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‘The Other End of a Trajectory’:

Operation Backfire and the German Origins of Britain’s Ballistic Missile Programme

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Abstract

The ballistic missile age dawned in September 1944, when Nazi Germany began its V-2 campaign against Britain and Western Europe. One year later, in October 1945, the British launched a V-2 rocket themselves, as the culmination of Operation Backfire. This article will chart Britain's development of a guided missile capacity in the years immediately following the Second World War, and the importance of German expertise therein. It will also explore how this transnational process occurred within a broader international context, especially the reconfiguration of the Anglo-American relationship and the growing threat of the Soviet Union. As such it will show how swiftly the Cold War arms race emerged from the ashes of the previous conflict, how technology and international relations are intimately entwined, and how Britain was an active and enthusiastic participant in the very earliest days of the missile age.

Keywords

Rocket, missile, Cold War, V-2, post-war Germany, Anglo-American relations

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Introduction

On 8 September 1944, at around 6:45pm, a V-2 rocket landed in Staveley Road, Chiswick, killing three people and doing considerable damage to nearby properties.[1] This was only the second V-2 rocket (also known as the A.4) to be launched operationally, and the first to kill on impact.[2] As such, Britain became the first nation to suffer casualties as the result of a ballistic missile attack.[3] On 2 October 1945, once the Second World War had ended in both Europe and Asia, the British launched a V-2 themselves, under experimental conditions. Therefore, in a little over twelve months, Britain went from being a victim of long-range guided missiles to a wielder of this impressive new military technology. However, that is not the whole story. By 1948, Britain had decided not to pursue the development of an independent long-range rocket capacity any further, instead choosing to focus on jet-powered, piloted bombers as the preferred method of delivery for conventional, and later atomic, payloads.[4] As a result, most accounts of Britain's missile programme begin with the initial (and ultimately abortive) development of the Blue Streak rocket in 1955, and the initial post-war efforts are largely forgotten.[5]

This article has three main objectives, the first of which is to challenge this conventional but incomplete narrative. While it may make sense in the form of a retrospective overview, only picking up the story with the first clearly-defined British missile project in the mid-1950s ignores the contemporary perspectives of the relevant officials and policymakers at the end of the Second World War, who very much saw themselves as active participants in the newly-dawned missile age. In particular, this account will emphasise a key principle which served to guide policy in the immediate post-war period – that atomic weapons would shape any future conflict and that the most effective delivery method for

nuclear warheads would likely be long-range ballistic missiles.[6] Furthermore, most histories of this topic also fail to mention another key principle which influenced early British plans for an independent missile programme – the assumption that the quickest and easiest way for Britain to obtain a missile capacity of its own would be to draw upon German technology and expertise once the Third Reich had collapsed.[7] It is the second objective of this article to combat this omission, to locate German contributions to this process, and thus to reframe the story as a transnational, rather than solely Anglo-centric, one.

With these first two objectives in mind, this article aims to show that, from the last months of the war until the independent missile programme was dropped in 1948, Britain saw itself as an active and significant competitor in the new international missile race, and believed that its chances of success hinged on the effective utilisation of German equipment and know-how. In this way, Operation Backfire – the assembly, preparation and firing of three V-2 rockets, by experienced German staff under British supervision and observation, in October 1945 – can be seen as a critical moment in Britain's first foray into missile development. Some histories of this subject have dismissed the results of Backfire as 'limited and of little practical value', but those involved in the operation certainly did not see it that way.[8] The official Backfire report noted that all relevant British Ministries 'were unanimous that it was most desirable to carry out such an operation', based on the widely-held view 'that it might save years of development work'.[9]

Naturally, all of this took place against the global backdrop of worsening relations between East and West and the increasing hostility and suspicion of the nascent Cold War.[10] Indeed, in the official predictions of future conflict which highlighted the importance of long-range rockets, the envisaged enemy was always the Soviet Union. The crucial requirement

for the most powerful of the ballistic missiles desired by Britain was that it would be able to hit targets in western Russia, if launched from the United Kingdom or from overseas bases in Cyprus or India.[11] The third objective of this article, though, is to show that the USSR was not the only foreign adversary which Britain faced in its drive to build up a missile capacity after the Second World War, especially in the first year or so after the conflict. Instead, it soon found itself entangled in a fierce rivalry with its closest wartime ally, the United States. Both countries (as well as the other occupiers of Germany, France and the Soviet Union) sought to make use of German expertise to build up a domestic missile arsenal but the greater resources and newly-minted superpower status of the US allowed them to essentially steamroll over their transatlantic allies. As such, the competition for the best assets of the German rocketry programme (both material and personnel) provided the British with an early and rather brutal realisation that they were no longer at the very top table of global politics and that they might have to be prepared to play second fiddle to the Americans moving forward.[12]

Once again, Operation Backfire proved a particularly sensitive flashpoint, especially when the US authorities withdrew their support for what had started out as an Anglo-American undertaking and then threatened to scupper the whole initiative by demanding the removal of several of the most prominent German engineers involved. It is, therefore, the intention of this article to use a close examination of Operation Backfire and the period immediately surrounding it to achieve the three stated objectives. Put simply, it will show that for a brief time after the Second World War, Britain was fully committed to developing an independent missile capability, that it identified the utilisation of German expertise as vital to attaining this goal, and that the greatest threat posed to this scheme came from American

intransigence and overriding self-interest. This short chapter of history can therefore tell us a remarkable amount about Britain, its views on new military technologies, and its relations with other countries, in the earliest part of the Cold War.

The Rocket Threat

Throughout the 1930s, as the threat of another European war loomed ever larger, much time and effort was expended by people of all stripes, from novelists to civil servants, attempting to imagine what the next war would look like. In nearly all cases, the expectation was that it would be fought to a considerable, perhaps even overwhelming, extent, in the air. The fear of the bomber dominated civilian life, especially after the establishment of an Air Raid Precautions Department in 1935 and the distribution of gas masks during the Sudeten Crisis of 1938. Throughout, the idea of the 'knock-out blow' from the air maintained a central place in strategic predictions, even after the limitations of aerial bombardment had been exposed during the Spanish Civil War.[13] In all of these calculations, the place of the long-range rocket or flying bomb remained peripheral at best. The threat of these untested and essentially hypothetical weapons paled in comparison to that of fleets of manned bombers delivering massive devastation to cities with impunity. When war broke out in 1939, these assumptions proved largely correct. While the 'knock-out blow' never materialised, aerial bombardment played a key part in the Nazi military campaigns of 1939-40 and was later utilised during the Blitz to try and bomb Britain into submission. The long-range rocket was nowhere to be seen.

Nevertheless, it did not entirely disappear from the minds of military strategists and intelligence experts. The Nazi menace was seen to be closely entwined with scientific and

technological innovation. Less than three weeks after the outbreak of war, Adolf Hitler gave a speech in Danzig in which he boasted: 'the moment might very quickly come for us to use a weapon with which we could not be attacked'.[14] Among more ludicrous assessments of what exactly Hitler could be referring to (such as 'death rays'), was the possibility of long-range guided ballistic missiles.[15] However, long-range rocketry actually received very little attention in the first years of the war. There were far more pressing concerns and the threat posed by some speculative weapon based on an entirely experimental and unproven technology did not seem to warrant the expenditure of much effort. This was compounded by a certain arrogance which possessed British military thinkers at this time – that if Britain had not developed a certain new type of weapon, then no other country could have done so either – and this particularly clouded notions of rocketry.[16]

Indeed, from the start of the war, British research and development on rockets was relatively minor and was deliberately limited to short-range weapons, mostly to be used in an anti-aircraft capacity – long-range missiles were hardly even considered.[17] Matters changed rather dramatically in the spring of 1943. In March, two German generals – Wilhelm Ritter von Thoma and Ludwig Crüwell – who were being held at the prisoner-of-war (POW) camp at Trent Park, north of London, were recorded (without their knowledge) discussing the German rocket programme, with von Thoma even expressing surprise that the long-range missile bombardment of Britain had not yet begun.[18] This confirmed the tentative conclusions of earlier intelligence work and prompted intelligence officers to review aerial reconnaissance photographs taken of the Peenemünde area on the Baltic coast (where German rocketry research was primarily based) in May 1942, as well as more recent images.

As such, a clearer picture of German work on long-range rockets (and later also on flying bombs) began to emerge.[19]

From this point on, British investigations into German rocketry expanded and accelerated considerably. On 11 April 1943, the Chiefs of Staff received a report from the Vice Chief of the Imperial General Staff, Archibald Nye, which gave a summary of existing intelligence on the long-range rocket threat. This report predicted, amongst other things, that 'each rocket might carry an amount of explosive at least equal to that carried by the German 1000kg bomb', that 'the extreme range would seem to be about 130 miles', and that 'an attack could fall without any warning'. While not all the details in Nye's report were accurate, it had the desired effect and senior policymakers responded to his call to action: 'Even though we have no proof or even indication of action to employ these rockets against us, so far, it is considered that the indications are sufficient to justify taking certain actions in view of the powerful moral and surprise effect of such weapons.'[20] Four days later, General Hastings Ismay, Winston Churchill's chief military advisor, relayed the thoughts of the Chiefs of Staff to the Prime Minister. They were 'of the opinion that no time should be lost in establishing the facts and, if the evidence proves reliable, in devising counter-measures', and recommended Duncan Sandys, Member of Parliament for Norwood, Financial Secretary to the War Office, and Churchill's son-in-law, to head the investigative committee. Churchill signalled his agreement by scribbling 'so proceed' at the bottom of the memo.[21]

Under Sandys' leadership, the so-called Crossbow Committee worked tirelessly to gather intelligence on the rocket threat, and to try and find ways to counter it. Their work became increasingly vital as the tide of war turned in favour of the Allies and fears grew of a new German secret weapon which could theoretically undo their hard-earned progress. In

December 1943, the Chiefs of Staff worried that if rockets were used against port facilities in southern England before the summer of 1944, it could seriously jeopardise Operation Overlord, the planned Allied invasion of Europe.[22] Indeed, after the war, Dwight Eisenhower, the commander responsible for Overlord, wrote that 'if the German [sic] had succeeded in perfecting and using these new weapons six months earlier than he did, our invasion of Europe would have proved exceedingly difficult, perhaps impossible.'[23] The issue was perhaps best expressed by the military head of the German V-2 project, Lieutenant-General Walter Dornberger, in his post-war memoir: 'Only one thing can be said with absolute certainty: the use of the V-2 may be aptly summed up in the two words: "too late".'[24]

Of course, this appraisal is only possible in hindsight and the fact that the V-2s would go on to have only a limited impact on the course of the war was cold comfort to the citizens of London (and Paris and Antwerp) when the rocket bombardment began in September 1944. Over the next seven months, some 1,115 V-2 rockets fell on Britain, resulting in 2,855 fatalities. In addition, 20,000 houses were destroyed and a further 580,000 were damaged. When compared with the impact of conventional bombing during the Blitz, which claimed the lives of over 51,000 Britons, and with the preceding and simultaneous V-1 attacks, which killed 6,184 people, these statistics seem somewhat less impressive.[25] In terms of morale, the effect is harder to judge – some responded to this new threat with little more than disinterest, confident that it would soon be eradicated by the advancing Allied armies, while others found the prospect of an explosive arriving without warning (as it travelled faster than the speed of sound) truly terrifying.[26] The Allied leadership were not unduly worried that this new weapon would turn the tide of war against them but, taken with the contemporaneous failure of Operation Market Garden and other German technological advances, such as jet aircraft and

the submarine Schnorkel system, the start of the V-2 campaign did cause a slight dent in the British belief that the end of the war was in sight in the autumn of 1944.[27] Moreover, the British preoccupation with rocketry during this period was not only about looking for a way to neutralise this technology, but also seeking to obtain it for their own use.

Looking at the other side of the story, it has been argued, relatively fairly, that the V-2 was a poor use of resources for the Third Reich, as it was extremely costly to produce while its impact was relatively small. The money diverted to the long-range rocket programme would perhaps have been far better spent on anti-aircraft defences and fighter production, though in the latter case there was a severe shortage of fuel as well as aircraft.[28] That said, Hitler and the Nazi leadership felt they needed to offer a visible response to the enormous and almost ceaseless Allied aerial bombardment of Germany (hence the designation of 'vengeance weapons') and to give the German people hope that the fortunes of the war could be turned by these new technological marvels. The generally unimpressive record of the V-2 during the war presents an interesting paradox – if long-range rockets were such an ineffective weapon, why did all the victorious Allies rush to gather German technology and expertise in this field once the war had ended? The answer can be summarised in a single word: potential. As the British Director of Guided Projectiles, Sir Alwyn Crow, put it: 'as might be expected, the first two weapons [the V-1 and V-2] are crude', but, he went on, 'further development may be expected considerably to improve the accuracy, to simplify the use and to increase the applications.'[29] In short, the V-2 was the primitive prototype for a new era in which much more advanced missiles, equipped with more sophisticated guidance systems and armed with more powerful (perhaps nuclear) payloads, would decisively shape the future of warfare.[30]

British military planners certainly internalised this notion. On 16 June 1945, with the war in the Pacific still ongoing, a committee, headed by the esteemed chemist and senior British military science advisor, Sir Henry Tizard, and acting under the instruction of the British Chiefs of Staff, produced a report entitled 'Future Development in Weapons and Methods of War'. On the subject of rockets, the so-called Tizard Report noted that: 'In its most revolutionary form, that of long-range rocket bombardment, the rocket has appeared too late to have a decisive effect. In all its forms, we believe that its use will be of great significance in a future war.' It even went on to speculate that 'it may contribute to render the "strategic bomber" obsolete'.[31] Even as early as November 1944, Duncan Sandys, who knew perhaps more about the nature of the V-2 than anyone else in Britain, predicted that 'in future, the possession of superiority in long distance rocket artillery may well count for nearly as much as superiority in naval or air power.'[32] This thinking motivated the British, as well as the other Allies, to try and learn as much as they could about German rocketry – the expertise of their former enemy was seen as a vital shortcut to achieving their own post-war technological superiority.

In fact, this attitude did not merely apply to rocketry. In the last year of the war, and even more so once it had ended, all the Allies embarked on major schemes to exploit the science and technology of the Third Reich.[33] From the very beginning of this initiative, however, rocketry occupied a particularly important place in Allied exploitation and any material or personnel pertaining to this highly important field were considered to be among the most valuable spoils of war. British exploitation of German science and technology began on an Anglo-American basis, under the auspices of the Combined Intelligence Objectives Sub-Committee (CIOS).[34] When this organisation first drew up its 'Black List' of high-priority topics

in August 1944, 'rockets' were the fourth item on the list.[35] Ten days later, the first team of CIOS investigators travelled to Europe, arriving in Paris just three days after it had been liberated. The first report which they sent back to the London headquarters was entitled 'Radar and Guided Missiles' and detailed work which had been done on these subjects by French experts and in French facilities during the German occupation.[36] Then, in November, CIOS operatives travelled to the Netherlands to gather intelligence on V-2 launching procedure, a task which was motivated as much by the need to prevent the rockets raining down on London as it was by the desire to learn more about this new technology. In the course of these investigations, CIOS agents were told by a Dutch Resistance fighter that one German soldier died of severe burns for each V-2 that was launched and that some of the warheads used contained anthrax. These strange and ultimately false claims give some sense of the rumour and conjecture with which exploitation investigators had to contend when researching rocketry.[37] The British demand for knowledge on missiles continued into early 1945 – in February, Colonel Terence Sanders of the Ministry of Supply led a four-man mission to northern France to investigate the seven so-called 'heavy' V-2 launch sites located there.[38]

Once the borders of the Third Reich were breached in the early part of 1945, the real spoils of war became available to Allied exploitation teams, who continued to operate under the Anglo-American auspices of CIOS in London and the Supreme Headquarters Allied Expeditionary Force (SHAEF) in the field. On 22 April, Colonel Holger Toftoy of the US Ordnance Department reported that Allied troops had captured 'two trainloads of substantially complete V-2 German long-range rockets', as well as 'a third trainload of warheads and fuses'. With palpable excitement, Toftoy noted that 'the capture of these rockets is of considerable interest and importance, since this is the first time that undamaged

specimens have been recovered and an opportunity afforded for their examination', and stated his belief that 'this capture will result in a considerably improved knowledge of the rockets'.[39] Less than two weeks later, SHAEF issued a directive to all Army Groups and Air Forces operating in the European theatre; it stated: 'Immediate steps will … be taken to ensure that all captured V-2s, associated launching and control equipment are carefully preserved for examinations and possible future use, and are not tampered with in any way. Captured V-2 launching crews and technical personnel will be kept together and not disposed of until clearance is obtained [from this Headquarters].'[40] It is clear therefore that investigations into German long-range rocketry were a top priority for the British and Americans, even while the war was still being fought. The next step was to decide how best to conduct those investigations moving forward, under the more favourable conditions of peacetime.

Operation Backfire

The origins of Operation Backfire lay in a memorandum prepared by Eisenhower, as the head of SHAEF, and transmitted to the Combined Chiefs of Staff (of Britain and the US) on 15 May 1945, exactly one week after the German surrender. It suggested the value to the Allies of a firing trial of captured V-2s and justified it in the following terms:

a) Such a trial would save many years of development work by Allies and enable us to "cash in" on the years of work which the Germans have devoted to this development;
b) The firing of captured V-2s now would ensure that no vital piece of equipment or operation is kept from our knowledge;

c) The launching and control of rockets is a complicated and intricate process and unless we get enemy technicians to demonstrate their technique now their skill will deteriorate and before long will be lost to us. Delays which would be caused by moving personnel and equipment out of theatre therefore not acceptable.[41]

It went on to stipulate that any such trials would be held under SHAEF auspices as they were of equal interest to both the British and the Americans, that approximately 30 rockets would be fired, and that the results of the firings would be appropriately collated and made available to both countries.[42] The British Chiefs of Staff considered this memo over the next two days and then asked the War Office to investigate further.[43] Two days later, under pressure from the US Chiefs of Staff to give their assent, they requested further information on the number of complete V-2s available in Germany, stating that 'it is obviously undesirable that all or even almost all available should be expended during [the] proposed trial.' Both Britain and the US had requested 100 each and there were 'other claimants' (presumably the Soviets and the French).[44] Reassured that Eisenhower 'has at least 300, and possibly as many as 500, rockets in his possession' and that he 'only visualises using 30 rockets in the trials', the Chiefs of Staff signalled their approval for Backfire to go ahead on 24 May 1945.[45]

With the full backing of the relevant authorities in both London and Washington, DC, Operation Backfire began in earnest. Eisenhower named Major-General Alexander Cameron, the Chief of Air Defence for SHAEF, as the head of the new Special Projectile Operations Group (SPOG), responsible for Backfire, and an establishment of some 100 officers and 900 other ranks was agreed. The site chosen for the test launches was the Altenwalde Naval Gun Testing Ground of the German armament manufacturers, Krupp, near Cuxhaven in Lower Saxony, on the North Sea coast at the mouth of the River Elbe.[46] The specific objective of the operation,

as dictated to Cameron, was 'to obtain, while the German technical staff originally employed on long range rockets are still available and the details are still fresh in their minds: (a) information on the testing, assembly and filling of the German A.4 rocket; (b) detailed knowledge and experience of the German technique for launching long range rockets.'[47] It was perhaps put best by one of the German experts involved, Dieter K. Huzel, who described it as 'an effort to become familiar with the other end of a trajectory'.[48]

Throughout the summer of 1945, work was undertaken at Cuxhaven to gather and record all knowledge and expertise on the V-2, and to prepare for the test-firings later in the year. By the end of August, SPOG was drawing on the services of over 600 German personnel – 79 technicians (49 of whom were working in the various workshops at the test site, while another 30 served as consultants), 120 military mechanics, and 414 unskilled POWs.[49] The military commander of the German V-2 programme, Lieutenant-General Walter Dornberger, was also separately detained nearby for the purposes of interrogation.[50] The British would later plan to try him on a war crimes basis for his role in the indiscriminate rocket bombing of London, but this flimsy and rather hypocritical case unsurprisingly came to nothing, though Dornberger did spend almost two years in a Welsh POW camp.[51] Despite a few obstacles along the way, not least the poor condition of many of the rocket components which had to be salvaged from ditches and railway sidings, Operation Backfire concluded successfully in October 1945. While thirty launches had been planned, only three took place – the first, on 2 October, was a great success: 'The behaviour of the rocket from the moment of take-off to the point of fall was perfect'. The second, two days later, was a failure, with the rocket crashing almost immediately into the sea. The third and final launch took place on 15 October, 'as a demonstration to representatives from the United States, Russia, France, the Dominions,

Whitehall, and the Press', and, despite poor weather conditions, was generally successful.[52] Three days later, it was agreed that Backfire could now be terminated, and the dissolution date was set for 30 November.[53]

As this shows, Backfire ended up as a relatively small operation and certainly did not match some of the lofty ambitions that accompanied its initial establishment. In large part, this can be attributed to the breakdown in Anglo-American relations which took place during the summer of 1945 and from which Backfire suffered especially acutely. After the United States' entry into the war in December 1941, the British and Americans had worked increasingly closely on almost all aspects of the war effort, their shared identity and purpose even seeming to erode traditional state sovereignty on occasion.[54] Scientific and technological collaboration had long been a cornerstone of this alliance, as shown by the Tizard Mission (headed by the aforementioned Sir Henry Tizard) which saw an unprecedented sharing of military scientific secrets between the two countries in 1940, even before they became formal allies.[55] One device which Tizard took with him as a gift for the Americans was a cavity magnetron (vital for airborne radar) which one American expert later described as 'the most valuable cargo ever brought to our shores'.[56] An even clearer example would be the Manhattan Project – the Allied atomic bomb project which was based in, and resourced by, the United States, but which utilised some British expertise, and which was widely acknowledged at the time to have been a combined effort, at least in part.[57]

But, by the time the war ended, the United States had emerged as one of only two global superpowers while Britain was a near-bankrupt empire, retaining some of its pre-war influence and international reach, but nevertheless clearly in decline; they were no longer equal partners and the nature of their relationship had to be renegotiated.[58] This was

manifested in a variety of ways, including the abrupt termination of the wartime Lend-Lease economic aid programme in August 1945 (and its replacement with a much less generous loan) and Britain's increasing post-war dependence on international alliances, especially with the US, to defend its global interests, as seen with the creation of NATO in 1949.[59] Another indication was the end of scientific collaboration, as shown in the US Joint Chiefs of Staff Memorandum No.5, issued in May 1945, which stated that 'technical information involving research and development projects, the application of which are incapable of being introduced in the present war, shall not be released [to foreign governments]'.[60] This attitude was reinforced even more firmly in the field of atomic physics, despite the earlier collaboration of the Manhattan Project – in August 1946, the US Congress passed the McMahon Act which prohibited the sharing of American atomic secrets with any foreign power, including Britain.[61]

The ramifications of this split were felt on the ground in Germany too. On 13 July 1945, SHAEF was liquidated and, from that point on, practically all British and American activities in occupied Germany, including the exploitation of German science and technology, were conducted on a unilateral basis (though co-operation did not entirely evaporate). In terms of Backfire, this new relationship manifested itself first in growing American disinterest in the operation, not least because it was seen as inferior to longer-term rocket research projects, also utilising German equipment and expertise, which had by then been initiated in the United States. Indeed, even as early as 4 June, the Chief of Staff of the US Army, General George C. Marshall, wrote to Eisenhower to make it clear that 'these firings must *not* interfere with [the] important US program.'[62] The process of US withdrawal did, however, begin gradually – a week after SHAEF had been disbanded, responsibility for Backfire was passed over to the

British War Office but Cameron was informed that the 'United States representative will participate on an equal basis at these firings and concurrence of United States authorities concerning the programme for such firings will be obtained. United States and United Kingdom will each have full access to the results obtained from such trial firings.'[63]

However, despite this stated intention to continue working in close collaboration, the US immediately began to treat Backfire as a nuisance and an obstacle, rather than an integral part of broader Anglo-American strategy. In early August, Cameron wrote to his superior, the Director of Royal Artillery, Lieutenant-General Otto Marling Lund, with this ominous message: 'I think I should warn you that a crisis is boiling up in the affairs of Backfire. I had a visit today from Colonel Toftoy of the US Ordnance Dept., who is now in charge of all the rocket development in the States. He says that he needs 27 of the German civilians I am using here.'[64] On this point, Cameron was quite correct – the tug-of-war which developed over these German experts did come to resemble a full crisis, and it served to highlight how quickly Anglo-American co-operation had been replaced by bitter, and ultimately petty, competition. To summarise, most of Germany's truly exceptional rocketry experts had ended up in American hands at the end of the war, and were detained at a US facility in Garmisch-Partenkirchen, in southern Bavaria. Eighty-five of these specialists had been 'loaned' by the US authorities to SPOG for Backfire but then, when the US launched Operation Overcast (a scheme to bring German rocket engineers to the United States for work on the American missile programme), these men were recalled as a matter of urgency. In a gesture of friendly spirit, the Americans only pushed for the return of 27 of these experts, those considered to have the highest scientific qualifications. The British agreed to return 15, but insisted that

they be allowed to retain the remaining 12 as they were considered of critical importance to the execution of Backfire.[65]

The diplomatic wrangling over these 12 individuals continued for some time, with messages regularly crossing the Atlantic in an increasingly heated exchange – each side insisting that they were being more co-operative than the other while also fervently stating their case. The US argued that Backfire was 'limited to the assembly and launching of V-2 rockets rather than to their research and development aspects' and therefore that alternates could easily be found for the 12 men in question.[66] The British, on the other hand, made their case as follows:

> If the Japanese War had still been in progress, and if it had been shown that the presence of these 12 scientists in the USA was vital for the defeat of Japan, no difficulties would have been raised as regards their despatch to the USA but it must be assumed … that their employment in America can only be in connection with a long-term research project. Under these circumstances we cannot believe that their retention at Cuxhaven for what would probably be a maximum of 2 months, could seriously inconvenience the United States Chiefs of Staff, whereas their withdrawal at this juncture would prejudice the success of Backfire into which much hard work and valuable effort has been put.[67]

In addition, the British authorities attributed much of the friction to 'the mysterious and rather parochial way in which it pleased US Ordnance to work'.[68] Nonetheless, a solution was eventually worked out between the British Director of Guided Projectiles, Alwyn Crow, and Lieutenant-Colonel R.L. Williams of US Ordnance – the British would return 15 of the 27 experts immediately, and the remaining 12 as soon as Backfire was concluded. Despite this basically being exactly what the British had wanted in the first place, they also managed to

secure a sweetener to the deal – the Americans would lend them four of the most prominent German rocket engineers who were not at Cuxhaven, including their de facto leader, Wernher von Braun, for one week for detailed interrogation in London.[69] A true crisis had been averted but the whole affair left a bitter taste in the mouths of all those involved.

The irony of this small dispute between the two largest Western Allies is that their conflicting demands were both motivated by the same general fear – that of another war, possibly involving long-range missiles, against the Soviet Union. In fact, Backfire was used as a reason to evacuate German rocket specialists from the region around Nordhausen (where rocket production had been moved after Peenemünde was bombed in August 1943), which was due to fall under Soviet occupation, to the relative safety of Cuxhaven, deep in the British zone.[70] Britain and the US even considered demolishing the massive underground factory there and destroying all its contents to preclude them falling into Soviet hands, but decided that so doing might have 'unfortunate repercussions'.[71] For the time being, they even maintained a façade of friendly relations with the Soviets, who were invited to send representatives to the final Backfire test-firing on 15 October. However, Cameron was requested to, at his own discretion, 'refrain from showing foreign or Press visitors any part of the equipment or records that you consider it advisable to conceal'.[72] The Soviets, for their part, did little to foster a relationship of trust either – despite only being invited to send three observers to the test-firing, they actually sent six, meaning the three who were subsequently denied access by the British had to try and catch a glimpse of the launch from beyond the site perimeter.[73]

Certainly, this behaviour suggests that the Soviets viewed Backfire as an important exercise and one they felt they wanted to learn as much as possible about. Assessing the exact

value of the operation is one of the biggest challenges in studying Backfire, particularly as much of the literature on Britain's missile development dismisses it as, for instance, 'of little practical value'.[74] However, at the time, the War Office and Ministry of Supply allotted it 'overriding priority over other guided missile projects in order to facilitate its early completion'.[75] In pushing for this level of priority, the Deputy Chiefs of Staff made their case as follows: 'It may be that the demands in respect of Backfire may cause some delay in work now being done in connection with Guided Projectiles generally. On the other hand the value to be obtained from Backfire may well lead to a shortening of the eventual time to be spent on Guided Projectile research, and in any case the duration of Backfire will be comparatively short.'[76] However, despite this priority, not all parties in Britain were in support of Backfire – Colonel Terence Sanders, who had been sent to examine launch sites in northern France in early 1945, was of the view 'that to assemble rockets from the components and then to launch them would be of doubtful value' and the technical advisor sent by Alwyn Crow to act as Cameron's right-hand man, had 'no enthusiasm for the project at all'.[77]

After the launches, the immediate response to the operation was largely positive. In the conclusion to his official Backfire report, Cameron summarised thus: 'It is believed that all is known and that it now remains for others to make use of that knowledge.'[78] Those involved also celebrated the completion of a successful operation. Major P.A. Chittenden, who had served as Superintendent of Electrical and Electronic Assembly for SPOG, recorded details of a commemorative dinner held one week after the final launch and where dessert was the mysterious 'A.4 Special'. He was also invited to attend lectures on the long-range rocket and screenings of the Backfire film, produced by a War Office film unit, and even received a 'Backfire trophy' in the form of a metal V-2 on a wooden plinth.[79] The German participants

had a similarly positive experience, though many of them saw Backfire as merely a bothersome delay to their real future in the United States. Dieter Huzel described the British treatment of him and his colleagues as 'generous', and commented that the extensive Backfire reports were 'more comprehensive than anything that existed in German files'.[80]

The British press also responded enthusiastically, with *The Times*, *Daily Worker*, *Daily Express*, and *The Sphere* all publishing reports on the test-firing, each accompanied by photographs of the V-2 taking off.[81] The special correspondent for the *Daily Telegraph*, Edmund Townshend, attended the launch on 15 October and described the rocket as 'like a pencil on a spear of flame as long as itself'.[82] The *Daily Mail* reporter, meanwhile, emphasised how much had been learnt from the operation, asserting that 'British scientists and army technicians have reached a point where, within three weeks, we could dispense with German help if we wished.'[83] While it was true that Backfire had allowed the British authorities to amass a substantial wealth of knowledge about the design, assembly, preparation and launch of the V-2, this did not mean that the services of German specialists were no longer needed. In fact, looking ahead, German expertise was to be directly integrated into the post-war British missile programme. In terms of a final verdict on Operation Backfire, while its long-term implications may have been relatively minor, its importance at the time was considered to be very high – a fact which is perhaps evidenced most clearly by the willingness of British officials to risk souring their relationship with the Americans just to ensure the retention of a few German experts for the duration of the operation. Ultimately, it met the terms of its limited mandate and laid the foundations for the guided missile research and development programme which emerged in Britain in the immediate aftermath of the war.

Looking to the Future

When asked to prepare a report on the future developments in weapons and methods of war, Henry Tizard and his expert committee spent six months examining over 300 documents and interviewing over 100 witnesses. The resulting report was wide-ranging, fairly comprehensive and bold in many of its predictions. As noted above, it included the belief that long-range missiles would have an important role to play in future conflicts. But in one area, information was notable by its absence – atomic warfare. Published in June 1945, before the use of the atomic bomb against Japan and while the Manhattan Project remained a closely-guarded secret, the Tizard Committee were denied access to any atomic information.[84] As a result, the best the Tizard Report could say in its section entitled 'The Atomic Bomb', was that 'there is … a possibility that some practical method may be found to release atomic energy explosively', and that, if so, 'a single bomber could do an amount of damage equal to that of a thousand bombers using normal bombs'.[85] Once the power of the atomic bomb had been revealed in August, it was decided that this predictive report was now distinctly out of date, so a new edition was deemed necessary. Tizard rejected the offer to make revisions, and the task was handed over to the Joint Technical Warfare Committee (JTWC) instead.

In the course of preparing the revised report, the JTWC received new information on the atomic bomb from Sir James Chadwick, the senior British officer on the Manhattan Project, and from Wallace Akers, the head of the parallel British development programme, codenamed 'Tube Alloys'. Chadwick informed the Committee that the current method of delivering the atomic bomb by aircraft had limited longevity, given advances in anti-aircraft defence and the ability to destroy enemy airfields. However, he described a rocket, or 'space projectile', as the 'ideal method of delivery for the atomic bomb', on account of its greater

range, the difficulty of shooting it down, and the reduced vulnerability of its small, perhaps mobile, launch sites.[86] Akers, meanwhile, warned that 'the only protection against an atomic weapon is to prevent it arriving or to live and carry on all industry in bomb-proof shelters burrowed some hundreds (or perhaps thousands) of feet in the earth.'[87] This echoed similar sentiments offered by others who were intimately aware of rocket development at this time. Even as early as November 1944, nine months before the bombing of Hiroshima, the ever-prescient British scientific intelligence expert R.V. Jones had written that 'a very long range rocket … by virtue of its relative immunity from interception … might be a feasible weapon for delivering a uranium bomb, should such a bomb become practicable.'[88] Germany's leading rocket pioneer, Wernher von Braun, also saw possibilities in 'the harnessing of atomic energy together with the development of rockets, the consequence of which cannot yet be fully predicted, though he may well have been referring to the possibility of nuclear engines rather than payloads.'[89] In the conclusion of his official Backfire report, Cameron agreed: 'If the high explosive content of the warhead can be replaced by an atomic bomb, its destructive ability will be colossal.'[90] It should be noted, however, that one of the main findings of Backfire was that a V-2 could not carry an atomic warhead, as the maximum V-2 payload was 2,150lbs, while the atomic bombs then available (that is, akin to those dropped on Japan) weighed at least 9,000lbs.[91] As a result, the new JTWC report confirmed that rockets were likely to be the most effective method of atomic bombardment in the future but would not be ready for use for perhaps another ten years.[92] Nonetheless, the principle remained sound.

Of course, all military planning is based on a certain set of assumptions about which nation is likely to be the future enemy – for Britain in this period, the Soviet Union was the obvious potential foe. Julian Lewis has argued that Britain responded to the post-war

breakdown in Anglo-Soviet relations with foresight, prudence and exceptional rapidity.[93] In a sense, this is almost an understatement. A few days after the war in Europe ended, and while the Grand Alliance was still in effect, Churchill asked his planning staff to devise a strategy for defeating the Soviet Union in open conflict, codenamed 'Operation Unthinkable' – remarkably, it involved utilising 100,000 rearmed German soldiers, reinforced by British and American manpower and air support, to launch a pre-emptive strike on the war-weary Soviet Union.[94] Later assessments suggested that the Soviet Union's overwhelming superiority in conventional manpower could only be counteracted by the use of weapons of mass destruction, such as the atomic bomb.[95] There was therefore a serious fear among British strategists about what would happen in the Soviets developed atomic weaponry of their own – in the JTWC report of July 1946, it was estimated that 'some 30-120 atomic bombs accurately delivered by the USSR might cause the collapse of the United Kingdom'.[96] Unsurprisingly, this thinking directly influenced British missile development – the range requirements for a long-range rocket were given as 800, 1,500 and 1,850 miles, based on calculations of the distance of major cities in the Soviet Union from 'Norwich, Nicosia in Cyprus, and Peshawar in India', that is, the places in British territory 'from which the best minimum range coverage is obtainable.'[97]

The potentialities of rocketry discussed in this period were not limited solely to military applications. Cameron thought rockets might provide 'a mail service which could bridge the Atlantic in 40 minutes [and which] might be of more value than a weapon of war'.[98] A *Daily Mail* article written in the wake of the Backfire launches speculated even more ambitiously – in a new form, the rocket 'could supplant aircraft and carry mail, goods and perhaps passengers across the Atlantic in 15 minutes'. (This must have seemed particularly

enticing as it appeared alongside another article noting that Pan-American Airways' re-established New York-London service would take 15 hours!) The V-2 piece continued: 'German experts have ideas which seem to go into the realm of fantasy. They say that if the crews can make their own oxygen, there is no reason why the men in rockets should not travel beyond the power of gravitational attraction and anchor in the space between planets', or even 'reach the moon'.[99] It is certainly true that individuals like von Braun, whose work in rocketry had initially been inspired by the notion of travelling beyond Earth's atmosphere, had bold visions of what this new technology could achieve. In the report he prepared for CIOS after the war, he was certain that, 'when the art of rockets is developed further, it will be possible to go to other planets, first of all the moon.' He summarised his views (and those of many of his contemporaries, both German and British) in the following way: 'We are convinced that a complete mastery of the art of rockets will change conditions in the world in much the same way as did the mastery of aeronautics and that this change will apply both to the civilian and the military aspects of their use.'[100]

As a result, rocketry remained a high-priority field in the British scientific and technological exploitation programme, which continued to grow and expand in the early post-war period. The most important development in this respect is that Britain moved from merely removing equipment and investigating facilities to detaining, interrogating and even recruiting German scientists and technicians themselves. In July 1945, the Deputy Chiefs of Staff committee (which took the lead on this initiative) described German progress in a range of fields, including rocketry, and noted that 'the related equipment will be transferred to this country but it needs, for its full exploitation, the presence of the scientists responsible for its development.'[101] In August, the government Service departments were asked for subjects in

which they would be keen to recruit German experts – both the Ministry of Aircraft Production and the Ministry of Supply included missiles and guided projectiles on their lists.[102] In all cases, the individuals brought in would be vetted as to their political pasts, subject to various security measures, and only employed on a limited basis, by way of renewable six-month contracts.

Naturally, Backfire offered the ideal platform for the British to try and recruit German rocketry experts. Once the test-firings were completed and SPOG was disbanded, the Ministry of Supply took complete control of the facilities at Cuxhaven, which became known as Ministry of Supply Establishment, Cuxhaven, or MOSEC. Here, the German personnel were tasked with documenting their work to date on guided projectiles, but a report on MOSEC filed in December 1945 noted that 'the purpose for this establishment, apart from general research, is to determine which German scientists it is considered could be taken for similar work in experimental stations in UK and to give practical experience to British scientists on German methods of guided projectiles.' This process was handled disastrously. No information was provided to the German experts about future employment until March 1946 when MOSEC was winding down. In addition, the British officials felt it was improper 'to enter into a contract with a beaten enemy'.[103] As a result, the contracts which were eventually offered were ungenerous and were judged by the German personnel to be utterly inadequate on two grounds: there was no clarity as to the nature of the work they would be doing in Britain, and there were no assurances about the fates of their families who would be left behind in Germany.[104]

With the contracts rejected, the British informed the German specialists that they were forbidden to work anywhere in Germany due to demilitarisation restrictions and then

cut them adrift when MOSEC was shut down in May 1946. Most of the German experts then immediately approached the French who very quickly offered them all contracts which they were willing to accept.[105] Panicked that, as a result of their miserly tactics, they were going to lose out on all these German experts, the British authorities tried to hold the engineers at another facility at Trauen while they tried to arrange a better offer.[106] On 23 May, new contracts arrived from London, only for the German experts to discover the terms had not changed at all from the originals.[107] Eventually, a solution was devised and ten German rocket engineers were brought to Britain in November 1946. Among their number was Walter 'Papa' Riedel, who had been head of the Design Office at Peenemünde, and Johannes Schmidt, the *de facto* leader of the group, who had spent the war working on submarines but had reinvented himself as a rocket expert in order to secure post-war employment.[108]

As this story shows, and as explored elsewhere in the article, one of the problems the British had to face was competition with their allies, both the Americans and the French. Throughout the summer of 1945, once the friendly but ultimately pragmatic wartime alliance broke down, relations became strained. The wrangling over the fate of the 27 rocket experts loaned to Backfire by the US authorities was just one example. At the same time, concerned that the greater financial, political and logistical power of the United States would give them a 'blank cheque' with regards to exploiting Germany, the Chiefs of Staff pushed for a fair allocation policy between the two nations on all secret weapons and technological equipment.[109] Driven by the fact that they were taking the lead in the ongoing war against Japan, the US proposal was 'to give preference to the Americans in all cases where there are insufficient samples, personnel or equipment available to provide for development to be continued simultaneously both in [Britain] and the United States.' The British felt that it would

be better to have in place administrative machinery to decide which country was best-placed to exploit each specific field but acknowledged that this would be time-consuming and would give 'further grounds to [US Army Chief of Staff] General Marshall in his complaint that we are not being co-operative in this matter.'[110] As a result, the British signalled their assent on 4 July, but they still held clear reservations: 'We agree in principle, but consider it most important that the Americans should not be given *carte blanche* to remove equipment, scientific personnel and documents without consultation, and we must insist that records of anything removed to either country must be exchanged.'[111] As for the French, they were only to receive an allocation when US and British demands had been met, and even then only if a direct request was received.[112]

It is worth noting, however, that this inter-Allied rivalry was only genuinely fierce in the first year or so after the end of the war, when all the occupying powers were adjusting to new positions in the global order. In any case, British officials and policymakers remained all too aware that the real future enemy was the Soviet Union, and that a Soviet missile capability was of far greater significance to British interests than any small-scale competition with the US or France. As such, Britain took active measures to prevent German rocket equipment or expertise from falling into Soviet hands. This need was sharpened by Operation Osoaviakhim, the Soviets' mass deportation of German scientific and technical workers from occupied Germany to the USSR, which they carried out in late October 1946.[113] Partially in response to this drastic action, on 11 December, the Defence Committee of the Cabinet, chaired by the Prime Minister Clement Attlee, agreed that 'it was necessary to deny to the Russians those German scientists and technicians, within our influence, who could contribute substantially to the building up of Russian war potential.' Schemes were developed to facilitate this 'denial

policy' and they did have some successes. A team of six specialists who had worked during the war on V-weapon production at the Linke-Hofmann-Busch firm were evacuated from Berlin to Britain, which was believed to have seriously 'affected Russian exploitation of German guided missile research.'[114] Nonetheless, the resources available to the Soviet Union meant that these minor non-proliferation measures were likely to have only a limited effect.[115] Indeed, the British authorities themselves concluded that while the denial of experts to the Soviet Union 'may have delayed Russian developments, it has hardly prevented them'.[116]

While this was concerning to the British, their main drive with regard to German rocket expertise was to utilise it for their own ends, not to deny it to the Soviet Union. In Alwyn Crow's October 1945 report to the JTWC, he stated his belief that British rocket technicians 'are equal and superior to those of USA, Russia and Germany. Given adequate facilities there is no reason to doubt that Britain could hold her own in the race for the development of these new weapons.'[117] Sharing Crow's optimism, the post-war British government decided to provide these 'adequate facilities' and ordered the creation of a Guided Projectiles Establishment (GPE) to be based at a former RAF aerodrome at Westcott, in Buckinghamshire.[118] The Westcott facility opened in the summer of 1946, though it remained incomplete for some time thereafter. The first group of ten German rocket experts, including Riedel and Schmidt, arrived in November. The reactions from local people were not wholly warm. A petition sent to the local MP read: 'we very strongly object to this move, which would almost certainly result in many Germans living in the district and being free to mix with our people', and suggesting that they be housed 'in some place where they would not be able to exercise what might be a harmful influence on village life'.[119] Over time, opinions softened

and when, a year after they had arrived, an explosion at the GPE claimed the life of Johannes Schmidt (as well as two British personnel), there was an outpouring of grief in the area. The local newspaper even went as far as to say that the 'poignancy [of the accident] was heightened by the fact that a great German scientist whose knowledge and skill were being applied to British research work was among the three who lost their lives.'[120] Even so, trust in the German recruits was not complete, as revealed when it was discovered in 1947 that caches of technical documents pertaining to rocketry had been hidden in Germany during the final days of the Third Reich, perhaps with a view to secretly recreating a missile programme in Germany after the war. Under the so-called Project Abstract, German rocketeers now in British or American employ were interrogated about these illicit stashes, and a spirit of suspicion returned to relations between the experts and their new employers, albeit briefly.[121]

The work that was conducted at Westcott, and to which the German experts directly contributed, was dictated by the priorities of the Service departments. In early 1947, on the list discussed by the Guided Weapons Advisory Committee (GWAC), one of the 'Priority A' items was a 'strategical rocket' codenamed 'Menace', in which the General Staff, the Air Staff and the Naval Staff were all interested. The criteria for this weapon included suitability for launching from any part of the world, 'ranges 400 to 2,000 miles approx. but maximum ranges of 800 to 1,500 miles of operational value', and 'Destructive [i.e. high explosive] and "Carrier" [i.e. atomic or biological] warheads required.' It also needed to have a '50% zone of 2 miles at all ranges', meaning that half of all rockets fired should land within two miles of the exact target.[122] In addition, long-range rockets seemed a smart investment as they could act as a deterrent, thus minimising the chances of war and reducing the need for Britain to maintain

a large and costly conventional army in a period of economic, not to mention geopolitical, decline.[123] However, even at this point, there were concerns that the development work involved in such a weapon was also prohibitively expensive for cash-strapped post-war Britain, not least because the technology needed considerable improvement before it could serve as the main form of long-range bombardment. In autumn 1947, the GWAC recommended that, 'at the present time, the method to be adopted for long-range bombardment must be the manned subsonic bomber.'[124] In 1948, the Ministry of Supply took the decision to curtail research into a long-range strategic missile and focus efforts instead on jet-powered manned bombers and anti-aircraft projectiles instead.[125] It was 1955 before Britain decided to pursue a long-range rocketry programme again, when it began work on the ultimately abortive Blue Streak medium-range ballistic missile.[126] Britain's first entry into the missile age had been tentative and fleeting but it did lay the framework for future developments.

Conclusion

To conclude, it seems appropriate to return to the three objectives set out in the introduction of this article. The first objective was to challenge the idea that Britain showed no serious interest in developing a ballistic missile programme immediately after the Second World War, and that Operation Backfire was a largely pointless exercise. It is true that Britain's early foray into rocketry was a brief one but the potential of the V-2 meant that initial enthusiasm was high, fuelling notions that the long-range rocket would promptly eclipse the manned bomber and that Britain had the resources to be a vigorous competitor in the post-war missile race.[127] It was only later that these proved to be misconceptions and re-evaluations of priorities were

necessarily made. Backfire, however, was embarked upon amid this atmosphere of post-war rocket fervour. In the conclusion to his operation report, Major-General Cameron, no stranger to the subject, wrote that, 'for the sake of their very existence, Britain and the United States must be masters of this weapon of the future.'[128] This sentiment just goes to show that in the immediate aftermath of the Second World War, not only did Britain embrace the potential of ballistic missiles but it also saw itself as able to participate fully in research and development in this field moving forward. Moreover, the subsequent abandonment of the British missile programme in 1948 does not diminish the importance of Backfire – in fact, the realisation that a rocket similar to the V-2 was not capable of delivering an atomic warhead was one of the operation's key findings, thus allowing the British to commit their scant resources to the development of jet bombers, an ultimately far more fruitful endeavour.[129]

The second objective was to locate German expertise in the story of British missile development. There can be little doubt that Britain, with its almost complete lack of wartime long-range rocket research, needed to rely heavily on German advances in creating a post-war missile programme. As Alwyn Crow reported to the JTWC in October 1945, 'the weapons V-1 and V-2 which Germany has produced represent considerable technical achievement, far beyond anything for which facilities and money have been made available in this country. These weapons have been developed with striking imagination … [and] with drive and initiative.'[130] As such, the recruitment of German personnel was of great value – in 1949, it was noted that 'the Guided Weapons fields in which the Germans were so far ahead of us at the end of the war have been particularly carefully combed … The result of this careful combing is that approximately one third of our present 90 German scientists are working for us directly on guided weapon problems and a fair proportion of the remainder are on related

work.'[131] The other side of the story here was the fear that the German expertise sought by the British might prove equally as useful to the Soviet Union. In May 1946, the Joint Intelligence Committee stated its anxious belief that 'the alliance of German brainpower and Russian resources may well prove to be the most important outcome of the occupation of Germany.'[132] Every German rocket engineer employed in Britain was one fewer who could fall into Soviet hands, making the German involvement in the British missile programme doubly important.

Finally, the third objective was to show that Britain and the United States did not always present a united front in the immediate post-war years, and that the changing global power dynamics involved in this reconfiguration of the Anglo-American alliance led to competition as much as co-operation. The wrangling over the group of 27 German missile experts which took place during Backfire was was one particularly glaring manifestation of this. Nonetheless, this transatlantic animosity could not last, especially under the shadow of the looming Soviet threat. In September 1948, when the Guided Weapons Advisory Committee concluded that pursuing a long-range rocket programme was beyond British resources, they noted 'that intensive work is in progress in the USA' and therefore recommended 'that the closest co-operation be maintained with the USA in the development problems associated with long range rocket bombardment', perhaps as 'the first steps to the realisation of a common policy on bombardment weapon development between the UK and USA.'[133] This suggestion became a reality with the bilateral military-technological sharing arrangements of the Burns-Templer Agreement in 1948, and the Sandys-Wilson Agreement of 1954, which led to a joint Anglo-American missile programme.[134] To this day, the British nuclear deterrent relies on Trident missiles which were developed, and are still

manufactured, in the United States.[135] In many ways, the origins of this state of affairs can be traced back to that first V-2 impact in Chiswick in September 1944, and the British attempts to understand 'the other end of a trajectory' which followed a year later.[136]

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[1] Norman Longmate, *Hitler's Rockets: The Story of the V-2s* (London: Hutchinson, 1985), 162-9.
[2] For a history of the Nazi rocketry programme, see: Michael J. Neufeld, *The Rocket and the Reich Peenemünde and the Coming of the Ballistic Missile Era* (Cambridge, MA: Harvard University Press, 1996); Neufeld, *Von Braun: Dreamer of Space, Engineer of War* (New York: A.A. Knopf, 2007); David Irving, *The Mare's Nest* (London: William Kimber, 1964).
[3] In contemporary usage, 'long-range rocket' was the most common term to refer to the V-2 and its ilk, though 'guided projectile' was also used. 'Ballistic missile' is a later designation but is important as to distinguish against 'cruise missiles', of which the V-1 flying bomb was a precursor. In this article, both rocket and missile, and their derivatives, will be used interchangeably.
[4] Andrew Brookes, *V-Force: The History of Britain's Airborne Deterrent* (London: Jane's, 1982), 13-14.
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[9] 'Report on Operation Backfire', 7 November 1945, Misc. 21/382, Imperial War Museum, UK [hereafter IWM].
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[11] 'Target Ranges', 5 January 1946, TNA, [Records of the Ministry of] DEFE[nce] 2/1252.
[12] Folly, '"The impression is growing … that the United States is hard when dealing with us": Ernest Bevin and Anglo–American relations at the dawn of the Cold War', *Journal of Transatlantic Studies* X (2012): 150-166; George L. Bernstein, *The Myth of Decline: The Rise of Britain since 1945* (London: Pimlico, 2004); B.J.C. McKercher, *Transition of Power: Britain's Loss of Global Pre–eminence to the United States, 1930-1945* (Cambridge: Cambridge University Press, 1999); Correlli Barnett, *Lost Victory: British Dreams, British Realities, 1945-1950*. London: Macmillan, 1995; David Reynolds, *Britannia Overruled*: *British Policy and World Power in the 20th Century* (Harlow: Longman, 1991).
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[14] Speech cited in I.V. Hogg, *German Secret Weapons of the Second World War: The Missiles, Rockets, Weapons and New Technology of the Third Reich.* London: Greenhill, 1999, 9.
[15] R.V. Jones, *Most Secret War* (London: Coronet, 1978), 102-3.
[16] McGovern, *Crossbow and Overcast*, 11.

[17] 'Minutes of the 1st meeting of the Projectile Development Establishment Priority Committee', 23 November 1939, TNA, [Records of the Ministry of] AVIA[tion] 22/143.
[18] Irving, *Mare's Nest*, 34-5; Martin Middlebrook, *The Peenemünde Raid: The Night of 17/18 August 1943*. London: Allen Lane, 1982, 36.
[19] Stocker, *Britain and Ballistic Missile Defence*, 11-12.
[20] 'German Long Range Rocket Development', 11 April 1943, TNA, CAB 80/68.
[21] Memo from Hastings Ismay to Winston Churchill, 15 April 1943, TNA, PREM [Records of the Prime Minister's Office] 3/110.
[22] 'Minutes of 314th (43) Chiefs of Staff Committee meeting', 22 December 1943, TNA, CAB 79/68.
[23] Dwight D. Eisenhower, *Crusade in Europe* (Baltimore, MD: Johns Hopkins University Press, 1948), 260.
[24] Walter Dornberger, *V-2,* translated by J. Cleugh and G. Halliday (London: Hurst and Blackett, 1954), 255. It should be noted that Heinz Dieter Hölsken has argued that the V-2 actually arrived 'too early', i.e. before adequate guidance systems had been developed, rather than 'too late'; see Heinz Dieter Hölsken, *Die V-Waffen: Entstehung-Propaganda-Kriegseinsatz* (Stuttgart: Deutsche Verlags-Anstalt, 1984).
[25] Stocker, *Britain and Ballistic Missile Defence*, 18-19.
[26] Ibid., 19.
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[37] CIOS Report X-13, 13 November 1944, CAC, METL.2.
[38] 'Crossbow: report by Sanders mission: Vol. I', 21 February 1945, TNA, [Records of the] W[ar] O[ffice] 106/2817.
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[40] 'Signal from SHAEF to all Army Groups and Air Forces', 4 May 1945, TNA, WO 219/3365.
[41] 'SCAF 395: Eisenhower to Combined Chiefs of Staff', 15 May 1945, TNA, WO 219/3365.
[42] Ibid.
[43] 'Minutes of 131st (45) Chiefs of Staff Committee meeting', 17 May 1945, TNA, CAB 79/33/17.
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