their potential 'customers', such as regular meetings between senior Air Staff figures and groups of RAE staff, it is apparent that the technologists held the upper hand in these encounters. Instead of the RAF shopping for suitable technologies to fulfil their operational requirements, what tended to happen was that the technologists shopped for applications for their projects. The rapid technological revolution underway and the uncertainty about which particular direction to take should also be born in mind. This created a pressing need for the world's air arms to rapidly re-equip with advanced equipment. This tended to create something of a 'seller's market' when it came to proposing projects.

Whilst Farnborough's influence upon weapons development during this era can partly be explained by structural factors, the RAE was also heavily involved in the internal politics of the MoS. Farnborough's position with regard to the introduction of weapons system management was rather more ambiguous than the outright hostility displayed by the Royal Radar Establishment, for instance. The RAE shared with the other establishments the fear that their ability to set the research agendas in their particular field would be broken, and that they would end up doing odd jobs at the behest of industry. However, it had reason to believe it would be less affected by this than the other research establishments. This was due to the airframe manufacturers almost total dependence on the RAE for virtually every aspect of advanced research and development, from scientific staff to infrastructure such as wind tunnels. Avro, for instance, had to recruit both of its senior engineers for the Blue Steel project from the RAE. This situation still left Farnborough with its desired level of control over national aerospace R&D, whatever type of management systems were used.

Farnborough's influence was further amplified by the fact that the concept of 'weapons system management' envisaged that the airframe manufacturers would have project leadership in any case. This intensified the opposition of the other research establishments, but left Farnborough with tantalising opportunity to actually expand its grip further. That the consequences of this major debate would leave the RAE essentially unscathed whatever happened gave it greater freedom to opportunistically pursue a variety of short-term objectives without fear of compromising its future. This further amplified the extent to which the disparate research interests within the establishment could compete in the hunt for applications.

The RAE is of particular interest as far as this study is concerned due to its position in the policy-making hierarchy. Theoretically it was very much a part of the policy implementation strata and did not impinge into high policy formulation in the way that the Air Staff and, to a slightly lesser extent, its parent organisation the MoS did. This needs to be qualified slightly by the lack of rigid definition between the two strata in the British system, but none the less its influence is more notable due to the RAE's position in the middle ranks of the procurement hierarchy. However, in this respect it was not totally unique. Several smaller actors, from interest groups and advocacy coalitions to individuals also worked their influence from the policy implementation strata, as will now be considered.

Other Actors

Noticeable by its seeming absence in this study is the inter-service rivalry that has traditionally been regarded as endemic within the British defence establishment. In many ways this is due to the focus of the study. The principal arena for inter service rivalry to manifest itself was in the Chiefs of Staff Committee or any of the other committees in which all three services were represented. These tended to be high policy bodies rather than the policy implementation bodies on which this study has concentrated.

However, even at the policy implementation level there is clear evidence of inter-service rivalry. The Air Staff's concentration on a conventional capability for the deterrent was almost entirely motivated by the need to maintain a long-range power projection capability with which to compete with the Navy. The demise of Blue Streak needs to be placed in the context of the intensifying importance of such considerations with the emerging doubt regarding the future of Britain's East of Suez commitments.

The Skybolt discussions undertaken by the BNDSG do show direct rivalry between the RAF and Navy at this level. They reveal two things. Firstly, that the Admiralty was just as keen as the Air Staff to use the deterrent as a means to expand its conventional capability. Secondly, both sides in the debate freely twisted concepts of threat and strategy until they were virtually unrecognisable - in order to score points. Whilst this was a convention that both protagonists recognised and of whose limitations they were well aware, it was still a breeding ground for misunderstandings by other interested parties.

This was quite often deliberately encouraged by some of the agents as the Blue Streak vulnerability issue shows. As well as the 'traditional' inter-service rivalry, various departmental interest groups can also be identified. In the Air Staff, a fighter and a bomber lobby can be identified, as can the different factions with regard to nuclear strategy. Inter-departmental coalitions also make their appearance. A wide-ranging advocacy coalition against the basing of the deterrent on British soil can be detected, with members not only within the political establishment but also in the Home Office and the Ministry of Supply. Another advocacy coalition can be discerned that entirely opposed the concept of the nuclear deterrent, but this was more fragmented and with its overly ambitious agenda it had less impact.

As well as these larger groupings, the influence of individuals is also very apparent. The selection and fate of particular technological solutions can be linked to particular individuals. The Avro 730, for example, only lasted as long as Air Marshal Satterly's tenure as ACAS (OR). However, it was not just at this level that individual personalities could effect a profound influence upon a project. The effect that the personality of Chief Engineer, Hugh Francis, had upon the Blue Steel project was profound. This wide variety of actors, from individuals to entire ministries illustrates the diverse levels at which policy can be assailed by bureaucratic politics agendas. The next question to be addressed therefore is how these various actors articulated their agendas.

How?

Threat Manipulation

The prevalence of politicised threat has already been commented upon. The manner in which this was achieved will now be examined. The classic technique, misrepresentation of the specialist knowledge held uniquely by one group to those surrounding it, was certainly present. A very good example of this was the misconstruction of CEP used to deliberately underestimate the number of Soviet missiles needed for a successful pre-emptive strike against Blue Streak. However, in most cases, and particularly when dealing with high policy makers, all that was really necessary was an ambiguous misstatement of Britain's already ambiguous nuclear strategy. Again Blue Streak provides a good example of this with regard to the question of 'launch on warning'. The entire concept of 'operational readiness' was turned on its head in a manner that even the missile's closest political supporters were unable to expose, due to the confused nature of British strategy at the time. When this type of subterfuge was impossible, the concept of technological viability was manipulated. This was used to put paid to the LAB.

Threat manipulation belongs to the traditional model of bureaucratic politics, in which subordinate actors compete to influence high policy makers to formulate high policy in their favour. This implies, though, that once high policy was formulated it was implemented to the letter. What becomes obvious from this study is that although all the traditional forms of bureaucratic manipulation are evident, a distinctively different mechanism of middle echelon bureaucratic politics is also at work. This might be called Policy Manipulation

Policy Maniputation

Policy manipulation relies upon a very different model of bureaucratic politics. It takes place after policy has been fixed, not during formulation, as traditional models of bureaucratic politics tend to assume. Whatever policy is handed down for implementation by the high policy elite is simply ignored by the middle echelon, and their own existing policy is substituted, with suitable cosmetic changes to conceal this substitution. The ability to do this gives the policy implementation strata vastly more power than has generally been supposed by historians.

Evidence of policy manipulation is extremely strong within the Air Staff, the Admiralty, the Ministry of Supply and the RAE. The Air Staff substituted Bomber Deterrence for Nuclear Deterrence and the Admiralty tried exactly the same trick with its concept of the 'composite submarine'. The Ministry of Supply continued to run its existing industrial policy and management structures, despite their unsuitability for the task in hand, simply by the cosmetic measures of the 'Guided Weapons Programme Management System'. Although these activities were supported by the application of traditional bureaucratic politics subterfuges, it is very surprising to note the extent to which they could be undertaken without challenge or need for any camouflage. This suggests that the actors were also assisted by structural factors within the procurement process. Perhaps the most significant of these was the overall bureaucratic culture of the British defence establishment.

Bureaucratic Culture

Two distinctive characteristics of British bureaucratic culture can be seen as particularly aiding the furtherance of bureaucratic politics agendas. These are, firstly, the traditional dependence on consensus in policy-making, and secondly the tendency towards 'compartmentalisation' in decision-making at the policy implementation level.

With regard to consensus, in most other areas of government activity the 'collegiate' nature of the Civil Service worked well, ensuring that decisions made were sound from both the theoretical and practical aspects and delivered the required policy result. However, this Civil Service ethos encountered serious problems with regard to defence policy. Here it collided with those of the far more partisan armed services and scientific establishment. This caused the emergence of stronger interest groups than the system was configured for.

It might be expected, however, that the characteristic 'informality' of the chain of contacts through which British governmental policy was traditionally formulated and implemented should have provided the means to negotiate a co-ordination of bureaucratic politics objectives. Some semblance of a united front had to be presented to counter the depredations of other departments, such as the Treasury. In general, though, this united front was of a far more transient and flimsy nature than the type of consensus that the Civil Service habitually produced.

In the case of the V-Bomber replacement projects this did not happen to anything like the extent necessary. The importance of the prize and the necessity of its total possession by both the RAF and eventually the Navy left little room for negotiation. The reliance of the system upon the formation of a consensus, which the structure and ethos of the Civil Service readily encouraged meant, however, that it was extremely vulnerable to bureaucratic politics manipulation when other actors, who did not share this ethos, were involved.

With regard to the level at which decision making was done, it is evident that there was a marked disinclination for any particular strata to appeal to its superiors for assistance or clarification of an issue, or involve them in any decision making that could be done at a lower level. For example, it is highly noticeable that the Secretaries of State for both Air and Supply were only informed of the existence of the LAB project once their subordinates had already decided to cancel it.[7] Instead of consulting vertically, there appears to be wide ranging consultation horizontally within the strata, even crossing departmental boundaries to communicate with others at a similar level. This in itself is an indicator that this was a widespread tendency within Whitehall, and not unique to one particular group.

A good example of this behaviour was the attempt by relatively junior officers within the Air Staff to formulate a nuclear strategy to inform procurement decisions regarding OR330, without any attempt to divine from their superiors exactly what British nuclear strategy was.[8] This particular incident warrants some examination as it contains two clues as to why this state of affairs should have come about. Firstly, although there was every legitimate reason why these officers should have sought clarification, they choose not to do this. Secondly, despite the centrality of their role to the issue it addressed they were obviously not involved in or informed of the debate that surrounded British nuclear strategy. These two facts indicate that there was a conflict between the upwards transmission of responsibly and the downwards transmission of information.

[7] AVIA54/749 CA to Minister of Supply, 4 October 1954.

[8] See AIR 20/7723 (various papers).

With regard to the upwards transmission of responsibility, there was almost certainly a strong cultural impulse at work, as logically there should have been no impediment to a request for clarification on an issue of such importance. Whether this trait is of civil service or military origin is not clear, as it seems to be prevalent in all the departments of the defence establishment, even those not totally dominated by the military.

The imposition of an ethos such as this upon the existing Civil Service 'Way of Administration' can easily be seen to be problematic. A core principle of the collegiate system was its relative informality in comparison to similar institutions abroad. Many of these, notoriously the German Foreign Ministry, employed a rigorous system of checking subordinate's decision making, ensuring that such decisions are scrutinised by at least two tiers above their origin. Due to the lack of this in the British system, there was great reliance upon the impartiality of all involved. The Civil Service, with its regular rotation of staff between departments and cultivation of formal advocacy skills expressly provided for this, but it was sadly lacking in the far more partisan world of the armed services and the scientific establishment.

The other component of this phenomenon, the poor transmission of information downward, is probably best attributed to the notorious culture of secrecy that pervades British officialdom. Its effects can be seen at work on many of the projects studied. For example, with regard to Blue Streak a major problem regarding silo design could have been easily avoided had there been any communication between Rolls Royce and Westcote, something that was not realised until a reunion in1999.[9] On Blue Steel, the Chief Engineer Hugh Francis was able to impose a level of secrecy on the project that made attempts by the MoS to impose any kind of control on him virtually futile. Both the tendency not to ask for guidance and that to seriously

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[9] British Rocketry Oral History Project Conference Proceedings1999

restrict the flow of information operating together in tandem resulted in 'compartmentalisation'.

This tendency was well recognised in certain quarters. At Aldermaston, for instance, briefings for different groups had to be tailored to fit a range of different perceptions as to what British nuclear strategy and the purpose of the deterrent actually was.[10] Compartmentalisation greatly facilitated policy manipulation by normalising a situation where the flow of information was always constricted and knowledge of policy limited. This gave bureaucratic politics actors the ability to not only camouflage their activities by restricting knowledge both of what was happening inside their departments to those outside and vice versa but also the potential to be able to 'claim ignorance as a defence' if detected. The effectiveness of this in some cases makes it extremely difficult to determine what is actually 'bureaucratic politics' and what is merely confusion induced by compartmentalisation.

A final structural influence must be noted, one that deeply affected the management of almost all industrial, administrative and military activity in Britain during the 1950s. This was the acute shortage of skilled manpower at all levels that has been commented upon frequently in this study. Fighting to retain staff was a major pre-occupation for managers, and frequently dictated the course other polices could take. This problem informed many important bureaucratic politics agendas, in particular the Ministry of Supply's resistance to restructuring. One of the major worries faced by senior officials in restructuring the Ministry was that any sign of such a thing coming to pass would result in a mass exodus of irreplaceable staff to lucrative jobs in industry at home and abroad.

It can be seen that bureaucratic politicking was greatly facilitated by a number of factors both structural and otherwise within the defence establishment, and

[10] Pyne, K., "Red Snow" Paper presented at the British Rocketry Oral History Project Conference, April 1999.

was indulged in by almost all the major actors. The question must now be asked, what did it actually achieve?

Why Did the Projects Fail?

If the bureaucratic actors were so influential, why did the whole V-Bomber replacement program end in a fiasco that seemingly benefited few of them? Answering this question demonstrates the relative balance of power between High Policy and the policy implementation strata. Policy manipulation by the middle echelons could only succeed if policy implementation decisions did not become too politicised. The decision to skip from the LAB to the Avro 730 and then to the Blue Streak/TSR 2 combination were all taken at the policy implementation level, as was, essentially, the decision to go for Skybolt.

The failure of Skybolt and its political ramifications effectively removed the decision from the realm of policy implementation and the Air Staff was no longer able to affix the needs of their bomber policy to it. Whilst this may seem a circumscription of the power of the middle echelons, it is an extremely broad one, and within it the bureaucratic actors enjoyed far too much freedom.

Indeed, it could be argued that it was this surfeit of power that ensured the ultimate failure of the Air Staffs designs. Had they not been able to engineer the abandonment of system after system in pursuit of the unattainable ideal of being able to combine conventional and deterrent roles they might have actually attained at least part of their objective. By being forced to concentrate wholeheartedly on one system, they would probably have been able to retain the deterrent and work at least some conventional capability into it.

As for the other bureaucratic actors, the picture is rather mixed, as several got what they wanted from the programme and were unaffected by its demise. The HTP interests at Farnborough and elsewhere at least got Blue Steel, and eventually by a circuitous route the Black Arrow satellite launcher, whilst the high altitude supersonic faction got Concorde. All these projects got their basic research and design 'kick-start' from the V-Bomber replacement programme, as has been discussed.

The MoS was ultimately unsuccessful in its survival attempts, but in many respects it is difficult to see how this could have been otherwise. The retention of Blue Streak would have given them rather more political clout but that could not have endured beyond the late 1960s. As it was, their strenuous efforts to stay above water, particularly their deep resistance to more streamlined project management procedures, caused severe problems for a large number of British defence and aerospace projects.

The big loser was therefore ultimately the Air Staff, whose freedom of action due to policy manipulation merely led them into the jaws of one of the great snares of aerospace procurement in the early post war era. This was the fact that as aerospace innovation rapidly accelerated the time such innovations took to mature increased at an equal rate. For the Air Staff this meant that all the false starts caused by their pursuit of a dual-purpose system ate away at the time available for development of such a system, something that was not immediately obvious to them. Had their full agenda been totally legitimate it could have been openly taken into consideration earlier on, instead its concealed nature meant that few of the projects were actually up to the task. By the time the Air Staff had manoeuvred themselves into possession of a suitable system, there was not enough time left to procure a replacement if anything went wrong. Having left itself in the hands of the Americans, the Air Staff had no control over the fate of Skybolt, and when the Kennedy administration killed off the weapon the Air Staffs hopes died with it.

Having considered the effect of bureaucratic politics on nuclear delivery system procurement, the implications of this for the existing historiography of British nuclear policy must now be examined.

Historiographical Ramifications

One of the core objectives of this study has been to resolve the inconsistencies in the current historiography concerning Blue Streak. It has attempted to do this by both examining the bureaucratic politics of the policy implementation strata and placing Blue Streak back in context with the other V-Bomber replacement projects. It must therefore be asked what these new perspectives have added to our understanding of the cancellation of Blue Streak.

Most significantly, perhaps, it has revealed the inconsistencies of the Powell report, the conclusions of which form the central plank of the revisionist argument with regard to Blue Streak. These inconsistencies principally fall into five categories:

(1) The use of data that was known to be constructed in a flawed manner;
(2) The lack of consistent analytical categories;
(3) The inconsistent and biased use of vocabulary;
(4) The use of extremely primitive threat assessments which wholly failed to address strategic, political and economic factors; and,
(5) The inconsistent and biased application of intelligence advice.

The examination of these inconstancies has revealed the existence of several bureaucratic politics agendas that have either not previously been recognised or not connected with Blue Streak. These are the 'fighter lobby' within the Air Staff and two advocacy coalitions, one opposed to the deterrent *per se*, and the other opposed to its basing in Britain. Secondly, it has challenged established views as to who was the major backer of Blue Streak. Previously believed to be the Air Staff, that organisation's attitude towards Blue Streak was essentially that of an opportunist latecomer. The original and most consistent supporter of Blue Streak was the Ministry of Supply, for whom the missile represented perhaps the most important weapon in its battle for political survival.

Placing Blue Streak back in context with the other projects reveals more bureaucratic politics agendas. The most significant of these was the Air Staff's desire to use the deterrent as a means of gaining additional conventional capability, evident in its attitude to all the V-Bomber replacement projects. This in its turn had a major impact on the Air Staff's attitude towards nuclear war fighting capability. It has also emphasised the link between Blue Streak and TSR 2 and the extent to which problems with TSR 2 affected Blue Streak.

How does the emergence of these actors and agendas affect the existing historiography? Whilst orthodox accounts point to cost overruns and technical obsolescence as the cause of Blue Streak's demise and the revisionists cite obsolescence both technical and strategic, the findings of this study differ considerably.

Firstly, and perhaps most incontrovertibly, Blue Streak was in no way obsolescent in either technological or strategic terms. Despite what has commonly been aired in the secondary literature, Blue Streak was a fully survivable second-strike system. It was the first ballistic missile to be capable of 'hot launching' from a silo, the first to incorporate penetration aids and the first to have a throttleable rocket motor. As such, it was one of the most advanced weapons systems under development anywhere, and its subsequent 100 *per cent* launch success rate has not been approached by any other ballistic missile. In terms of cost, the £500 million figure that seemed to horrify the Treasury so much had also been quoted for the Avro 730 and seems to have been the 'going rate' for a nuclear delivery system at the time. All this being so, why then was Blue Streak cancelled?

This study would indicate that there were two decisive factors affecting the cancellation of Blue Streak. Firstly, opposition to the basing of the deterrent on British soil within the Government and elsewhere. Secondly, doubt within the Air Staff regarding the strategic viability of TSR2, causing the bomber lobby to become active once more.

The means by which the cancellation was achieved were threefold. Firstly, the establishment of the BNDSG by the upper echelons of the Government. This provided an arena in which opposition to Blue Streak could be articulated. Secondly, the distortion of information regarding Blue Streak by various interested parties, the most damaging of which was the distortion of a proposal by air defence interests that advantage be taken of Blue Streak's excellent readiness capabilities. This was to propose a move to a launch on warning posture for the deterrent. By the time this reached the BNDSG it had been distorted within the Air Staff, almost certainly by manned bomber interests, to infer that Blue Streak could only operate in a launch on warning mode. It was essentially this that gave the BNDSG the rationale to cancel it. Finally, the total failure of the MoS to fight its corner and combat the misinformation regarding Blue Streak that was circulating within the BNDSG was also extremely damaging. As the most powerful of the advocacy coalitions was one that opposed the basing of the deterrent on British soil, the presence as the MoS's representative of Sir William Strath, author of the report that largely informed this coalition, may very well be connected with this.

Other contributing factors might be cited, such as programme delays and technical problems. As Nicholas Hill has pointed out, Aldermaston, for example, had particular problems in providing a suitable warhead and there were also geological problems regarding the siting of the silos.[11] However, despite the extensive research fostered by the Air Staff into all aspects of nuclear war fighting and the operational effectiveness of nuclear weapons, including much ground-breaking work at both Aldermaston and Farnborough, ultimately this is best regarded as an organic activity rather than policy-driven. Such considerations were seldom paramount, if considered at all, when the Air Staff ultimately made procurement decisions. Nothing better underlines the disingenuous nature of the CAS's concurrence with the BNDSG's assessment of Blue Streak's strategic unsuitability than this continual disregard for operational effectiveness and nuclear war-fighting considerations in the Air Staff's internal policy-making.

It is also to be doubted that programme delays contributed significantly to the cancellation of Blue Streak. It has been argued that adoption of a single engined design, for instance, or a better management structure would have speeded the project and kept costs down. The two advantages of this were that the system would have attracted less hostility from the Treasury and been so far advanced towards entry into service that cancellation would have been politically far more difficult. However, this relies upon the twin assumptions that the Treasury's influence was decisive and that a project could be too advanced to be cancelled. The case of the TSR 2, cancelled despite the fact that a prototype was already flying and that work on production aircraft was already well advanced, tends to discount this, as does the Treasury's political inability to cause the scrapping of the deterrent. Whilst these factors undoubtedly contributed to the general discontent with the project, they cannot be considered fatal in themselves. All British defence projects, great and small, suffered from cost overruns and delays during this period. Equally, as long as Blue Streak was solidly backed as the only viable deterrent system, it was ultimately immune to Treasury pressure.

The cancellation of Blue Streak was not due to strategic or economic concerns, and certainly not to technological obsolescence as has been claimed by both orthodox and revisionist writers. Instead, it is argued by this study that its demise was almost entirely political. Blue Streak ran fatally foul of the political agendas of both the policy elite and the policy implementation strata, in the shape of the Air Staff. It would seem that it was a conjunction between the interests of an advocacy coalition opposed to the basing of the deterrent on British soil and pro bomber elements within the Air Staff that was the decisive factor in the cancellation. Where, therefore, does this leave the revisionist contention regarding the influence of strategy upon British nuclear policy?

The Influence of Strategy

It is perhaps paradoxical that despite taking extreme issue with the revisionist narrative concerning Blue Streak, this study upholds the basic revisionist contention regarding the importance of strategy in British defence planning, in two important respects. These are that there was a distinctively British strand to the strategy evolved, and that strategy did influence policy. Where it departs from the revisionist agenda is in the source and scope of this strategic view. Revisionism locates the distinctiveness of British nuclear strategy as a product of the 'Great British Strategy Debate', which preoccupied the Chiefs of Staff and a host of other prominent figures in the defence establishment for most of the early and mid-1950s.

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[11] Hill, N., (2001) *A Vertical Empire: the History of the UK Rocket and Space Programme 1950-71*, London: Imperial College Press, pp. 69-89.

Although study of this debate provides an excellent insight into the formulation of strategy at the high policy level, it becomes apparent that this debate had a closely circumscribed influence on policy and planning at lower levels. This was for two reasons. Firstly, there appears to be little dissemination of this debate down to the planning level, as the previously mentioned case of the nuclear strategy debate regarding the Avro 730 indicates. Secondly, and perhaps most significantly, it was completely detached from the reality of Britain's actual nuclear capability. At no time during this debate did Britain possess enough operational nuclear weapons or delivery systems to implement any of the various strategies suggested.

The strategy vacuum caused by this enabled, or forced, the lower echelons to produce its own strategies to fill the gap. However, although this throws doubt on the influence of the Great British Strategy Debate, it does not totally undermine the revisionist perspective, despite the centrality of this strategy debate to the revisionist perspective. The Air Staff's response to the strategy vacuum was to use the strategically free floating nuclear deterrent to solve a conventional dilemma. How this arose paradoxically demonstrates the soundness of the underlying revisionist hypothesis.

The sidelining of nuclear war-fighting capability in favour of conventional power projection capability in Air Staff procurement decisions was mainly motivated by the needs of inter service rivalry. However, it was only made possible by a unique British approach to nuclear strategy. This was not some magic formulation contained within a document such as the 1952 Global Strategy Paper, more a widespread perception amongst the British defence establishment. This was the unique sense of vulnerability that it was felt Britain had to nuclear attack. The belief that Britain would succumb to nuclear bombardment faster and more totally than any other nation predated the thermonuclear era, which itself only served to make Britain's prospects even starker. This meant that initiating or in any way engaging in nuclear warfare would never be a winning option for Britain, in fact, quite the opposite.

This came as blow to one strategy making faction in the Air Staff who had been propounding the initiation of counterforce strike as a solution to Britain's vulnerability. Instead, they were eclipsed by one whose mantra was 'as regards atomic warfare we are only interested in the deterrent'.[12] This, in effect, meant that attaining actual war fighting capability in a system was no longer of paramount importance. Only 'visible' capabilities were required, such as airfields full of bombers and the missiles to hang under them. The 'invisible' capabilities, such as actual operational effectiveness, weapon serviceability and an effective command and control system could be sacrificed to the fulfilment of other roles, particularly those that furthered traditional bomber strategy.

This was very much the strategic rationale that informed the requirement for both the Avro 730 and Blue Steel Mk1 and it in many respects mirrored the pre-nuclear considerations that shaped the V-Force. The Low Altitude Bomber, specifically designed for the counterforce role and lacking a conventional capability met its demise at this time. The utter impracticality of the Avro 730, and the opposition of the pro nuclear war-fighting faction led to the rise of Blue Steel Mk2 and the replacement of the Avro 730 by Blue Streak. The failure of the Avro730 project abruptly ended the 'bomber strategy' factions attempt to combine deterrent and limited war roles in one delivery system. This led to a bifurcation of 'bomber strategy' that essentially ended the confrontation between the warring factions. Blue Streak would take over the strategic nuclear role of the V-Force, whilst TSR 2 would take over the V-Force and Canberra Force limited war role.

This state of affairs lasted until three developments at the very end of the decade forced a radical rethink. Firstly came the development in the United States of the Skybolt missile. This breathed new life into the concept of the manned bomber and made its enthusiasts gaze covetously at the role for

[12] AIR 20/7723 DDOR1 to D of Ops Bomber Command 18/10/56

which Blue Streak was intended. Secondly, the proliferation of the Soviet nuclear arsenal had reached a point when even the most die-hard war-fighting enthusiasts could no longer dream of any thwarting of a Soviet attack. With the fading away of counterforce strike this point is generally considered to have been reached by 1957. There is, however, evidence to suggest that the basic concept of forestalling a Soviet strike lived on in a 'decapitation' strategy being prepared for Blue Streak. However, this was viewed as very much a clutching at straws, particularly as increasing integration with the SAC strike plan loomed.

Finally, therefore the war-fighting interests were in a very poor position to resist the renewed offensive by the exponents of 'Bomber Strategy' which came as it was realised that TSR 2 would be unsuited to the likely change in nature of Britain's limited war commitments. The possibility of using the Skybolt carrier in the limited war role instead gave even more impetus to its adoption and radically changed the Air Staff's attitude to Blue Streak. It can be seen that the procurement decisions made were informed by a uniquely British perspective on nuclear strategy as well as by the bureaucratic politics agendas described. It is worth noting that the other major agenda that caused the downfall of Blue Streak, the removal of the deterrent from British soil, can also claim some of its inspiration and support from exactly the same source. Even though short term political considerations were probably paramount, there was a strong element for whom the implications of the Strath Report made the procurement of a land based system such as Blue Streak totally unacceptable.

Similarly the Air Staff's attempts to ensure the continuation of the RAF's 'institutional essence' may seem like a mere exercise in bureaucratic self-perpetuation but it can be argued that it had a fundamental strategic motive. In certain respects, the Air Staff regarded the RAF itself as a 'strategic concept' with particular components that had to be maintained in order to maintain conceptual cohesion. Therefore, it may be a mistake to assess Air

Staff procurement policy in terms of an intended operational role that serves a specific strategic application. This was indeed a necessary pre-condition of strategic systems procurement. Nuclear deterrent systems can, in certain respects, be viewed as a self-contained strategic and tactical entity with a single specific role. This, however, is not true of conventional systems which are invariably integrated within a doctrinally determined entity that can then be applied to a range of strategic requirements. The problems regarding procurement of the V-Bomber replacement could be explained as a failure to appreciate that the linkage between strategic systems and strategy is virtually direct, whereas conventional or limited war systems are distanced from strategy by the integration into doctrine. The attempts to integrate the strategic and limited war role into a single system missed this essential point. When divorced from its doctrinal context, the attributes of a conventional weapon system become difficult to define whereas the provision of the necessary interfaces for doctrinal integration may completely compromise the very specific attributes required of a weapon system for a narrow strategic role.

However, whilst evidence can be discerned for this process occurring, it perhaps overstates the extent to which the formulation of operational requirements was a formal process with a rigid structure. Indeed, there is little that is rigid or consistent in the manner in which operational requirements emerged. Various factors, including strategy, were usually investigated but there appears to be no universally applied hierarchy of priorities to determine which factors were actually influential. This was partly due to the traditional informality of the British administrative process with its emphasis on peer group discussions amongst interested parties. The participants were largely self-chosen because of their personal interest rather than the administrative function of their office. This is why ACAS (Training), Air Marshall the Earl of Bandon, could have so much influence over bomber policy, for instance.

It is notable that in such debates, the boundaries of strategy and doctrine became blurred. Strategy was in fact a loose term in Air Staff discussions and, in the documents examined, doctrine is never specifically mentioned, although doctrinal points emerge interlaced with strategic considerations. Therefore, although the influence of strategy can be detected, it is largely as an influence that worked at a subliminal level and was infrequently consciously articulated or rationalised.

It can be seen, therefore that although the degree of strategic content varied between decision-making groups it was seldom if ever completely absent at any level. Indeed, it could be said that its prevalence as an influence is occasionally more marked at levels other than the high policy strata that is generally regarded as its sole legitimate home. It is not therefore a question of whether strategy was influential in British policy-making, but whose strategy and with regard to whose policy?

The Influence of High Policy

To what extent did the bureaucratic politics of the middle echelons subvert high policy? In certain respects the influence of the various bureaucratic politics agendas described was merely to fill the existing policy vacuum with the amount of extraneous substance necessary to give it some semblance of policy. As there was no real policy it cannot be described as 'subversion', more 'improvisation'. It must also be remembered that there were a large number of structural factors at work that hindered the smooth transmission of even the workable aspects of high policy.

The whole Air Staff debate as to whether to maximise the combat effectiveness of the deterrent or use it to enhance limited-war power projection capabilities can also be seen as part of the continental/maritime strategy debate that Howard and Graham believe characterised the formulation of British defence policy through out the twentieth century.[13]

Confronting the main continental threat head on with a heavy disabling blow to its 'centre of gravity' compared with confounding its intentions by a limited eastern manoeuvre can be seen to be a perennial British strategic dilemma. It might be argued that in this respect it was not merely an inter-service rivalry stratagem, but part of an on-going high policy debate. Nonetheless, the premise that strategy and operational effectiveness, as defined by high policy, have a primacy in weapons procurement is clearly unsupportable with regard to the projects studied. In these cases, technology does not spring from strategic need, though it frequently flourishes by it. By the time this occurred, the technology had already been irrevocably pre-programmed with a variety of developmental and strategic preconceptions. The extent to which pieces of technology were a cultural rather than a purely functional construct should also not be ignored in this respect.

Why is this significant? The vulnerability of the British nuclear deterrent to this type of influence had potentially profound consequences. The entire edifice of British foreign and defence policy seemingly rested upon the apparent effectiveness of a few pieces of technology. Technology selection therefore had a direct effect on all levels of policy making to a degree that was almost unique. The choices involved in selecting these technologies determined the range, accuracy and number of warheads that could be deployed and also the extent to which they could be expected to penetrate enemy defences. Any change in the ratio between these factors had a direct influence on operational strategy. As far as the deterrent was concerned,

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[13] Howard, M., 'The British Way In Warfare: A Reappraisal' in Howard, M., (1984) *The Causes of War*, London: Allen & Unwin; Graham, C.S., (1972) *Tide of Empire: Discursions on the Expansion of Britain Overseas*, London: McGill-Queen's University Press.

operational strategy defined Grand Strategy and therefore, in theory, the options made available by its possession. It was, in some respects, fortunate that the policy ambiguity that caused this state of affairs also largely acted to mitigate it.

This inexorably leads to a final question, what is policy? This study would indicate it is far more a game of 'chinese whispers' than a tablet of stone. In this respect, bureaucratic politics should not perhaps be regarded as 'manipulation' of policy, rather as an 'interpretation' to fit the culture and power realities of whatever strata of the organisational apparatus it is passing through. Policy-making is a dynamic process that cannot ignore the geography of power within an organisation.

This study has also shown that it is not just policy that has unappreciated dynamic qualities. The weapons procurement process as a whole has dynamics of its own and is not totally the puppet of either economics or strategy, as the historiography of Blue Streak has variously tried to show. Examining these dynamics through the perspective of threat is an extremely fruitful process, even if it does tend to highlight inconsistencies rather than unities. These inconsistencies do, though, leave a distinctive trace which, if followed, map a hidden landscape of power within the British defence establishment during the 1950s and early 1960s.

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