

The Royal Air Force and Airfield Air Defence Since 1933

Air Historical Branch (RAF)



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Introduction

Airfield air defence is one of the more neglected spheres of air power history. Most air power scholars prefer to view the world from above and carefully avoid being drawn into the ground environment. Equally, historians of land warfare seem rarely to embrace air-related topics, such as the broad theme of ground-based anti-aircraft (AA) defence, let alone the more narrowly defined subject of airfield AA protection. Sandwiched between the air and land studies communities, AA defence has tended to be ignored by both. In 1988, writing for the US Office of Air Force History, John F. Kreis produced his seminal study, *Air Warfare and Air Base Air Defense*, which despite its age remains at the forefront of academic research in this field. Otherwise, air base defence has been the focus of several RAND projects over the years,¹ but they have invariably approached the subject from a largely American perspective or in the wider context of defence against both land and air threats.

Where the UK is concerned, virtually any history of the Battle of Britain, the siege of Malta and the capture of Crete must necessarily cover the subject of air base attack and defence to some extent, but it is rare for histories of campaigns or operations to address air base defence as an issue in its own right. The Royal Air Force Regiment was created specifically to defend airfields, but a planned Air Historical Branch narrative of RAF ground defence in the Second World War did not progress further than the draft stage.² More recently, the work of Kingsley Oliver and Nigel Warwick has added valuable depth to our knowledge of the Regiment's history, but their analysis extends far beyond its airfield AA role.³ Studies by such authors as Colin Dobinson, Edward Westermann and Kenneth Werrell survey the general application of anti-aircraft defence but are similarly not focused on airfields.⁴ Historical coverage of airfield defence has otherwise largely been confined to short articles and conference papers.⁵

Yet airfield air attack is almost as old as military aviation itself. The earliest air strikes on airfields were executed in the First World War, when the first anti-aircraft artillery (AAA) batteries were also deployed in their defence, and airfields have consistently been priority air targets ever since.⁶ To a significant extent, the key to air superiority lies in the effective targeting of adversary airfields and in the protection of friendly airfields from hostile action. Airfield targeting featured prominently in the Second World War from the outset and has continued unabated into the 21st Century. It was employed by the RAF during the Suez crisis and the Falklands War, in the first Gulf War, in Bosnia in 1995, in the Kosovo conflict and in the Second Gulf War. As part of a counter-air campaign, the RAF and

NATO allies most recently targeted airfields in Libya in 2011. But just as airfield attack has been fundamental to air targeting for the UK and her allies, so also has it been employed by potential adversaries. Most recently, airfields were an important target set for Russia's opening strikes on Ukraine.

This is why airfield air defence remains a critical factor in modern warfare; we ignore it at our peril. And it is – or should be – a particularly important consideration for the RAF now. Since the end of the Cold War, UK Ground-Based Air Defences (GBAD) have been reduced to the barest minimum. As part of this process, the RAF lost its organic GBAD capability during the first decade of the century, and, following the Strategic Defence and Security Review (SDSR) of 2010, the UK's contingent Short-Range Air Defence (SHORAD) capability was also eliminated, leaving no SHORAD available for deployment in defence of RAF bases thereafter. Only a residual capability for the protection of the Mount Pleasant base in the Falkland Islands remained.

Yet this occurred at a time when the range and mass of air threats confronting the UK and her allies was increasing. The array now includes not only conventional aircraft, but air and surface-launched cruise missiles, ballistic missiles and a wide variety of Uncrewed Air Systems (UAS). Moreover, while the number of potential threats has risen steadily, the interminable search for economies has reduced the RAF's airfield infrastructure to a handful of vitally important but potentially very vulnerable main bases and exposed overseas Deployed Operating Bases (DOBS).

Against this background, recent years have witnessed limited signs of a renewed interest in GBAD; related areas, such as passive air defence, have also reappeared on the Defence agenda after many years of neglect. This is, then, an opportune time to attempt a survey of the salient features of the RAF's historical association with air base air defence. It should be emphasised that this is *not* a history of the RAF Regiment, nor is it a study of anti-aircraft weapons and tactics employed beyond the air base defence role. Moreover, while the Second World War features prominently, it would have been impractical to produce a comprehensive account of this subject extending from 1939 to 1945. Instead, the focus here is on the main theatres where the defence of RAF airfields emerged as a prominent operational factor.

The story began in the rearmament years of the 1930s and then continued with the expansion of both scale and capability in the Second World War, when the RAF Regiment was established. Disaster in France made way for triumph in the Battle of Britain in 1940 before the focus of the war shifted to the Mediterranean and North Africa – from the trauma of the siege of Malta to the birth of tactical air power in the desert. But if airfield air defence gradually improved in the west, the

opening of hostilities in the Far East confronted the UK with another debacle, this time in Malaya and Singapore.

In every theatre, the tide turned in the Allies' favour in 1943. Active GBAD was strengthened further, but improved air base protection always resulted from a range of mutually reinforcing air defence provisions. By the final year of hostilities, the threat to friendly air bases had been reduced to relatively limited proportions, but the war in Europe nevertheless had an unpleasant sting in its tail.

The post-war evolution of RAF air base air defence extended through British decolonisation and the final years of AAA to a missile age that encompassed both medium-range and SHORAD capabilities. The RAF Regiment deployed its Bofors guns repeatedly in the European theatre and beyond, their commitments including West Germany, the Middle East, Cyprus (during the Suez crisis and in support of the UK's Central Treaty Organisation membership), Malaysia (during the Indonesian Confrontation), and Belize in the 1970s. After the introduction of the Rapiet SHORAD missile, the Regiment's presence in West Germany and Belize continued, and further commitments emerged, such as the provision of GBAD in the Falkland Islands after the 1982 conflict and the defence of USAF bases in the UK. Meanwhile, over three decades, the RAF also operated the Bloodhound medium-range SAM system to defend bases in the UK, Malaysia, Cyprus and West Germany. Nevertheless, from a post-war high point in the 1980s, RAF GBAD entered a terminal decline after the Cold War until there was literally nothing left.

While the approach here is chronological, several major themes recur throughout. The first is the concept of integrated air defence. Integrated air defence is a force multiplier: properly integrated and under centralised command, an air defence system can produce a capability greater than the sum of its individual parts. RAF air defence doctrine focused on the integration of air defence capabilities from the outset, and GBAD was incorporated into this integrated system, which also included command, control and communications, warning and tracking, fighter defences and passive air defence measures. Airfield anti-aircraft defence involved the integration of a ground-based combat capability into the air environment and not merely the ad hoc engagement of hostile aircraft.

Doctrinal acceptance of its contribution to an Integrated Air Defence System (IADS) also elevated the status of GBAD in the RAF and helped to ensure the maintenance of a world-leading capability until the very point that it was withdrawn. As late as 2002, the Ministry of Defence (MOD) Directorate of Operational Capability characterised the RAF Regiment as the exemplars of UK best practice in the GBAD sphere.⁷ This means that the airfield air defence story

would be incomplete and impossible to understand if it was considered in isolation from the broader history of air defence.

A second major theme is air superiority. This was especially the key to airfield defence in the Second World War. Against an adversary holding the advantage in the air, there were limits to what GBAD could reasonably be expected to achieve. However, in the context of a favourable air situation or outright air superiority, GBAD could operate in conjunction with other air defences to deliver a potent contribution. Typically, in history, a paucity of GBAD for airfields has only become particularly problematic in campaigns or theatres where air superiority and other air defence capabilities, such as radar warning and tracking, have been absent. A failure in one sphere of air defence usually implies failure in others.

The third theme is deterrence. All active air defences, including airfield defences, function primarily as deterrents. If deployed capabilities are not actually used in anger, it does not mean that the resources allocated to them have been wasted. Rather, their deterrent effect may well have helped to dissuade adversaries from offensive action. If anything, deterrence should be viewed as the primary air defence objective, with actual testing of the defences being a secondary and less desirable alternative. It has always been difficult to measure deterrent effect and the resources necessary to achieve deterrence scientifically, but of one thing we may be sure: if there is no air defence capability at all, there will be no deterrence.

In air defence, deterrence can function at the operational and tactical levels. Operational deterrence by GBAD could mean its contribution to an adversary's decision not to mount an air operation or campaign; tactical deterrence could mean influencing enemy air attack profiles or flying altitudes rather than physical interception, making it harder to execute accurate strikes. This is all too easily forgotten or misunderstood, even by gunners frustrated about their inability to hit high-flying aircraft.

After the revival of UK air power doctrine in the 1990s, one leading RAF publication described GBAD in the following terms:

Ground Based Air Defence in the form of Surface to Air Weapons Systems (SAWS) includes surface-to-air missiles (SAMs) and anti-aircraft artillery (AAA). Medium and long-range SAMs are used for area defence whilst the term SHORAD is used to describe SAMs and AAA used for short range air defence. All ground-based systems are integrated into the area air defence network and contribute to the overall defence counter-air campaign. However, short-range systems providing point defence for an air base can be regarded as an essential

element of the STO (Survive to Operate) capability of that airbase.⁸

This was a principle that endured in the RAF for six decades. It lives on in the continuing commitment of joint doctrine to layered and integrated air defence, but the gulf between doctrinal theory and practical capability has rarely been so wide.

Notes (unless stated, all sources are held at the Air Historical Branch)

1. Alan J. Vick and Mark Ashby, *Winning the Battle of the Airfields: 70 Years of RAND Analysis on Air Base Defense and Attack*, RAND Corporation (Santa Monica, 2021).
2. Draft Air Historical Branch (AHB) narrative, *Ground Defence* (Box 210).
3. Kingsley Oliver's *Through Adversity: The History of the Royal Air Force Regiment, 1942-1992* (Forces & Corporate, Rushden, 1997), drew extensively on the draft AHB narrative, *Ground Defence*.
4. Colin Dobinson, *AA Command: Britain's Anti-Aircraft Defences of the Second World War* (Methuen, London, 2001); Edward B. Westermann, *Flak: German Anti-Aircraft Defenses, 1914-1945* (University of Kansas, 2001); Kenneth P. Werrell, Archie, *Flak, AAA, and SAM: A Short Operational History of Ground-Based Air Defence* (Air University Press, Maxwell Air Force Base, Alabama, 1988).
5. Notably the proceedings of the Royal Air Force Historical Society, recorded in Journals 15 (1995), 62 (2016), and 67 (2018).
6. John F. Kreiss, *Air Warfare and Air Base Air Defense 1914-1973* (Office of US Air Force History, Washington DC, 1988), p. 18.
7. CAS 3/23 Pt C, Ministry of Defence Directorate of Operational Capability, Operational Audit 01/02, *Air Defence*, 25 June 2002.
8. Air Warfare Centre, *Royal Air Force Air Operations* (first edition, 1996), 7.II.I.

1. North-West Europe, 1933-1942

In the inter-war years, UK air defence was the subject of a striking paradox. In strategic air defence, the UK led the world. The rudimentary air defence system generated in the First World War to combat Zeppelin and Gotha raids on southern England gradually evolved in the 1920s and early 1930s so that the RAF had addressed many of the challenges involved in the creation of an IADS even before the appearance of radar and fast monoplane fighters after 1935. Senior RAF officers who had served in the First World War retained at least some experience of airfield attack and defence, which, coupled with their respect for the Luftwaffe, caused them to revisit the issues involved at an early stage of rearmament in the 1930s, while passive air defence measures such as camouflage, on-base dispersal, and protective buildings like air-raid shelters featured with increasing prominence in airfield construction plans later in the decade.¹ As the RAF expanded, the number of bases multiplied to create a widely dispersed airfield infrastructure, and in 1937 the Air Ministry began planning satellite airfields to provide back-up for Service bases in wartime. Sometimes, civil airfields could be used, but many purpose-built satellites were also built.²

By the summer of 1940, under RAF Fighter Command, the UK IADS incorporated radar and other warning and tracking capabilities such as Wireless Interception ('Y') and the Observer Corps, which between them substantially reduced the scope for aircraft attacking the British mainland to achieve tactical surprise. Front-line squadrons had been equipped with two of the best interceptor fighters in the world and, combined with early warning, fighter control provided the means to employ squadrons economically against incoming air raids; there was no longer a need to maintain constant standing patrols over areas that were not directly threatened.

Beyond this, however, Fighter Command presented a scattered primary target array backed up by satellite airfields and complicated by the presence of military airfields that were not fighter bases. The Command's victory in the Battle of Britain occurred partly because of its capacity to fight and partly because it could sustain operations while under attack, but it also resulted from the dispersal and dissipation of the Luftwaffe's bombing effort across a multiplicity of air-related sites.

Yet if a combination of advanced strategic and passive air defence measures ultimately protected Fighter Command in 1940, it could not be claimed that they operated alongside equally capable active GBAD, and in no military sphere was this deficiency more pronounced than in airfield anti-aircraft gunnery. In the late

1920s and early 1930s, the Army's Anti-Aircraft Corps was a part of the UK air defence system, then known as Air Defence Great Britain, and it remained within Fighter Command after it was formed in 1936 under Air Chief Marshal Sir Hugh Dowding – a former Royal Artillery officer. This arrangement continued when the Corps became a Command in 1938, the RAF and the Army acknowledging the importance of integrating air defence capabilities and of constructing a single, layered air defence system. Yet the AA formations were primarily tasked with strategic air defence employing heavy guns and were woefully under-resourced. At the beginning of rearmament, their Order of Battle amounted to 17 batteries of eight guns each – 136 in total.³

The RAF and the Army viewed the provision of active GBAD for airfields as an entirely separate issue. In November 1933, they agreed that the RAF should be responsible for the defence of airfields against attack by low-flying aircraft, but hardly any suitable weapons were available at that time. The acute scarcity of AAA left the RAF with nothing more than .303-inch machine guns, which were of obsolete First World War vintage, until Vickers 'K' guns were replaced on aircraft by Brownings, making the K guns available for AA duties. The Army meanwhile began re-equipping the Royal Artillery with 40mm Bofors guns, which could fire at 120 rounds per minute and reliably engage aircraft up to 12,500 feet, but their high cost at first ruled out an equivalent RAF acquisition for airfield defence.⁴ It was in these circumstances that the Deputy Director of Plans at the Air Ministry committed the ultimate heresy by proposing a reduced purchase of aircraft to fund the procurement of Bofors guns. 'It's better to start the war with 800 bombers operating from reasonably secure bases than with 1,000 bombers, of whom perhaps more than half will be unable to operate because their aerodromes have been put out of action.'⁵

As the perceived threat from Germany grew and rearmament gathered pace, the Services were obliged to reconsider the allocation of responsibility for airfield defence. In 1935, they agreed on an Army role that involved area defence and the reinforcement of RAF airfields in an emergency, including the provision of AA guns to protect airfields located beyond the established AAA defence zones. However, given the desperately limited availability of AA weapons and the scope of the Army's strategic air defence commitments, their capacity to fulfil this undertaking was always doubtful. Meanwhile, the Services reaffirmed the RAF's responsibility for the defence of airfields against low-level air attack – a task they were still to discharge using machine guns and their own personnel trained as ground gunners.

The prevailing lack of confidence in these arrangements served as a major stimulus to the development of passive air defences,⁶ and Dowding later went so far as to describe dispersal as ‘the main safeguard for aircraft against air attack’.

Some experiments on Salisbury Plain in the Summer of 1938 had shown that dispersal alone, without any form of splinter-proof protection, afforded a reasonable safeguard against the forms of attack practised by our own Bomber Command at the time. Thirty unserviceable fighters were disposed in a rough ring of about 1,000 yards diameter, and Bomber Command attacked them for inside of a week with every missile between a 500-pound bomb and an incendiary bullet, and without any kind of opposition. The result was substantially: 3 destroyed, 1 damaged beyond repair, 11 seriously damaged but repairable, and the rest slightly damaged or untouched.⁷

These results persuaded him to ask for small splinter-proof pens for single aircraft to be built at fighter airfields. At a time when he was already urging the construction of all-weather runways, this went too far, but the Air Ministry did agree to the provision of pens for groups of three aircraft; these were eventually subdivided by splinter-proof partitions.⁸

In 1937, the Air Council ruled that Air Officers Commanding-in-Chief (AOCs-in-C) were responsible for ‘the defence of Royal Air Force aerodromes and other Air Force establishments against low-flying air attacks, and for local defence against attack by land forces’. For this purpose, flying stations would be issued with up to eight Vickers or Lewis .303 machine guns for AA defence – a hopelessly inadequate allocation.⁹ By January 1939, 406 primary or satellite RAF stations had been scaled for up to eight machine guns each, but only 124 of these were positioned inside the Army’s AAA defence zones. A meagre supply of two-pounder or First World War 3-inch guns had to be rationed between the remaining airfields and the Field Army for heavier AA protection. A new and far more capable 3.7-inch gun had appeared in prototype form in 1936, but hardly any were available for airfield defence on the outbreak of war in September.¹⁰

On 1 September 1939, Germany invaded Poland and initiated the Second World War. That day, the Luftwaffe struck nine of the Polish Air Force’s main airfields and 19 secondary air bases. The Polish Air Force was only saved by timely dispersal to a series of airfields that did not feature on the Luftwaffe’s target list.¹¹ The ten squadrons of the RAF’s Advanced Air Striking Force (AASF) first echelon subsequently deployed to France and were allocated 84 Lewis guns for

anti-aircraft defence, but some of these were inoperable and it was necessary to obtain temporary replacements from the French until the supply of British guns improved. Positioned outside the British Expeditionary Force's (BEF) area of responsibility, the ten airfields of the AASF were entirely dependent on the French for airfield AAA.

The Air Component of the Field Force (ACFF) deployed next. Located in the BEF area, the ACFF airfields could count on some general protection from the Royal Artillery but also relied heavily on the French for local AA defence. Subsequent pressure from the French high command for the transfer of their guns to undefended Armée de l'Air airfields led the British Army to form 12 Anti-Aircraft Brigade to defend eight AASF airfields. At first, the brigade was entirely equipped with 3-inch guns; no LAA guns such as Bofors were available.¹²

The personnel situation was no less problematic. To operate the machine guns in France, the RAF assembled 300 airmen from remote stations in the UK. The first hundred deployed on 27 September without kit, arms, pay books, and, most of all, training. Only one man, formally a member of the Territorial Army, had any experience with machine guns. A second group of 135 equally deficient personnel arrived on 13 October, at which point the Commander of the AASF, Air Vice-Marshal Patrick Playfair, referred the problem to the Air Council's Air Member for Personnel, citing the case of a reservist who, having suffered a recent dental extraction, arrived without teeth!¹³ Both these drafts were distributed across the AASF stations, where they received their gunnery training on an improvised basis. In November, the RAF established 1 Ground Defence Gunners School at North Coates, and the first reinforcements crossed the channel in the following month.¹⁴

During the winter, Headquarters British Air Forces France (BAFF) urged the provision of more AAA for airfield defence in the AASF area. In February 1940, the Army promised to send out a battery of 3.7-inch guns and two batteries of Bofors guns – 24 guns. The heavy anti-aircraft (HAA) battery deployed on the 16th, but only a single Bofors battery appeared in April. The remaining weapons were diverted elsewhere.¹⁵

By 10 May, when the German offensive against France and the Low Countries began, the total gun provision to defend the AASF airfields and other sites amounted to the single 3.7-inch battery, 40 3-inch guns and 12 Bofors guns. Additionally, there were some 244 machine guns. The ACFF derived at least some protection from the more general AAA defence of the BEF area and from formations specifically detailed to the protection of airfields. The latter were equipped with 32 heavy guns and 36 light guns; 190 machine guns were also deployed to provide AA defence at ACFF facilities.¹⁶

Only the 3.7-inch and Bofors 40mm guns offered an effective capability against modern aircraft, the 3-inch guns providing a limited capability up to medium altitude. Of the machine guns, the AASF Ground Defence officer wrote in March that the existing equipment included 'every conceivable kind of mounting, yoke and tripods ... The sights provided ranged from the Lewis 100 mph ring site to various types of front-gun sights as used in the last war.' About 70 per cent of the Lewis guns supplied were of the air pattern, depending for cooling on being in a slipstream.¹⁷

There were also, of course, other air defences, such as the RAF and Armée de l'Air fighter forces, but they were outnumbered and substantially outclassed. Moreover, the development of radar-based integrated air defences on the continent began too late and did not produce a functional system by May. In the absence of effective radar warning and tracking and the purpose-built command and communications system that sustained the UK IADS, it was impossible to integrate air defence capabilities across northern France and the Low Countries.¹⁸ The subsequent despatch of the AOC-in-C, British Air Forces in France, reads:

The defence of Component aerodromes was integral with the general air defence organisation of the BEF^a Area and was dealt with directly by GHQ. For the AASF area, the 12th AA Brigade with two Heavy AA Regiments [a total of six batteries by May 1940], one Light AA Battery and one searchlight Battalion was placed under the command of the AOC. My recommendations are on record asking for increases, particularly in light units, and although the AASF Squadrons did not suffer unduly during the German offensive from air attack, I still consider their defences were dangerously weak.¹⁹

The Luftwaffe had already demonstrated in Poland that, in accordance with their doctrine, airfields would be their primary target at the beginning of an offensive campaign.²⁰ In the event, ten RAF airfields came under air attack on 10 May, along with 45 French and eight Belgian airfields. The Belgian Air Force was largely destroyed; otherwise, the main factor that reduced the effectiveness of these initial strikes was the multiplicity of targets: the Luftwaffe bombing effort was so widely dispersed that only a few airfields sustained major damage. However, on the following day, one of these was an RAF base. At Condé-Vraux, a force of Do. 17s eliminated 114 Squadron from operations before they had even

a. BEF – British Expeditionary Force.

begun, destroying six Blenheims and damaging the remainder. This represented half the AASF's medium bomber force.²¹ Ground defences consisting of just 16 Lewis guns claimed eight German aircraft shot down, but this was probably an exaggeration.²²

As the German campaign developed, their bombing effort shifted towards support for the ground offensive, but the airfield attacks continued at varying degrees of intensity until the British withdrawal. The AOC-in-C afterwards praised the arrangement whereby 12 AA Brigade had been placed under his command despite their lack of resources. More broadly, he concluded:

A reasonable measure of camouflage and dispersion coupled with good light AA defence may be expected to render low flying attack against aerodromes unprofitable ... Aerodrome defence must therefore include adequate 40mm and light AA weapons on mobile mountings, and constant attention must be given to dispersion ... Damage to hangars and aerodrome surfaces by high altitude attack may in certain circumstances become a serious menace, and the answers lie in adequate fighter and heavy AA defence. A further effective precaution is the development of sufficient alternative landing grounds.²³

The Air Ministry meanwhile established a Directorate of Ground Defence under Air Commodore APM Sanders in recognition of the fact that airfield defence required a level of expert and specialist attention and resourcing that had not been forthcoming in the past. The new directorate was to coordinate plans and issue instructions on ground defence relating to all RAF stations in the UK, and was also responsible for liaison with the other Services and with government departments on airfield defence matters, and for questions relating to passive air defence in so far as it concerned the RAF.²⁴ It was increasingly clear that the RAF could not rely for airfield defence on an Army that was itself severely overstretched by operational pressures. In June, a meeting between the Director of Ground Defence and the Air Ministry's Directorate of Organisation highlighted the multiplicity of problems that stemmed from the ad hoc transfer of airmen, many from the technical trades, to base defence duties. The meeting concluded that each airfield should have an established defence unit consisting of suitably trained personnel.



A Royal Artillery 3-inch HAA gun in the airfield defence role in France in December 1939.



Aircraft recognition was fundamental to AA defence: here, King George VI is shown a recognition chart in France in 1939.



A Royal Air Force AA gunner equipped with a Lewis gun at an airfield in France during the harsh 1939-1940 winter.



A bombed-out hangar and wrecked Fairey Battle bombers at Mourmelon-le-Grand airfield after a heavy German attack on 14 May 1940.



A Spitfire of 222 Squadron destroyed during a Luftwaffe raid on RAF Hornchurch on 31 August 1940.



Typical of Fighter Command airfield AA defences during the Battle of Britain: a twin Lewis gun; this position was at Tangmere.

The establishment of the RAF Station Defence Force was announced on 16 June 1940. While Army detachments were to remain at airfields and all personnel were to assist in defence, established RAF defence units would now be located on every site. These were to be formed from personnel already committed to the task and strengthened by reinforcements. Some 6,000 recruits were to be given two weeks disciplinary training at No. 3 School of Technical Training, Blackpool, and some 5,000 aircrew awaiting training volunteered to serve on airfield defence duties as a temporary measure.

The 16 June announcement also defined the strength of the various airfield defence elements. The AA machine gun crews were to consist of one corporal and three gunners per gun.²⁵ At each airfield, the Station Commander retained ultimate responsibility for ground defence, but he was to be assisted by Station Defence Officers. By September, some 800 had been appointed, many of whom had previously served in the Army. More senior Army officers were also appointed as Local Defence Commanders at 112 RAF stations and 13 Royal Navy air stations. They were responsible to Station Commanders for preparing airfield defence plans and co-ordinating them with wider military activity.²⁶

Meanwhile, in July, a joint study by Major-General GBO Taylor (Director of Fortifications)(Army) and the Director of Ground Defence (RAF) made a series of further recommendations for improving airfield defence. Of these, the most notable was the proposal to establish a single ground defence organisation under the Army *or* the RAF. However, while the so-called Taylor Report's findings were accepted in principle by both Services, the General Staff believed strongly that airfield defence was an Army duty and expressed an aspiration to generate a force of some 60,000 personnel to provide one company per airfield. The RAF, for its part, correctly doubted that this was a realistic goal, and the Air Council subsequently set up a departmental committee to consider the formation of an RAF ground defence corps. For the time being, the system of dual responsibility continued.²⁷

The completion of many new airfields in the first half of 1940 confronted the RAF with yet another difficult dilemma. On one hand, backup and dispersal options increased considerably, and the proliferation of bases promised to complicate adversary targeting of the most important sites. On the other, individual base defence requirements exacerbated the pressure on GBAD provisions – both guns and gunners. Eventually, it was only possible to pay Paul by robbing Peter. Responding to pressure from the AOC-in-C Bomber Command for more protection, Dowding allegedly replied 'Certainly, if you will state another of your stations which I can deprive of its AA defence.'²⁸

During the Battle of Britain, some 3,000 RAF gunners equipped with machine guns provided anti-aircraft defence at 365 airfields; they also deployed 376 20mm Hispano cannons designed for use in aircraft. The Army provided anti-aircraft guns for 139 airfields, although many were the outdated 2-pounders or 3-inch guns rather than Bofors or 3.7-inch weapons, and some of the deployed Bofors guns were equipped with primitive forward area sights rather than electrically operated predictors, which were far more effective.²⁹ As we have seen, some RAF airfields were also sited within AAA defence zones protecting urban areas or industrial installations.

The most intensive phase of the Battle began on 13 August, when the Luftwaffe launched an all-out offensive against the RAF in southern England, and RAF airfields remained the primary German target until the end of the first week of September: they were subjected to nearly 300 raids. German bombers frequently penetrated the RAF's fighter defences to reach the aerodromes and caused extensive damage to operating surfaces, infrastructure, support facilities and command nodes, but aircraft losses on the ground were relatively light. AA fire often reduced the accuracy of German bombing and helped to break up larger formations into smaller groups that were more vulnerable to airborne interception, and shell bursts helped guide RAF fighters towards the raiders. Nevertheless, airfield AA gun crews claimed just 15 aircraft destroyed and six damaged during the Battle out of a German total of just under 2,000 aircraft destroyed.

Between 12 and 24 August, Manston was subjected to eight Luftwaffe raids, six of which were opposed by GBAD. On 14 August, a formation of Me. 110s was heavily engaged by the ground defences and two aircraft were shot down, one by Royal Artillery Bofors fire and one by RAF Hispano guns. During the attack on the 24th, another aircraft was destroyed by ground fire. On 18 August, Biggin Hill was attacked by 30 aircraft, one of which was brought down by the AA defences; six more raids followed in August, but no more aircraft were downed by AA guns until 5 September, when a single Condor was destroyed. On 11 September, a lone Ju. 88 was driven off by AA fire before it could deliver an attack.

West Malling was targeted even more frequently: the airfield was struck 21 times between 10 August and 31 October. AA fire destroyed one He. 111 on 16 August and two Ju. 88s on the 18th, and successfully turned away raiders on 11 September and 7 and 13 October. Another Ju. 88 was destroyed during an attack on Hawkinge on 15 August.³⁰

At Kenley, single Do. 17 was destroyed by the Parachute and Cable (PAC) rocket and cable system, whereby a linear arrangement of rockets, to which light steel cables were attached, was electronically discharged on the approach of hostile aircraft. The rocket ascended to a height of 500 to 600 feet, where a

parachute attached to the cable deployed and thus suspended the cable long enough for a curtain to be aligned before the approaching aircraft.³¹

There were many acts of extreme bravery. At RAF Detling, Corporal Bruce Jackman continued firing his twin Lewis guns at attacking aircraft until his gun position was demolished by a bomb and he was severely wounded; he was awarded the Military Medal. At Biggin Hill, Sergeant Robert Cunningham engaged three enemy aircraft using a dismounted machine gun from an armoured car.³² Yet the remarkable courage and determination exhibited by these personnel – and many others – could not make up for the prevailing limitations of capability and tactical doctrine,³³ and Dowding also highlighted combat identification problems that are of long-term historical significance. Earlier in the year, an Aircraft Recognition Wing had been established to train Anti-Aircraft Command gunners at RAF Biggin Hill,³⁴ and they were continually warned not to engage friendly aircraft; yet this resulted in ‘some instances of late engagement or failure to engage’.

In some cases, had the standard of training been higher to enable the earlier recognition of a machine as ‘hostile beyond reasonable doubt’, the number of machines destroyed would have increased.³⁵

Estimates of the total number of aircraft downed by AA fire during the Battle of Britain range between 220 and 300.³⁶ Far more were intercepted by RAF fighters. Yet Dowding still felt that GBAD had played an important part in the British victory. His ‘outstanding lesson learnt’ from the Battle was ‘the soundness and suitability of the organisation and arrangements of the control and direction of the anti-aircraft defences’ – the IADS. GBAD had been an integral part of this organisation. ‘The way in which the activities of the anti-aircraft [guns] linked in and were capable of co-ordination with the major partners in the venture – RAF Fighter Command, No. 11 Fighter Group, and sector commands – is perhaps worthy of special note.’³⁷ Among other things, the system also provided the means to warn airfield and other AA gunners of incoming raids. The air picture generated from radar plots, Observer Corps reports and other intelligence sources could be exploited to improve situational awareness at even the lowest tactical levels.

By March 1941, it was clear that the Army would not be able to raise sufficient troop numbers to cover the UK airfield defence task without significant RAF support on a permanent basis. In April, the RAF decided to turn the station defence units into numbered squadrons and flights, each squadron to comprise an AA Flight and several Rifle Flights.³⁸ This strategy was still in the early stages of

implementation when the Germans captured Crete, their airborne forces primarily targeting the island's airfields. Subsequently, the Chiefs of Staff set up a committee under Sir Findlater Stewart to consider how airfield defence could be improved. After reporting on the broader issues in June and July 1941, the committee was tasked to investigate the vexed question of inter-Service responsibilities for airfield defence. Even at this stage, the Air Ministry was openly pressing for the formation of a special corps of RAF airfield defence guards, and the committee's deliberations were chiefly focused on the implications of this proposal. A formal Air Council paper on the subject was submitted to the committee on 2 October. In November, it proposed that the RAF should generate its own aerodrome defence corps, and both the Chiefs of Staff and the Cabinet subsequently approved this recommendation.³⁹

The Royal Air Force Regiment was duly created on 1 February 1942. During a debate in Parliament on 8 January, the Deputy Prime Minister, Clement Attlee, described the operational importance of airfields and airfield defence, and the difficulties that had arisen because of divided command responsibilities.

The RAF Ground staff are ... under the control of the Station Commander as are also all the material resources of the aerodrome, and the Station Commander is himself under the command of his RAF superiors. If the regular garrison of the aerodrome is made up of Regular soldiers under the control of the military authorities, there will be divided responsibility with all its attendant dangers ... As a majority of Royal Air Force personnel on aerodromes is to have personal weapons and to take part in its (*sic*) defence, it is right that the regular garrison should be composed, not as now of soldiers under the control of the military authorities, but of personnel forming part of the Royal Air Force.⁴⁰

The Secretary of State for Air, Sir Archibald Sinclair, elaborated on Attlee's statement two weeks later:

Our object has been to banish divided responsibility for ground defence from our aerodromes ... We require a hard core of specialised troops, a force small in number compared with the total number of fighting men on the station, but highly trained, and equipped with a variety of special weapons. If the Army were to raise, train and organise this comparatively small force,

divided responsibility on the station for the ground defence of the aerodrome would remain. The formation of the Royal Air Force Regiment, on the other hand, will ensure that the defenders of an aerodrome will belong to one Service, and it will bring into operation a direct chain of responsibility from the Air Council, through the Royal Air Force command and group, down to the station commander, for the efficiency of the garrison on any Royal Air Force Station.⁴¹

Air Ministry Order N. 221/1942 stated that existing airfield defence squadrons and flights were to be reorganised, expanded, re-equipped and incorporated into the RAF Regiment with effect from 1 February 1942.⁴² No 1 Ground Defence Gunners School was transformed into 3 RAF Regiment School in May 1942, which included, among other things, a dedicated Aircraft Recognition Wing. This was in turn replaced by the Central School of Aircraft Recognition in September.⁴³ In October, the AA flights were withdrawn from the squadrons and established on an independent basis. Each RAF Regiment AA flight consisted of one officer, 60 airmen and 12 Hispano cannon.⁴⁴

A total RAF Regiment strength of more than 100,000 personnel was originally proposed, but manpower constraints, the declining threat of invasion or air attack, and prioritisation in the allocation of resources to airfields still deemed vulnerable caused this figure to be reduced to 75,000 in October 1942, of which 22,000 would have been AA gunners at airfields and other RAF facilities. Subsequently, the ceiling was reduced to 55,000 and then 50,000. By January 1943, the need for further manpower economies and the reduced likelihood of invasion led to the RAF Regiment in the UK being substantially focused on LAA defence. The AA flights were then reorganised into squadrons.⁴⁵

Notes

1. AHB monograph, *The Second World War, 1939-1945, Royal Air Force, Works* (Air Ministry, 1956), pp. 81, 203, 239.
2. AHB narrative, *The Expansion of the Royal Air Force, 1934-1939*, pp. 147-148.
3. Kreis, *Air Warfare and Air Base Air Defense*, p. 43.

4. Oliver, *Through Adversity*, pp. 14-16; the Bofors' maximum range was considerably higher but its practical maximum was 12,500 feet.
5. Oliver, *Through Adversity*, p. 17.
6. Ibid., p. 18.
7. *The Battle of Britain*, despatch by Air Chief Marshal Sir Hugh Dowding, 20 August 1941, published in the *London Gazette*, 11 September 1946, para 151.
8. Dowding despatch, para 152.
9. *The Royal Air Force Regiment: A Short History* (RAF Regiment Fund, Dorking, 1982), p. 11. The reader should note that several editions of this volume have been published and that page numbering has changed significantly over time. The numbering used here applies to the 1982 edition only.
10. Oliver, *Through Adversity*, p. 21. The 3-inch gun had an effective ceiling of 16,000 feet; the Mk III 3.7-inch gun had an effective ceiling that ranged from 23,500 feet to 32,000 feet, depending on the predictor and fuze employed; Werrell, *Archie, Flak, AAA, and SAM*, p. 4.
11. Kreis, *Air Warfare and Air Base Air Defense*, p. 56.
12. AHB, *Ground Defence*, Chapter 2, pp. 1-4. The 12 AA Brigade elements initially assigned to airfield defence were 157, 158 and 159 Batteries of 53 HAA Regiment and 209 and 311 Batteries of 73 HAA Regiment.
13. AHB, *Ground Defence*, Chapter 2, p. 4.
14. *Short History*, p. 14.
15. AHB, *Ground Defence*, Chapter 2, p. 10.
16. Ibid., p. 12.
17. AHB narrative, *The Campaign in France and the Low Countries, September 1939-June 1940*, p. 109.

18. Ibid., pp. 103-105, 108.
19. *British Air Forces, France*, despatch by Air Marshal Sir Arthur Barratt, July 1940, para 152.
20. Major William F. Andrews, 'The Luftwaffe and the Battle for Air Superiority: Blueprint or Warning,' *Air Power Journal*, Fall 1995, p. 2.
21. AHB, *The Campaign in France and the Low Countries*, p. 200.
22. Over-claiming was common among anti-aircraft gunners and was encountered in most theatres and operations covered by this study. In some cases, official AHB historians working in the immediate post-war period were able to check Allied claims against German loss records.
23. Barratt despatch, para 154.
24. Oliver, *Through Adversity*, p. 29; AHB, *Ground Defence*, Chapter 2, pp. 38-39.
25. AHB, *Ground Defence*, Chapter 2, pp. 45-48.
26. Ibid., pp. 47-48, 50-52.
27. Ibid., pp. 57-61.
28. Ibid., p. 41. Anti-Aircraft Command came under Fighter Command, which fared considerably better. Gun allocations were partly based on geographical considerations that did not favour Bomber Command, and the opening of many new Bomber Command stations made matters worse.
29. *Short History*. p. 15; Dowding despatch, Appendix C, 4 (i).
30. AHB, *Ground Defence*, Chapter 2, pp. 53-55.
31. AHB narrative, *The Air Defence of Great Britain, Vol II, The Battle of Britain*, pp. 19, 200.

32. Kingsley Oliver, *The RAF Regiment at War* (Leo Cooper, Barnsley, 2002), p. 5.
33. *Short History*, p. 15.
34. Tim Hamilton, *Identification Friend or Foe, being the Story of Aircraft Recognition* (HMSO, London, 1994), p. 84.
35. Dowding despatch, Appendix C, 9(e).
36. *Ibid.*, Appendix C, 7, gives a figure of 221.
37. *Ibid.*, Appendix C, 9(a).
38. AHB, *Ground Defence*, Chapter 2, pp. 66, 72-74.
39. *Ibid.*, pp. 77-78, 80, 83, 85-87, 91-92.
40. *Hansard*, Vol 377, War Situation, debated on 8 January 1942, statement by Clement Atlee.
41. *Hansard*, Vol 377, Aerodromes (Defence), debated on 22 January 1942, statement by Sir Archibald Sinclair.
42. *Short History*, p. 16.
43. Historical Notes, Central School of Aircraft Recognition (AHB Box 230).
44. AHB, *Ground Defence*, Chapter 5, pp. 15-16.
45. *Ibid.*, pp. 18, 26-28, 30.

2. Malta

After the Battle of Britain, the most immediate threat to RAF airfields developed in Malta – a valued Mediterranean colonial possession, island harbour and staging post, but with a strategic significance undetermined during the first year of the war. By the late 1930s, it was clear that the fundamental starting point for creating an effective air defence system was radar, and the RAF duly deployed radar to Malta in 1939 in recognition of its proximity to Italy, the threat of air attack from Sicily (just 80km away) and the vulnerability of its harbour and military facilities.¹

During 1940, after Italy entered the war on Germany's side, high-level deliberations continued over Malta's position in British strategy. While the British government and the Chiefs of Staff accepted the island's value as a maritime and air staging post, proposals for mounting bombing raids against Italy from Maltese airfields proved more controversial. The problem was simple: strikes on Italian targets seemed certain to result in large-scale retaliation. In the summer, the Air Ministry's Directorate of Plans proposed launching air strikes from Malta but only if the island was equipped 'with strong defences'.² When Italy declared war, Malta's fighter defences consisted of just four Gladiator biplanes, while the two Royal Artillery anti-aircraft batteries operated a total of only 14 guns. It is therefore not surprising that the Chiefs of Staff rejected the idea of attacking Italy from Malta – a decision supported by the AOC-in-C of Middle East Command, the Air Commander on Malta and the island governor.³ At a time when the UK was under sustained air attack and threatened with invasion, there was no realistic prospect of sending many bombers, fighters and AA guns to the island, and only a trickle of reinforcements arrived in the second half of the year.⁴

Yet the Chiefs' calculations were overturned by the outbreak of hostilities between Italy and Greece in October. To assist the Greeks, they decreed that Malta be used as a base for bombing missions by RAF Wellingtons against Italian targets. This did not immediately result in retaliatory strikes of the scale anticipated, although the island's four airfields and its harbour facilities were regularly targeted by the Regia Aeronautica in the later months of 1940.⁵ However, when Sicily-based Luftwaffe operations against British shipping brought a defiant counterstroke by the Wellingtons against the Axis airfields on 12 January 1941, the German response was only too predictable. A force of some 80 Ju. 87s and Ju. 88s with Italian CR42 escorts attacked the aerodromes at Luqa and Hal Far, causing severe damage, destroying six parked aircraft (a Wellington, a Hurricane, and four Swordfish) and disabling others.⁶

After Malta's capacity to disrupt Axis shipping movements to North Africa was also revealed, its airfields were subjected to sustained and frequently heavy Axis bombing, which extended throughout the first half of 1941 and from December to April 1942. The British responded by developing possibly the most extensive network of active and passive airfield defences on historical record (relative to the small surface area of defended territory) and the role of anti-aircraft guns in the defence of Malta must be considered in this context. As in the UK, they were part of an integrated air defence system. After the outbreak of war, the AOC Malta actually requested a copy of Fighter Command's Battle Orders as a basis on which to organise the combined operations of fighters, AAA and radar.⁷

Again, the island's air defences were placed under the Air Commander and integrated through a centralised command and control structure. At first, this was substantially improvised, but purpose-built underground facilities were established during 1941 and further improved over time.⁸ Initially, radar coverage was provided by two Transportable Radio Units (TRUs) – early deployable systems based on the same technology that underpinned the UK Chain Home (CH) system – while construction began on a permanent Chain Overseas (CO) facility.^{9b} The TRUs were 'floodlight' systems that scanned outwards. Sited at Fort Dingly, one of Malta's highest points, they functioned effectively against aircraft operating at medium-to-higher altitudes. They were augmented by an Army Gun Laying (GL) system, which was activated as soon as incoming radar plots were detected. The GL set was tasked to track contacts that had passed beyond the coverage of the outward-looking RAF radars. A GL plotting board was installed in the main Air Operations Room to allow radar and GL plotting information to be combined.¹⁰

The original TRU installations were augmented by the low-altitude capability of Chain Overseas Low (COL) at the end of 1940, and additional improvements followed. These provisions functioned effectively against Italian day raids (which usually consisted of formations of bombers escorted by fighters and flying at around 20,000 feet), daylight reconnaissance missions and night raids of single aircraft or a succession of single aircraft operating at about 10,000 feet. They proved less capable against single very high-flying Luftwaffe raiders – usually Ju. 88s – several of which exploited the limitations of RAF radar coverage in the early months of 1941 to reach the island undetected or before fighter interception could be orchestrated. After one attack that caused both casualties and damage, the Army

b. 'Radio', in the context of a TRU, meant radar. TRUs were 'transportable' in that they could be sent from the UK to overseas theatres, but they were not 'mobile'; they were not intended for frequent relocation within theatre.

increased their GL coverage to help warn of aircraft that had evaded radar detection.

By the beginning of 1942, the radar facilities at Fort Dingli had been upgraded to a full CO standard.^c There were also three COL stations on Malta, and a TRU numbered 314 had been positioned at Qawra Point in the far north. This could provide a double-check on tracks identified from Fort Dingli, but the two stations also collaborated in the interception of enemy raids, the CO station being used to track friendly fighters while the TRU concentrated on hostile contacts. For night air defence, a Ground-Control Intercept (GCI) station had been deployed by 1942, and extensive searchlight defences were organised into six areas. Every searchlight was connected by telephone to its Area Headquarters, and the Area HQs were in turn connected to the higher operations facilities.¹¹

Augmenting radar-based early warning was a limited but valuable communications intelligence or 'Y' capability. During the most desperate period of the 1942 siege, a series of limited improvements to Malta's 'Y' Service brought substantial operational benefits. Among other things, they established the routine of the Comiso-based KG 77, from the take-off of the bombers and their fighter escorts to their outward passage across the coast of Sicily, to their flying altitude. On occasion, Y passed incoming raid intelligence (including detailed tactical instructions) to the Air Operations Room forty minutes before the first warnings were received from radar.¹²

In parallel, Malta's ground-based air defences were steadily augmented. In mid-1941, in addition to the island's HAA guns, the position at each airfield was as follows:

	Light machine guns, low-flying attack primary role.	Light machine guns. Low-flying secondary role.	<u>Bofors</u>	3-inch guns
<u>Luqa</u>	31	11	8	2
Hal Far	33	Nil	7	Nil
Ta Kali	31	9	8	4
Safi	16	Nil	4	Nil

c. The CO station consisted of 242 TRU with a new MB2 transmitter and RF7 receiver; the old transportable equipment was maintained on a standby basis, in case of problems with the CO systems.

Plans were in hand to move more Bofors guns from the docks to the airfields, and the AOC Malta had agreed with his Army counterpart that all the airfield machine guns should be operated by Army personnel as there were not nearly enough airmen available.¹³

By 1942, Malta's AAA defences comprised one HAA brigade with 112 guns and one light anti-aircraft (LAA) brigade with 156 guns, as well as the machine guns that provided a final line of airfield defence against low-level raiders. With careful distribution of the heavy guns to protect military facilities that were substantially concentrated in a limited area to the east, it was possible to achieve an HAA gun density of 80, which was five times the figure recommended by the main Royal Artillery training manuals for Vulnerable Points (VPs) at that time. At an altitude of 16,000ft, coverage of 60 to 80 guns extended across Luqa airfield, part of the adjacent satellite strip at Safi and part of Takali; equivalent coverage for Hal Far and the remainder of Takali was 40 to 60 guns.¹⁴ The LAA Brigade numbered four regiments and 13 batteries, each with 12 Bofors guns. Each of the three main airfields was assigned one battery for low-level local defence, the guns of which were distributed around the perimeter within 200 to 300 metres of the airfield boundary. The other LAA batteries were deployed in defence of VPs.¹⁵

Deconfliction between the fighters and AAA was a significant challenge. Until the summer of 1942, due to a range of warning, control and communications factors, airborne interception was predominantly attempted over Malta.¹⁶ For much of 1941, HAA fire was directed into geographically defined boxes, well clear of the fighters, and the combination of radar and GL provided the means to initiate predicted barrages.¹⁷ GLII, which gave the distance, bearing, speed of approach and elevation of enemy aircraft, later allowed designated layered air zones to be targeted. Under the Air Commander's supervision, other zones might then be assigned to fighters and bombers, integrated command and control being exercised across the various force elements.¹⁸ As one Royal Artillery officer remarked, 'Co-ordination between the Royal Air Force and Anti-Aircraft Artillery was essential and we maintained it to a paramount degree.'¹⁹

In terms of 'hard' kills, the guns were not very effective. Analysis for the period 15 December 1941 to 20 April 1942 concluded that HAA guns had expended 2,904 rounds per aircraft destroyed, while LAA had expended 1,817.²⁰ Yet while these calculations accurately recorded the number of rounds fired, they substantially overestimated Axis losses. Total 'confirmed' claims for the AAA in this period amounted to 241 aircraft destroyed, with April 1942 alone accounting

for 102 German aircraft.^d This was more than double the number – 45 – actually shot down in that month, according to German records, and some of the Luftwaffe's combat losses were inflicted by RAF fighters. The Germans managed to establish the cause of their combat losses on 29 occasions: fighters shot down 16 of their aircraft while AAA destroyed 13.²¹ In short, the AAA on Malta fired even less accurately than the wartime analysis suggested. On the other hand, in terms of 'soft' kills, it was a very different story before the arrival of Luftflotte 2 on Sicily at the end of 1941. As one Royal Artillery officer later wrote of the guns:

Not many planes were destroyed by them, as can well be imagined, but the island was saved an immense tonnage of bombs being dropped on it by the fact that we discovered that the Italian bombers would drop their bombs as soon as they saw the flashes of the guns. It was not long, therefore, before we decided to open fire on them when they were still out of range and, in consequence, the majority of Italian bombs fell harmlessly into the sea.²²

Even in January 1942, when Luftflotte 2 began their onslaught against Malta, the guns functioned as a persuasive deterrent. The official RAF narrative records:

A feature of these January attacks was the number of raiders which appeared off the island, both by day and night, and, without pressing home their attacks against their objectives, dropped their bombs in the sea. Sometimes, out of five alerts, as many as four would prove abortive in this way.²³

This was 'due in large measure to the lethal appearance of the AA barrage as they approached the island'.²⁴ The barrage reduced the accuracy of Axis bombing over Malta, as it did over Britain in 1940, and deterred low-level attacks. Few raids were executed without significant interference from HAA at higher altitudes, and from Bofors, cannon and machine guns lower down. One of the best known general historical surveys of GBAD concluded of its role in Malta: 'This action was probably the most important contribution that Allied ground-based anti-aircraft made to the war effort.'²⁵

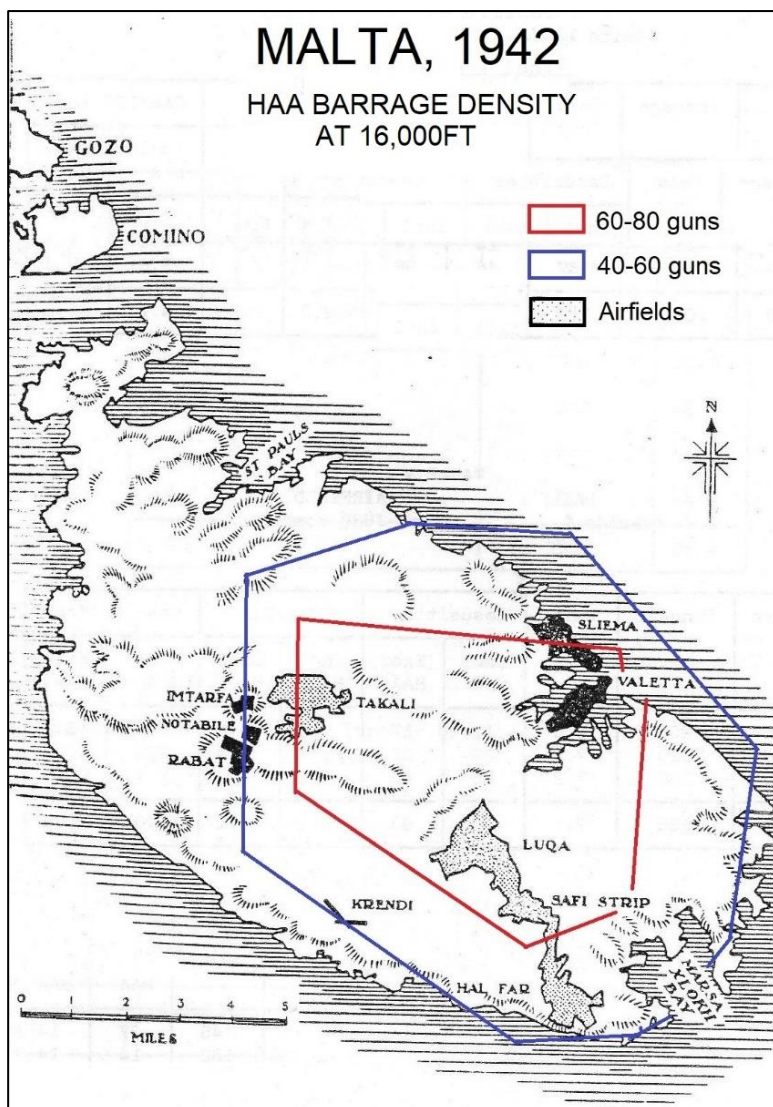
d. All AA and fighter claims in this period involved German aircraft – Ju. 88s, Ju. 87s and Me. 109s. The Italians played little part in the Axis air offensive against Malta in the early months of 1942.



A Royal Artillery Bofors gun and crew; the RAF depended on the Army for heavy and light AAA during the siege of Malta.



As in France and Britain, light machine guns were deployed for airfield AA defence on a significant scale.



The density of the Malta HAA barrage covering the airfields in 1942; the guns did not shoot down many aircraft but they exerted a considerable deterrent effect.

It is nevertheless important not to underestimate the difficulties that confronted those responsible for Malta's air defence in 1941 and 1942. The development of radar-based fighter control was hampered by limited command facilities and by radar and communications capability issues. Manning levels were inadequate for many months, and personnel with experience of radar reporting and fighter control were in particularly short supply. And then there were geographical factors – the harsh realities of defending the airspace over a small island against a numerically superior adversary, and the close proximity of the Axis bases. Moreover, the need to transmit incoming raid information had to be balanced against the danger that the enemy might intercept R/T communications revealing the capability and limitations of radar. Command and control architecture, manning levels and capabilities improved over time, but key vulnerabilities remained when the Germans renewed large-scale operations against the island in January 1942.²⁶

Realistically, in the circumstances of the early war years, active air defences were never likely to eliminate the Axis threat to Malta's airfields. Passive air defences were thus critically important. The island was too small to offer more than the most limited scope for airfield dispersal, but the potential gains provided by on-airfield dispersal had already been demonstrated during the Battle of Britain, and this became one of the primary goals of Air Vice-Marshal (later Air Marshal Sir) Hugh Lloyd, when he was appointed AOC Malta in May 1941.

By June, it was possible to disperse all aircraft based on Malta away from their main airfield facilities and runways, and from one airfield to another, but far more robust protection was nevertheless required, primarily in the form of individual aircraft pens protected by blast walls and revetments. When the RAF's Inspector General, Air Chief Marshal Sir Edgar Ludlow-Hewitt, reported on the island's defences in July, he noted that runways at the satellite aerodrome of Safi were complete, and that those of another satellite, Krendi, were developing rapidly. Most remarkable, however, was the amount of work being devoted to the provision of dispersal standings and inter-linking taxi tracks at the three main airfields. He found aircraft 'well dispersed at a considerable distance from the airfields ... The construction of pens was going ahead well.'²⁷

The Safi strip lay between Luqa and Hal Far. One of the first major construction projects involved linking the two main airfields by extending their taxiways north and south through Safi, as well as lining the taxiways with dispersal points. Ultimately, across the three main airfields and the two satellites, some 43 miles of taxiway were brought into service connecting more than 350 protected pens and a total of 600 dispersal points.²⁸

The task was completed in conditions of almost unimaginable difficulty by a military (chiefly Army) and civilian labour force equipped with very little heavy

or automatic plant and only the most rudimentary hand tools and materials. Environmental conditions were challenging in both the summer and winter, and it became increasingly difficult to feed the army of labourers as the Axis blockade reduced supplies to the island to minimal levels. Frequent air attacks interrupted construction work, and urgent bomb damage repair requirements constantly diverted the labour force. Nevertheless, as Lloyd put it,

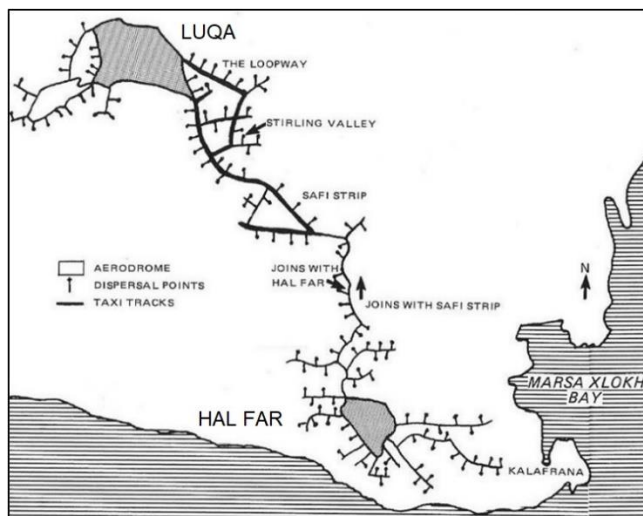
In a period of six months, the area in which the aircraft were dispersed had been increased ninefold. The three compact Axis targets had been replaced by something resembling a huge sprawling octopus with three nodal points, where aeroplanes were to be seen only when taking off and on landing.²⁹

Passive air defence extended further into the field of tactical deception. Carefully arranged damaged and decoy aircraft attracted considerable attention from the Axis raiders at the Safi satellite airfield and elsewhere, and the Krendi strip was equipped with decoy airfield lighting and served as a so-called 'Q' site to draw night raids away from Luqa. Radio messages intercepted by the Germans confused their understanding of the battlespace by issuing control instructions to entirely bogus RAF fighter formations.³⁰

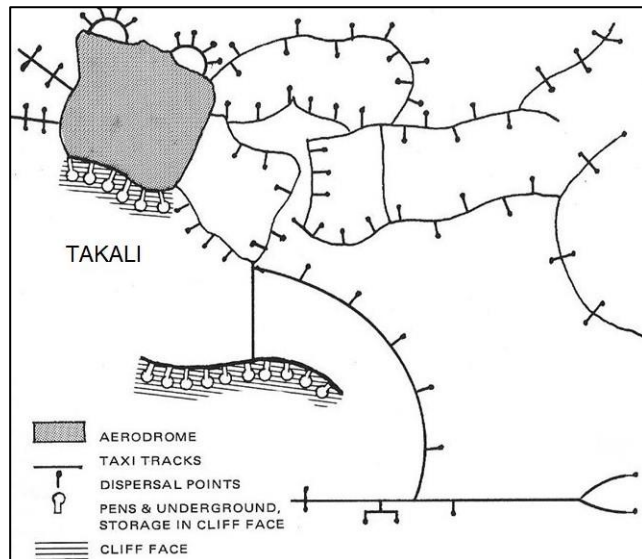
Through their incorporation into an integrated system, Malta's air defences, including GBAD, substantially reduced the advantage that mere scale might otherwise have conferred on the Axis air forces. Acknowledged experts in air defence fully appreciated this at the time. For example, Air Commodore TW (later Air Marshal Sir Thomas) Elmhirst, a veteran of the 11 Group Operations Room in the Battle of Britain, visited Malta after the first Axis offensive in 1941 and subsequently recorded:

Perhaps the main lesson to be learnt is that a very small force of fighters and bombers well handled with a strong A.A. defence can defend a limited objective and defeat an attacking force, even of German aircraft nearly eight times its size.³¹

It is true that, as in the Battle of Britain, the German failure over Malta stemmed partly from their inability to select and maintain operational aims, yet this may also have reflected the capability of British active and passive defences to some extent. In the spring of 1942, in order of importance, Kesselring's target priorities for the air offensive against Malta were:



The track and dispersal pen network ran from Luqa, through Safi, to Hal Far.



The tracks and dispersal points at Takali.



Protective aircraft pens under construction at Takali; they were built entirely by hand using a variety of materials, including locally quarried limestone blocks.



An Italian Macchi C205 fighter shot down over Malta in 1942.



German air reconnaissance image of RAF bombers bombed at Luqa:
destroyed aircraft are at (1) and (2), (3) and (4) are empty pens,
(5) and (6) are Vickers Wellingtons.

1. Anti-aircraft artillery
2. Airfields and aircraft
3. Naval targets and the dockyards³²

In fact, the Axis air forces failed to adhere to any fixed list of scientifically devised priorities. As one Italian report noted afterwards, ‘the three phases corresponding to the various categories of objectives, were non-existent in practice.’³³

In the critical month of April 1942, the British estimated that a greater bomb tonnage was dropped on the dockyard area than on all four main airfields combined, and noted that further significant efforts had been expended against a range of other targets, most of which were non-military.³⁴ While the Axis plan provided for a degree of targeting flexibility, it seems unlikely that their preference for attacking a single large, urban target on Malta’s north coast rather than the sprawling and dispersed inland and southern airfields was entirely unrelated to calculations of the difficulties and risks involved. The commander of Luftflotte 2, Field Marshal Albert Kesselring, wrote later that ‘The concentration of powerful British anti-aircraft defences on the shores supported by naval AA guns protecting the harbour, put up a barrier of fire to be penetrated only by stout hearts and at the loss of many aircraft.’³⁵

Ultimately, there was no single solution to Malta’s plight. The island’s defence hinged on the deployment of more and better fighters in the form of Spitfires, and on the development of interception tactics that enabled optimal exploitation of the available warning and control capabilities. As this implied the interception of incoming raids beyond Malta’s coast, it coincidentally simplified spatial deconfliction between the fighters and the AAA.³⁶

Meanwhile, although the first Spitfires reached Malta in March, the Axis achieved their aim of preventing the island from functioning as an air and naval base for a brief period in April. On occasion, it was impossible to launch any fighters against incoming bomber formations, and Malta was left entirely dependent on GBAD. On 20 April, the first of some 46 Spitfires transported by the American aircraft carrier USS Wasp landed on Malta. Within 90 minutes of the first landings and before the Spitfires were ready for action, the Luftwaffe launched extremely destructive raids on Takali and Luqa. By the 23rd, the AOC Malta could signal the AOC Middle East in the following (abbreviated) terms:

Both places a complete shambles in spite of soldiers working day and night. Have made every effort to get Spitfires off the ground ... All Spitfires in pens widely dispersed, some with

complete cover^e from blast, other with pens and blast walls. In spite of this, nine destroyed on ground direct hits, twenty-nine damaged splintered rocks. Owing to heavy fighter escorts our battle casualties eight Spitfires destroyed and 75% remainder damaged in combat. In addition usual defects which affect serviceability, landing and take-offs fraught with danger owing to bomb-holes and debris. Army filling holes night and day. Shortage rollers and mechanised equipment. All big bomb holes one hundred tons to fill. Dispersal tracks often blocked. Airmen work all day and in shifts throughout night. Eight Wellingtons very well dispersed over wide area and in pens. Dive-bombers make for them ... Cannot do more to protect Wellingtons or Spitfires.³⁷

And yet, over the entire month, the Axis air forces only achieved this by mounting more sorties than their total from January to March – 11,819 sorties, of which 9,599 were flown by the Luftwaffe. The Germans increased the size of their bomber force in Sicily by 31 per cent and the serviceability of their bombers from 54 per cent to 72.5 per cent – presumably through a substantially enlarged logistical effort. This provided the means to improve bomber utilisation, which did not exceed ten sorties per aircraft per month from January to March but jumped to 22.5 sorties in April. Fighter utilisation also increased from 18.4 sorties per aircraft per month to 28 per aircraft per month.³⁸ As these figures are based on total strength rather than serviceable strength, and there was no recorded increase in fighter serviceability rates in the same period, in practice the Germans must have resorted to mounting more than one sortie per aircraft per day with part of their fighter fleet.

In modern parlance, this would be referred to as a surge, and, in the context of pressing demands for air support from other battlefronts, it was not sustainable. The first Luftwaffe units were withdrawn from Sicily before the end of April, and there were further substantial departures throughout May. On the 10th, Kesselring reported that his task was complete, and the Axis air offensive was reduced to relatively small-scale raiding. Nevertheless, on the previous day, repairs to Malta's airfields had allowed the Allies to deploy 60 more Spitfires to the island from the USS Wasp and HMS Eagle. After their arrival, these aircraft were brought to operational readiness in just 35 minutes. Each was met by a runner and directed to

e. 'Complete cover' in this context apparently meant that they were in roofed pens or shelters.

a dispersal pen. Each pen had a supply of petrol, oil, glycol, and ammunition; a team of armourers, fitters and electricians was ready and waiting, and a replacement pilot was also on hand. As soon as the necessary servicing, arming and refuelling was completed, the aircraft could be scrambled. The entire effort was sustained across the widely scattered network of protective pens using Army transport and communications. The Luftwaffe still responded in strength but to far less effect than in April.³⁹ More Spitfires arrived in the second half of May, and during June, and the RAF also resumed offensive operations from Malta. When the Axis mounted further large-scale strikes on the airfields in July and October, they proved prohibitively expensive and were soon called off.⁴⁰

In the wartime history of airfield GBAD, Malta may ultimately rank as a success story, but the anti-aircraft artillery was part of an integrated system with multiple elements. Where poor organisation, lack of resources or sheer ignorance prevented the establishment of truly integrated air defence, airfields remained attractive and extremely vulnerable targets. After the first major blitz against Malta in the early months of 1941, and their occupation of the Greek mainland, the Germans turned their attention to Crete. British and Commonwealth forces were confronted by the task of defending the main air bases at Heraklion and Maleme, a third strip at Rethymnon, and the naval base at Suda Bay. Again, they set out to construct an IADS based on primitive mobile radars, a small fighter presence and a scattering of AA defences, coordinated via rudimentary operations rooms; a Greek observer contingent reported over civilian telephone lines.⁴¹ Such limited provisions were never likely to represent a serious threat to the Luftwaffe, but detailed forewarning of the impending attack and intelligent deployment of the available AAA allowed heavy losses to be inflicted on the Germans before they gained the upper hand.⁴² The scale of their casualties helped to persuade Hitler not to launch a similar airborne operation against Malta.⁴³

Next, it was the Soviet Union's turn. The German invasion on 22 June 1941 was accompanied by a Luftwaffe onslaught against the most important Red Air Force bases, which were concentrated close to the frontier. Lacking radar and with minimal anti-aircraft artillery or passive air defence measures, the Soviets were desperately vulnerable, and their own historians subsequently admitted to the destruction of 800 aircraft on the ground. The German claim was 1,489.⁴⁴

Notes

1. AHB narrative, *The Middle East Campaigns, Vol XI, Malta, June 1940 to May 1945*, pp. 20-21.
2. Ibid., pp. 30-31.
3. Ibid., pp. 52-53.
4. Ibid., p. 33.
5. Denis Richards and Hilary St George Saunders, *The Royal Air Force, 1939-1945, Vol I, The Fight at Odds* (HMSO, London, 1974), p. 263.
6. AHB, *The Middle East Campaigns, Vol XI*, p. 72, Appendix XV.
7. AHB narrative, *The Middle East Campaigns, Vol III, Operations in Libya and the Western Desert (including Malta), 21 January 1942 to 30 June 1942*, Appendix XXIII.
8. Air Marshal Sir Hugh Lloyd, *Briefed to Attack: Malta's Part in African Victory* (Hodder & Stoughton, London, 1949), p. 68.
9. AHB monograph, *The Second World War, 1939-1945, Royal Air Force, Signals, Vol IV, Radar in Raid Reporting* (Air Ministry, 1950), p. 157.
10. UK National Archives (TNA) AIR 24/908, RAF Mediterranean Command, Operational Intelligence Summary, Period Covering Second Four Months of War, 11 October 1940 to 10 February 1941, Appendix D and E; report on a visit by Group Captain JA Tester to Malta, 18 to 22 October 1942 (AHB Box 471).
11. AHB, *Radar in Raid Reporting*, pp. 165, 166, 167, 186; AHB, *The Middle East Campaigns, Malta*, p. 170.
12. AHB, *The Middle East Campaigns, Vol XI*, pp. 315-316.
13. AOC Malta to CAS, 20 June 1941 (AHB Box 471).

14. Brigadier AL Pemberton, *The Second World War 1939-1945, Army, The Development of Artillery Tactics and Equipment* (War Office, 1950), p. 131 and Map 3, Malta HAA barrage density at 16,000 feet.
15. Operational Research Branch, HQ Strike Command, Note for the Record 7/88, *Battle Casualties from Air Bombing of Malta Airfield in 1942*, Annex B (AHB Box 474).
16. AHB, *The Middle East Campaigns, Vol III*, Appendix XXIII.
17. TNA AIR 24/908, RAF Mediterranean Command, Operational Intelligence Summary, Period Covering Second Four Months of War, 11 October 1940 to 10 February 1941, Appendix E.
18. Kreis, *Air Warfare and Air Base Air Defense*, p.126.
19. Philip Vella, *Malta: Blitzed but not Beaten* (National War Museum Association, Valetta, 1985), p. 104.
20. Vella, *Malta*, p. 233, Appendix K.
21. AHB, *The Middle East Campaigns, Vol XI*, p. 331.
22. Lieutenant Colonel HEC Weldon, *Drama in Malta: A Personal Flash-Back* (Pickle Publishing, 2016, Kindle Edition), location 963 of 2399.
23. AHB, *The Middle East Campaigns, Vol XI*, p. 265.
24. Ibid.
25. Kenneth P. Werrell, *Archie to SAM: A Short Operational History of Ground-Based Air Defense* (Air University Press, Maxwell Air Force Base, Alabama, 2005), second edition, p. 11.
26. AHB, *Middle East Campaigns, Vol III*, Appendix XXIII.
27. AHB, *Middle East Campaigns, Vol XI*, p. 148.

28. Lloyd, *Briefed to Attack*, pp. 149, 176.
29. Ibid., pp. 63-64.
30. Ibid., pp. 166-168.
31. AHB, *Middle East Campaigns, Vol XI*, p. 85.
32. Ibid., p. 328, citing Field Marshal Kesselring, *The War in the Mediterranean*, AHB6 Translation VII/106.
33. AHB, *Middle East Campaigns, Vol XI*, p. 328.
34. Ibid., pp. 327-328. 'Significant efforts' defined as a total bomb tonnage greater than that released against any single airfield.
35. Field-Marshal Albert Kesselring, *The Memoirs of Field-Marshal Kesselring* (William Kimber, London, 1953), p. 122.
36. AHB, *Middle East Campaigns, Vol III*, Appendix XXIII.
37. AHB, *Middle East Campaigns, Vol XI*, p. 344.
38. Ibid. Calculated from data on p. 360 and appendices XVII, XIX, XXI and XXIII.
39. AHB, *Middle East Campaigns, Vol XI*, pp. 368-370.
40. Ibid., pp. 423-426, 487, 488.
41. AHB narrative, *The Campaign in Crete, 1941*, p. 16; AHB, *Radar in Raid Reporting*, pp. 170-172; Pemberton, *Artillery Tactics and Equipment*, pp. 70-71.
42. Werrell, *Archie to SAM* (second edition), p. 10.
43. AHB, *Middle East Campaigns, Vol XI*, p. 354.
44. Kreis, *Air Warfare and Air Base Air Defense*, pp. 177-181.

3. Malaya

By the summer of 1941, the Luftwaffe had established a clear and predictable operational pattern. Their campaigns typically prioritised airfield attack as a precursor to winning air superiority and employing air power in support of ground forces. Over the UK and the Mediterranean, they were confronted by an adversary that fully grasped the importance of integrated air defence, even if, at first, there were not enough resources to ensure the defence of air bases and other key targets. However, it subsequently proved impossible for the British to exploit the key lessons of the European air war after the outbreak of hostilities with Japan in the Far East in December.

Many of their difficulties lay in the vexed sphere of command and control. Between the wars, the RAF's case for air primacy in the defence of Malaya and Singapore was rejected by the other Services in favour of a more conventional land-based defence strategy that assumed any attack on the island would be made from the sea and dismissed the possibility of an enemy ground offensive from the north through the dense Malayan jungle. It was only in 1940 that these assumptions were revised to attach far greater importance to the defence of Malaya and, within its defence, the role of air power. Yet the measures to be implemented in support of this strategy were the subject of entrenched inter-Service arguments and misunderstandings.¹ The other key problems lay in the logistical sphere. At a time when British and supporting Commonwealth forces were under intense pressure in Europe and the Middle East, commanders in Singapore struggled to secure virtually every resource needed for their defensive preparations.

RAF planning for the defence of Malaya and Singapore was founded on the creation of a force of 336 aircraft and base facilities that would allow at least two thirds of this number to operate from northern or southern Malaya,² but only 178 operational aircraft were available in theatre on 7 December 1941. The day fighter squadrons were entirely equipped with Brewster Buffalos, which were inferior to the Oscars of the Japanese Army Air Service and were heavily outnumbered. Of the 27 airfields constructed in Malaya by that date, just nine were occupied, and the others merely served as defensive liabilities.³

On the ground, responsibility for airfield defence lay overwhelmingly with the Army, but consultation between the two Services on siting and construction issues was wholly inadequate for many months and only improved in the spring of 1941 following the replacement of the senior RAF and Army officers in theatre.⁴ Partly for this reason, most of the airfields in northern Malaya and on the east coast were in tactically weak or exposed positions. Their location was also influenced by the

availability of construction labour, the proximity of communications and the need to base aircraft as close to the eastern coast as possible to maximise their operational range.⁵ To the west, the Army's efforts were divided between the RAF's airfields and defence of the main communications artery – the most likely route of a Japanese offensive.⁶

Air defence provisions improved somewhat during the second half of 1941. AAA deployments were increased on Singapore and provided general cover for the island aerodromes (Tengah, Seletar, Sembawang and Kallang). However, the HAA batteries were primarily sited to protect Singapore city and the naval base rather than the airfields. Similarly, while Bofors guns were positioned at multiple locations, the airfield defence allocation amounted to just eight guns at Seletar. Of the heavy weapons, about one third were First World War 3-inch guns.⁷

Otherwise, such anti-aircraft defences as were deployed at Malayan airfields barely provided any effective protection. Whereas the Commander-in-Chief, Far East, had directed that each airfield should have eight heavy and eight LAA guns, in no instance was this scaling achieved, and some airfields had no AA defences at all. Moreover, only manually operated height-finding and fire-control equipment was available in Malaya, and many of the Indian troops deployed there were inexperienced, poorly trained and poorly led.⁸ Passive air defence measures were also unevenly spread across the Malayan bases, the construction of dispersed or protective facilities depending much on the supply of labour, plant and materials.⁹

Other key air defence elements were similarly lacking. Of 20 stations planned for the radar chain, only six had been built by December 1941 and 5 were operational. Radar coverage was almost entirely restricted to Singapore.¹⁰ The Observer Corps came under the Army until July 1941 and was designed to provide a civil air raid warning system rather than military early warning or tracking. Subsequently, while Observer Corps operations rooms were established in Kuala Lumpur and Singapore, hardly any time remained to train personnel, and there was a substantial gap in coverage in central Malaya, where the rugged mountain and jungle terrain prevented the deployment of observation posts.¹¹

Communications between Singapore and Malaya were poor, and fighter control was greatly restricted by the absence of VHF radio. A fighter Group Operations Room was only completed and manned at Kallang (Singapore) in December 1941, and there was no opportunity for training or exercises with fighter squadrons before the Japanese invasion.¹²



Malaya, illustrating the limited completion of radar facilities by December 1941.

Japanese airfield attacks began under cover of darkness in the early hours of the morning on 8 December. The first raid, which included strikes on Kallang, Seletar and Tengah (as well as other targets in Singapore) was plotted on radar, but active defence was assigned entirely to the AAA because the gunners and key elements within the air defence command and control chain had no knowledge, training or experience of co-ordinated night AA and fighter interception. The guns were deemed to pose an excessive risk to friendly aircraft.

Yet the far more effective raids occurred against the main air bases in northern Malaya. Machang and Gong Kedah were the first to be targeted that morning, and two Hudson bombers were severely damaged in a series of low-level fighter attacks on Kota Bahru, which continued throughout the day. At Sungei Patani, despite a brief advance warning and the presence of several 3.7-inch AA guns, the Buffalo fighters of 21 Squadron, Royal Australian Air Force (RAAF) were caught lined up by a stand-by hut when Japanese bombers appeared overhead; a Blenheim night-fighter unit, 27 Squadron, was airborne. Bombs hit the station headquarters and a petrol dump, and seven aircraft were damaged, four of which were set on fire. A second raid at 1100 caught 27 Squadron after its return to base. The two attacks left only four aircraft from each squadron in a serviceable condition, and they were subsequently evacuated to Butterworth.¹³

Butterworth was meanwhile being used as a forward arming and refuelling point for the Blenheims of 34 Squadron, which had been sent out from Tengah to bomb the Japanese landing area at Kota Bahru. Their first flight was still awaiting fuel when the second arrived, swiftly followed by 15 enemy fighters that were never seriously threatened by a ground-based AA defence comprising nothing more than light machine guns. Ultimately, five Blenheims were damaged or destroyed and only two were left operational.¹⁴ The remnants of 21 Squadron and 27 Squadron then began to arrive from Sungei Patani and came under further attack; by the end of the day, only two of the remaining Buffalos and three Blenheim night-fighters remained operational.¹⁵

Alor Star suffered a similar fate. There, the Blenheims of 62 Squadron were rearming and refuelling when the airfield was bombed by 27 aircraft from 13,000ft; four Blenheims were destroyed and five damaged, while airfield buildings and a fuel dump also fell victim to the Japanese bombers. A heavy AAA defence comprising four 3-inch guns proved completely ineffective against modern, high-flying aircraft.¹⁶ The official narrative describes these attacks as ‘nothing short of disastrous’ for the RAF in Malaya, and there is no reason to dispute this assessment. The total number of operational aircraft in northern Malaya on 8 December 1941 was 110. By the end of the day, only 50 were still available; 51 had been destroyed or severely disabled on the ground.¹⁷

On the following day, the attacks continued. A mixed force of 62 and 34 Squadron aircraft was about to take off from Butterworth when a combined Japanese formation of bombers and fighters appeared. All the RAF aircraft were damaged or destroyed except for the Blenheim of Squadron Leader Arthur Scarf, who mounted his mission alone and, although mortally wounded, returned his crew safely via a forced landing near Alor Star. He was posthumously awarded the Victoria Cross. No AAA reached Butterworth until the end of the afternoon, when eight Bofors guns arrived at the station. At Kuantan, where AAA remained entirely absent, another Japanese raid inflicted further aircraft losses and resulted in the evacuation of the resident squadrons to Singapore. Butterworth was vacated on the 10th.¹⁸ More withdrawals inevitably followed, as Japanese ground forces advanced south.¹⁹

Subsequently, the Japanese used much of their air power to support the ground offensive in Malaya, but the airfield attacks resumed at the end of December. They targeted Kluang in central Malaya on the 29th but then turned their attention to Singapore. Thereafter, near continuous raids progressively degraded airfield infrastructure, support provisions and the RAF's operational strength throughout January 1942. Presumably with the deliberate aim of destroying the RAF's offensive capability, the Japanese mounted more raids against the bomber base, Tengah, than the other three airfields combined.²⁰

Sometimes, the AAA was effective. In the initial raid on Kluang, a newly arrived battery broke up the attacking Japanese formation, and another group of aircraft then expended considerable efforts against a nearby decoy airfield.²¹ On 21 January, the gunners claimed to have shot down nine Japanese aircraft during one of the many strikes on Tengah.²² More broadly, low and medium-level fire from the Bofors and 3-inch guns helped to push the Japanese raiders up to higher altitudes than they had employed in earlier attacks, where they were less vulnerable but also less able to bomb accurately.²³

Yet the AA fire itself was often inaccurate,²⁴ and other elements of the air defence system were unable to fill the vacuum. Radar did not provide sufficient warning of approaching trouble from the north to allow the RAF's Buffalos to scramble and climb to intercept altitude before hostile aircraft formations reached Singapore, and there were not enough fighters or pilots to mount standing patrols. Deficient communications continued to hamper command and control.²⁵ The Hurricanes sent out to reinforce Singapore's fighter defences were invariably outnumbered and were outclassed by the best Japanese fighters, and Japanese air combat tactics often accentuated their advantage.²⁶

Supply chain problems abounded. A consignment of VHF radios and supporting equipment, which would have substantially enhanced fighter control,

disappeared without trace en route from the UK. The Hurricanes, originally destined for the Middle East, were famously fitted with desert oil filters that reduced their performance, and they were dispatched with inadequate spare parts and tools.²⁷ A battery of the 5th Battalion, 16th Heavy Anti-Aircraft Regiment, received four new 3.7-inch guns but no accompanying height-finding equipment. It transpired that the height-finder pedestals had been sent to the Middle East in error, and there were no replacements.²⁸

By the end of January, the RAF's position in Singapore had become untenable, and the majority of aircraft were evacuated to Palembang, Sumatra, early in February after the Japanese advance brought three of the four airfields under artillery fire.²⁹ Only a handful of fighters remained to operate from Kallang, but, by the 7th, the airfield had been hit by so many bombs that, in the words of one squadron commander, it 'resembled a sieve'. Singapore's fighter defence ended two days later, when eight Hurricanes scrambled to intercept a Japanese formation of 84 bombers and fighters. The few surviving Hurricanes followed the other British aircraft to Palembang.³⁰

They did not receive a long respite. The Japanese air attacks soon switched to the main P1 airfield at Palembang, where multiple strikes between 6 and 13 February destroyed or damaged numerous aircraft on the ground.³¹ The fall of Sumatra soon afterwards brought a further RAF evacuation to Java, but the airfield attacks began once again on the 19th: six Hudsons were destroyed at an undefended strip at Semplak.³² Less than two weeks later, the Japanese landings on Java brought resistance on the island to an end.

Air Vice-Marshal PC Maltby, who was unfortunate enough to assume command of RAF forces in theatre in February 1942, finally prepared his report on operations in Malaya after his liberation from Japanese custody in 1945. He wrote that the RAF was 'driven out' of Malaya and that 'the Army had to fight ... without any air support, and to face an enemy whose air support was constant and strong.'³³ This was a direct result of the insecurity of the mainland airfields.

There were neither the fighter aircraft, nor sufficient AA defences, nor an effective early warning system to ensure their defence against air attack. The enemy could, and did, destroy our aircraft on the ground in N. Malaya almost at will, and our aerodromes there were evacuated in a matter of days.³⁴



Brewster Buffalo fighters over Sembawang, Singapore,
in November 1941.



RAF Regiment gunners with a 20mm Hispano light anti-aircraft
gun at Tabingaung airfield, Burma, later in the war; in the
background is a Spitfire VIII of 155 Squadron.

The Japanese did not stop targeting airfields in March 1942. On the contrary, towards the end of the month, they evicted the RAF from Magwe airfield in Burma, inflicting heavy losses in the process, and then turned their attention to Akyab. It was finally evacuated on 4 May.³⁵ Airfields were again the primary Japanese target during the first Arakan campaign from March to May 1943.

Meanwhile, however, the RAF's theatre presence was substantially reconstructed from bases, logistical and training facilities in India, including an RAF Regiment Training Centre at Secunderabad, which was expanded into an RAF Regiment Depot for training, equipping and forming squadrons and flights. By June 1943, 17 AA flights had been formed, and a further 33 had been established by the end of the year.³⁶ Meanwhile, air defence provisions were developed on the same multi-layered principles that characterised the UK IADS: primarily, these were radar-based early warning and fighter control, enlarged fighter defences equipped with better aircraft (notably Spitfires from November 1943), and expanded AA deployments that soon included the RAF Regiment for airfield defence. Augmenting the role of the defences by 1944 was an offensive counter-air campaign that targeted air bases so successfully that the Japanese were forced to withdraw their aircraft to rear locations from where it was difficult to operate over forward areas in strength.³⁷

By the spring of 1944, air superiority had passed decisively to the Allies. During the siege of Imphal between March and June, Japanese air power hit back against the air strips used to sustain the Allied ground presence, but with results that could hardly have differed more fundamentally from those achieved in the first months of hostilities. In the words of the official RAF narrative:

It has been estimated that some 45 or more enemy aircraft were probably shot down by our fighters during the siege while something like 60 were damaged. To these totals should be joined the claims of the anti-aircraft units, including the RAF Regiment detachments, on the plain; they amounted to about 40 enemy aircraft probably destroyed and 19 damaged ... None of our airfields was unserviceable after raids by the enemy for more than two or three hours. We lost nine fighter aircraft over the area, the pilots of four being saved.³⁸

The Air Commander South-East Asia, Air Chief Marshal Sir Keith Park, wrote of the subsequent Allied advance that the RAF's capacity to operate combat and transport aircraft at newly captured airfields close to the front line was critically important. Once again, it quickly became apparent 'that forward airfields, radar

sites and other force installations would not necessarily be guarded if their locations did not happen to fit into the tactical scheme adopted by the local army formation.’

Unless the air forces were to withdraw everything to a safe distance behind the front lines, they would themselves have to provide the necessary defence force.³⁹

Notes

1. AHB narrative, *The Campaigns in the Far East, Vol I, Far East Defence Policy and Preparations for War*, pp. 25-28.
2. Ibid., p. 32.
3. Ibid., p. 40, note 2.
4. Ibid., p. 40. Air Vice-Marshal JT Babington was replaced as AOC Far East Air Force by Air Vice-Marshal CWH Pulford, while Lieutenant-General Arthur Percival took over as GOC Malaya Command from Lieutenant-General Sir Lionel Bond.
5. Operations in Malaya and NEI, 8 December 1941 – 12 March 1942, Report by Air Vice-Marshal PC Maltby, para 126 (AHB, Siracourt archive).
6. Ibid., para 127.
7. Ibid., paras 124 and 315; Kreis, *Air Warfare and Air Base Air Defense*, pp. 104, 109.
8. Kreis, *Air Warfare and Air Base Air Defense*, p. 97.
9. AHB, *Campaigns in the Far East, Vol I*, pp. 40-41.
10. Ibid., pp. 41-42.
11. Ibid., p. 41.

12. Ibid., p. 42.

13. AHB narrative, *The Campaigns in the Far East, Vol II, Malaya, Netherlands East Indies and Burma*, pp. 17-18.

14. Ibid., p. 18.

15. Ibid., p. 19.

16. Ibid., p. 19.

17. Ibid., p. 21.

18. Ibid., pp. 26-31.

19. Ibid., pp. 58-62.

20. Ibid., pp. 78, 99-105, 116-119.

21. Ibid., p. 78.

22. Ibid., p. 117. The claim was probably exaggerated, but at least some aircraft must have been intercepted.

23. Maltby report, para 315.

24. AHB, *Campaigns in the Far East, Vol II*, p. 99.

25. Ibid., pp. 103-104.

26. Ibid., p. 117, Appendix I, p. 3.

27. Ibid., pp. 103, 117.

28. Kreis, *Air Warfare and Air Base Air Defense*, p. 109.

29. AHB, *Campaigns in the Far East, Vol II*, pp. 118-119.

30. Ibid., pp. 130-131.
31. Ibid., p. 140.
32. Ibid., p. 150.
33. Maltby report, paras 633 and 634.
34. Ibid., para 662.
35. AHB, *Campaigns in the Far East, Vol II*, pp. 197-208.
36. AHB, *Ground Defence*, unnumbered chapter entitled *Ground Defence and the RAF Regiment in India and South East Asia, 1942-1945*, pp. 14-15.
37. AHB narrative, *The Campaigns in the Far East, Vol IV, Southeast Asia, November 1943-October 1944*, pp. 72-76, 90-91.
38. Ibid., p. 89.
39. AHB, *Ground Defence*, unnumbered chapter, *Ground Defence and the RAF Regiment in India and South East Asia, 1942-1945*, extract from despatch on Air Operations, June 44 – May 45, by Air Chief Marshal Sir Keith Park.

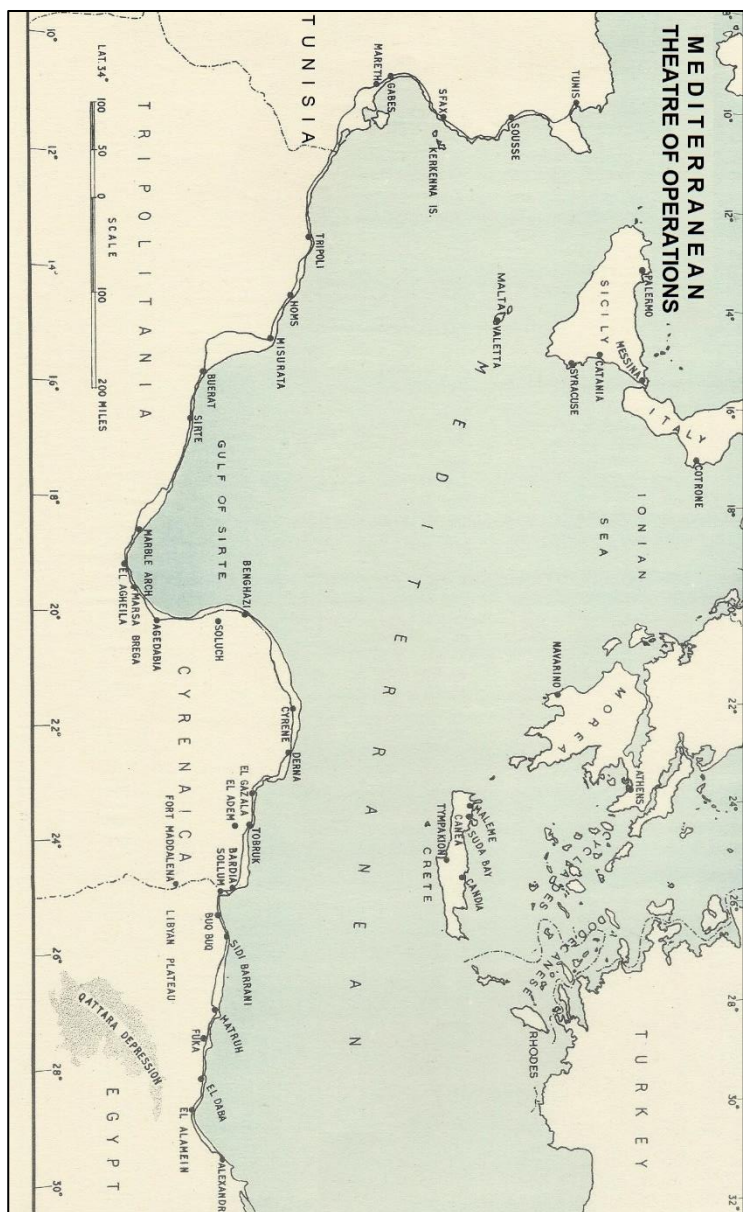
4. The Middle East to Alamein

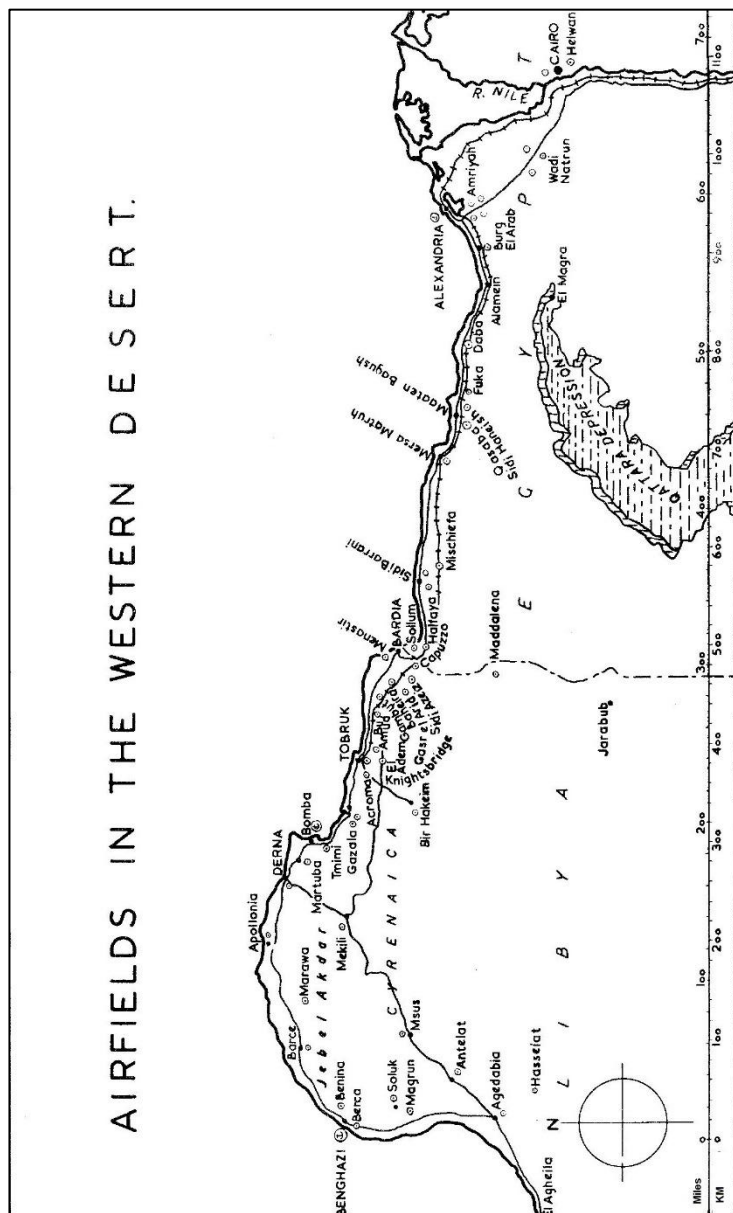
In the Middle East, as in other theatres, active GBAD functioned most effectively as one of the multiple components of an IADS. The challenge throughout 1941 and much of 1942 lay in developing capabilities, expanding resources, and in optimally combining the different air defence elements to meet the distinctive demands of the desert war – especially mobility. Resource issues were complicated by the parallel need to develop an effective air defence system to cover Cairo, Alexandria and bases between the Nile and the Suez Canal. For many months, there were not enough deployable or mobile radars to provide comprehensive coverage extending from Suez to the more westerly battle zones, and ‘mobility’ in this context meant only that the radars could be moved within theatre. They took days to erect and dismantle.

The deployment of fighters and AAA in the rear diverted desperately needed resources from forward areas. Reports on the early months of the campaign highlighted a lack of radar warning, sector control and AAA, particularly in the more forward westerly locations. On 28 June 1940, an Italian air raid on the RAF station at Mersa Matruh achieved complete tactical surprise, damaged the runway, destroyed supply dumps and adjacent rail facilities, and targeted nearby troops and motor transport.¹ Mobile Radio^f Units (MRUs) followed the British advance in December and January 1941 to sites as far west as Tobruk and Benghazi, but cover was substantially restricted to lines of communication and logistical hubs.²

Perversely, the situation improved somewhat during the Axis counter-offensive in the spring, as the area under British control shrank. When the front stabilised again at the end of April, the RAF established a mobile radar at Mersa Matruh, which covered their fighter bases. Another radar at Sidi Barrani monitored the front line, while the radar at the besieged port of Tobruk scanned across Axis lines of communication and reported all enemy aircraft movements between their forward and rear areas. This information was passed by W/T in encoded form to the Fighter Wing Operations Control.³ Nevertheless, the availability of radar early warning in the Middle East remained partial, at best, with shortages of equipment and trained personnel preventing the expansion of effective coverage and exploitation.⁴

f. ‘Radio’ here again meant radar.





The acute challenges that confronted the RAF's fighter forces in this period have been described in multiple histories and require no detailed analysis here; for many months, they lacked both the numbers and the capability to confront the Luftwaffe on equal terms. Far less has been written about GBAD. In October 1940, the only AAA in the Western Desert was a Royal Artillery troop of HAA guns at Mersa Matruh; LAA at first consisted entirely of RAF light machine guns. Establishment scales set in November 1940 were based on 12 guns per static RAF station and for each mobile squadron. They were to be operated by one corporal and two airmen per gun, with one sergeant in charge of each detachment.⁵

This situation only improved marginally towards the end of the year, but there was still hardly any HAA provision for airfield defence. The LAA allocation in no instance exceeded two Bofors or captured Italian Bredas for each rear airfield, which were crewed by both Army AA and RAF station defence personnel, although the RAF airfield defence units were still overwhelmingly equipped with machine guns. The Army elements had no specialised airfield defence training, and the RAF lacked a training infrastructure in the theatre to prepare their own personnel for AA or broader base defence duties.⁶ According to one official account, 'The RAF gunners were unorganised, untrained, lacked supervision and were frequently misemployed.'⁷

In the Western Desert during the first months of 1941, the limited AAA available was allocated on a divisional basis (two Western Desert Force divisions, two AA Regiments) and with priorities that ranged across the field artillery area, including forward troops and wagon lines, divisional MT areas, forward dumps and reserves, and RAF airfields.⁸ Scarce resources had thus to be stretched over an impossibly wide range of commitments, leaving the more forward airfields dangerously exposed. Nevertheless, the responsible Royal Artillery officers soon realised that they could employ their very limited gunnery more effectively via integration with RAF air defences and established a Gun Operations Room at the RAF's Sector Operations Room with communications extending back to the Anti-Aircraft Defence Commanders, as well as individual gun and searchlight units. Inland, beyond RAF sector reporting and control, visual observers were deployed as far in front of the guns as possible.⁹

Active air defences were again supplemented by passive measures such as on-airfield and, at night, off-airfield dispersal. Numerous decoy flare paths and hundreds of dummy Hurricanes and Blenheims helped to divert the Axis air forces away from their intended targets.¹⁰

The diversion of resources to Greece subsequently weakened British forces in the Western Desert and facilitated a succession of Axis victories punctuated only by their failure to capture Tobruk. However, from the air defence perspective, this

was a period of rapid and positive development. RAF command and control was reorganised, 204 Group being established as a highly mobile tactical group even before Air Marshal Arthur Tedder (later Marshal of the Royal Air Force Lord Tedder) was appointed AOC-in-C, RAF Middle East, in June 1941. It was then enlarged into the Western Desert Air Force (WDAF – retaining direct command of six wings) after the Eighth Army was created in September. Rear areas remained primarily under 202 Group, which eventually became Air Headquarters Egypt. Reinforcements arrived from the UK, and the RAF's logistical organisation was also overhauled to produce improvements in serviceability and repair that translated directly into increased front-line strength. By contrast, the Axis air forces struggled under the pressure of logistical problems, air interdiction of their land and sea supply lines, and combat losses, including losses inflicted by RAF attacks on their airfields.¹¹

Meanwhile, the Air Ministry assigned top priority to the Middle East in the allocation of radar and associated equipment and sent at least some more experienced operators and controllers to Egypt,¹² and the Royal Artillery's 12 Anti-Aircraft Brigade arrived in theatre to resume the airfield AA task it had undertaken in France. In July, despite a severe shortage of guns, they were given responsibility for the AA defence of Mersa Matruh and several airfields. By September, when the Eighth Army was established, the Brigade had been enlarged – particularly with LAA – and was chiefly deployed at strips around Sidi Barrani, which were coming under frequent attack by the Axis air forces.¹³ Also in September, the RAF formed a ground defence branch at Headquarters Middle East Air Force, and unit defence officers were established at all levels, extending from commands down to stations and flying squadrons. They also set up a ground defence school at Helwan.¹⁴

By the time Operation Crusader began in November, the air defence position was more promising. While the Axis air forces retained numerical superiority over the RAF in the Mediterranean theatre as a whole and the Luftwaffe possessed the best air-to-air combat platform in the Me. 109, the RAF had more aircraft – including fighters – immediately available for operations in the prospective battle area, and some 25 radars were operating across Egypt.¹⁵ In the words of the official monograph,

By November 1941 the R.D.F. system had been improved considerably throughout each link in the system. The number of stations had been increased, the efficiency of the individual stations improved, the filter organisation developed, and

Controllers experienced in the use of R.D.F. information were in charge of base area Sectors and desert Wings.¹⁶

In the Western Desert, the Wing Operations Rooms were supplied with raid information derived not only from radar but from the 'Y' Service and observer units.

While, on paper, 12 AA Brigade operated under Eighth Army Headquarters, tactical control of the Brigade passed to the Western Desert Air Force after Crusader started, and their brigadier virtually functioned as an executive officer of the senior fighter and bomber wing commanders. The Army's primary airfield AAA formation was thus effectively integrated into the RAF command and control organisation.¹⁷ Via co-located operations facilities, the brigade received the same raid information and deployed their guns accordingly.¹⁸ Early warnings were passed down to lower tier AA Operations Rooms and on to the guns, either by siren or by firing a specified number of rounds from a selected gun position.¹⁹

After Crusader's launch, the initial British advance quickly complicated the task of airfield defence. The RAF's wings had to operate as far forward as possible to maintain air cover and air support for the Army. Their forward deployment extended the area requiring anti-aircraft defence, and AA cover was often suspended while units were in transit from one location to another. Again, AA resources were stretched to the limit.²⁰ In January, the AAA protection for airfields from Gambut to Benghazi amounted to 44 heavy and 81 light guns, inclusive of those at harbours that were able to provide cover for adjacent airfields.²¹

The most westerly airfields were the most problematic. They were the easiest for the Axis air forces to attack, and the deployment and erection of conventional mobile radars for their defence took too long. In Crusader, two portable radar sets adapted from ASV equipment were deployed forward but proved hard to operate effectively. In December, the only truly mobile COL station in theatre (which was apparently adapted in theatre) replaced them. Numbered 510, its performance was very promising, but it could not be used to any great effect before the Axis launched their counter-offensive at the end of January.²² A further problem was the time required by fighters to scramble and reach combat altitude. As it became clear that the creation of a fully functional radar-based air defence system was impossible in the Western Desert given the prevailing capability and resource constraints, the RAF fell back on the only feasible alternative – standing patrols or sweeps at wing strength (at least two squadrons), so that superior numbers made up for the inferior performance of their Hurricanes and Tomahawks, relative to the Me. 109. Such tactics were far from economical in terms of flying effort but were broadly successful.²³

When the Axis counter-offensive began, the more forward landing grounds came under frequent attack. In mid-January, a raid on Antelat destroyed several RAF fighters, although the AA guns shot down three of the attackers.²⁴ The withdrawal of the front-line radar units is described in the official narrative as 'rather chaotic'. There were hold-ups due to transport and fuel shortages, and command and control came close to collapse. As one RAF radar officer put it, 'At this time, orders to advance and retreat were coming so fast the A.M.E. Stations^g were passing each other in opposite directions on the road.'²⁵ In these circumstances, there was inevitably a reduction of radar coverage, which did nothing to help the fighter squadrons or the gunners.

However, withdrawal again served to facilitate the air defence task. Not only did it reduce the size of the defended territory; it also brought the forward airfields into an area of better radar cover. In total, eight radar units – four CO and four COL – provided coverage for the so-called Gazala Line. The RAF fighter wings were incorporated into 211 Group, and the necessary command and control linkages with 12 AA Brigade were established at Group level.²⁶

Among other things, 510 COL was deployed near Gazala, in advance of the most forward airfields, and with the protection of four armoured cars and a detachment of Bofors guns. From this favourable location, it could scan across the Gulf of Bomba to the main Axis airfields around Derna.²⁷ It was soon possible to control fighters over some 40 miles from the west of Gazala back to Bardia, three Wing Operations Rooms connected by landlines being supplied with radar information for their respective areas. This enabled fighters to be employed far more economically, and the standing sweeps of two-squadron strength increasingly made way for smaller formations of four or six aircraft launched in response to radar warnings. Fighter wings were also detailed in rotation to provide aircraft at readiness for the defence of aerodromes in the forward area.²⁸

Process and capability improvements were also much in evidence. An important step towards the generation of primitive but effective network centrality was the merger of the RAF's signals and radar branches in the Middle East under the Chief Signals Officer:

Under this re-establishment there was an interchange of information between Signals and Radio^h Officers in the Cairo area by means of lectures and friendly discussions. Radio Staffs were established at the Headquarters of subordinate Commands,

g. A.M.E. Station or AMES – Air Ministry Experimental Station; a cover name for radar.

h. 'Radio' here again meant radar.

and every effort was made to encourage Signals Officers to become conversant with RDFⁱ work and Radio Officers to acquire a knowledge of Royal Air Force Signals procedure and practice.²⁹

At the front, this period also witnessed the development of more accurate methods for estimating the altitude of incoming raiders and, in a nod to the Forward Fighter Director Posts of the future, the first effective daylight fighter control from a forward radar.³⁰

Operations from Crusader to the Battle of Gazala produced multiple lessons that exerted a significant influence on airfield anti-aircraft defence in subsequent campaigns. The main report reflecting 12 AA Brigade's experience of airfield defence in this period noted that each RAF squadron had an establishment of 12 machine guns and 36 gunners, but 'the full number was seldom available on the forward LGs,'^{31j} To address this deficiency and improve gunnery standards, the RAF formed a second ground defence school at Bagush on 1 April, and some 300 gunners attended courses at the school over the following three months. Unit defence schemes were overhauled, and the multiplicity of different alarm signals used in the event of air attack were discarded and replaced by a single system for RAF airfields in May 1942. The same signals were circulated to Army units together with a standard 'take post' alert for AAA sites.³²

To the extent that 12 AA Brigade was integrated into the more general air defence system, it provided anti-aircraft defence described in the official RAF narrative as 'generally satisfactory throughout the period'.³³ The Brigade was, by this stage, no less mobile than the component elements of 211 Group. As always, the main challenges were raised by the most exposed airfields, particularly El Adem, where 262 Wing was based in February. On the 18th, an attack by Me. 109 fighter-bombers damaged seven aircraft and forced the wing to withdraw to the Gambut – Gasr el Arid area, leaving El Adem to be used only as an advanced landing ground.³⁴ By early April, AAA provision for Gasr el Arid and Gambut was:

i. RDF was the original term employed for radar; it was a compression of the initials 'RD', for radio detection, and 'D/F', for direction finding.

j. LG – Landing Ground.

	RAF Unit	LAA 40mm	HAA 3.7-inch near airfield
Gasr el Arid	322 Wing	12	
Gambut Main	243 Wing	20	16
Gambut Satellite	239 Wing	16	

To supplement radar coverage west of El Adem, a screen of some 30 visual observation teams known as Wireless Observation Units (WOUs) was deployed to cover all possible Axis air approach routes. Fully mobile, they reported hostile aircraft directly to the Group Operations Room via W/T.³⁵

Yet the standard of inter-Service collaboration left a lot to be desired. The relationship between the Army and the RAF was addressed by 12 AA Brigade's analysis (see above), in which the commander of 2 Light Regiment Royal Artillery noted that, while command relations between the two Services were stable and well established, the same situation had not prevailed at unit level.

The RAF expressed the desire that they should be allotted an AA defence force which should become virtually part of the Wing, living and working hand in glove with the latter, so that whatever the movements of the wing its AA defences would accompany it ... The RAF were also anxious that the units of the AA defences should be changed as seldom as possible, so that they might be defended by batteries experienced in the particular problems of defence of LGs and in co-operation with fighter aircraft. It was hoped that as the personnel on both sides got to know each other and to understand each other's problems, that close liaison and intimate cooperation which is so essential to success would grow up between the two Services ... Disappointment lay ahead; for though this HQ has been working continuously with one or other of the two Fighter Wings, no less than 17 different batteries have been under my command during this time.³⁶

His principal conclusion was that a permanent defence force should be established to protect airfields. Soon afterwards, the Wing Defence Officer at Air Headquarters Western Desert drew attention to a variety of problems generated by

the establishment of airfield defence elements as flights or sections within RAF units and proposed the creation of a permanent defence force, self-contained and self-administered, consisting of wings and squadrons that could be allotted to the defence of an area or a group of landing grounds.³⁷

Although, inevitably, it was possible to identify weaknesses and limitations in the arrangement whereby 12 AA Brigade was committed to the support of 211 Group, far more serious inter-Service friction occurred outside this system. Hence, responsibility for the AA defence of tactical reconnaissance squadrons belonged to the corps to which they were assigned, and they rarely gained top priority. Indeed, 'No 208 Squadron reported a complete lack of defence at advance landing grounds because Corps was never able to release guns for the purpose.'³⁸

Equally, the AA gunners at nearby Tobruk were unused to fighting in an environment in which the RAF was overhead and regularly engaged friendly aircraft. On 12 February, during a controlled fighter interception of an incoming Axis raid, the Tobruk AAA damaged one Hurricane and shot down another. The pilot, who baled out, 'had a somewhat anxious descent, however, as he was fired on by rifles and machine guns from the Tobruk defences before he reached the earth.'³⁹ Over the next two days, the gunners shot down six Allied aircraft, killing five pilots. The GOC-in-C Eighth Army subsequently issued instructions restricting delegated engagement to circumstances in which targets were positively identified by their markings as Axis aircraft or were committing a hostile act. All other engagements were to be subject to higher-level authorisation. Inter-Service discussions at Tobruk also produced an agreement that if RAF aircraft were intercepting raids successfully, the responsible Wing Operations Room would signal 'Tally Ho' to the Gun Operations Room, and the guns would hold fire.⁴⁰

After a lull in fighting in April, the Axis offensive at the end of May put further pressure on the air defence system. The radar units were forced to withdraw, 510 COL being briefly cut off by Axis forces before it was extricated; it was subsequently given an escort of 15 Valentine tanks and moved to a more easterly location to resume plotting. Other stations along the East Cyrenaican and Egyptian coast remained operational until the very last moment. One station passed 744 plots in seven hours by W/T and did not leave its position until it was immediately threatened by the enemy.⁴¹ The retreat was complicated by constant Axis pressure, with ground forces regularly threatening forward RAF units, and by frequent communications outages and reduced radar support.⁴² The RAF nevertheless maintained fighter cover above the Eighth Army as it withdrew to the Alamein line and persistently targeted Axis columns and airfields, although suffering heavy losses in the process.⁴³

Notes

1. AHB narrative, *The Campaigns in the Middle East, Vol I, Operations in Libya and the Western Desert, September 1939-June 1941*, pp. 40, 94.
2. AHB, *Radar in Raid Reporting*, p. 172.
3. Ibid., p. 173; report on RAF Operations in the Western Desert and Eastern Mediterranean Area, 18 November 1941 to 19 May 1942, prepared by Wing Commander, Operations Record Officer, Headquarters RAF Middle East, 30 August 1943 (AHB, Siracourt archive).
4. AHB, *Radar in Raid Reporting*, p. 179.
5. AHB, *Ground Defence*, Chapter 6, pp. 40-41.
6. *Short History*, p. 19.
7. AHB, *Ground Defence*, Chapter 4, p. 85.
8. Pemberton, *Artillery Tactics and Equipment*, p. 63.
9. Ibid., p. 64.
10. Brief report on the Royal Air Force Operations from the time of our retreat through Cyrenaica, including the Operation "Battleaxe", by Air Commodore R. Collishaw, 12 August 1941 (AHB, Box 370).
11. AHB narrative, *The Middle East Campaigns, Vol II, Operations in Libya and the Western Desert, June 1941-January 1942*, p. 63.
12. AHB, *Radar in Raid Reporting*, pp. 178-180.
13. TNA WO 204/7254, The History of HQ 12 AA Brigade, 1939-1945; Kreis, *Air Warfare and Air Base Air Defense*, p. 144.
14. *Short History*, p. 19; AHB, *Ground Defence*, Chapter 4, pp. 59-62.

15. AHB, *Radar in Raid Reporting*, p. 179; AHB, *Middle East Campaigns, Vol II*, pp. 87-89. On the eve of the offensive the 14 RAF Hurricane and Tomahawk squadrons available had a strength of 367 aircraft (315 serviceable or serviceable in three days). Luftwaffe operational fighter strength in the desert amounted to 90 single-engined fighters and 14 twin-engined fighters with far fewer immediately serviceable; the Italian Air Force had a strength of 154 fighters but the British estimated that their serviceability was about 65 per cent.
16. AHB, *Radar in Raid Reporting*, p. 180.
17. AHB, *Middle East Campaigns, Vol II*, p. 121.
18. AHB, *Radar in Raid Reporting*, p. 181; Kreis, *Air Warfare and Air Base Air Defense*, p. 143.
19. Pemberton, *Artillery Tactics and Equipment*, p. 130.
20. AHB, *Middle East Campaigns, Vol II*, Appendix C (i).
21. AHB, *Ground Defence*, Chapter 4, p. 55.
22. AHB, *Radar in Raid Reporting*, p. 182.
23. AHB, *Middle East Campaigns, Vol II*, Appendix G(i), Fighter Operations and Tactics in the Libyan Campaign, November 1941 to January 1942.
24. TNA WO 204/7254, The History of HQ 12 AA Brigade, 1939-1945.
25. AHB, *Radar in Raid Reporting*, pp. 182-183.
26. Kreis, *Air Warfare and Air Base Air Defense*, p. 142; AHB, *Radar in Raid Reporting*, p. 183; AHB, *Middle East Campaigns, Vol III*, p. 99.
27. AHB, *Radar in Raid Reporting*, p. 184.
28. AHB, *Middle East Campaigns, Vol III*, pp. 40, 93, 97.
29. AHB, *Radar in Raid Reporting*, p. 185.

30. Ibid., p. 184.
31. AHB, *Ground Defence*, Chapter 4, Appendix 5, Notes on the Defence of Fighter Landing Grounds, by Lieutenant Colonel TEH Helby, RA, Commanding 2 Light AA Regiment Royal Artillery, 25 April 1942.
32. AHB, *Ground Defence*, Chapter 4, p. 67.
33. AHB, *Middle East Campaigns, Vol III*, p. 220.
34. Ibid., p. 42.
35. Ibid., p. 99. They were known as 'wireless' because they reported by signalling rather than land telephone lines. Each unit consisted of three airmen trained in Royal Observer Corps recognition procedures, support personnel and a suitably equipped communications vehicle.
36. AHB, *Ground Defence*, Chapter 4, Appendix 5, Notes on the Defence of Fighter Landing Grounds, by Lieutenant Colonel TEH Helby, RA, Commanding 2 Light AA Regiment Royal Artillery, 25 April 1942.
37. Ibid., p. 80.
38. AHB, *Middle East Campaigns, Vol III*, p. 220.
39. Ibid., pp. 40-41.
40. Ibid., pp. 40-41, 43.
41. AHB, *Radar in Raid Reporting*, p. 189.
42. AHB, *Middle East Campaigns, Vol III*, pp. 42, 160.
43. AHB, *Middle East Campaigns, Vol III*, pp. 148, 151, 164-165, 180, 182.

5. The Middle East from Alamein to Tunis

The Battle of Gazala routed the Eighth Army, but a more favourable situation once more resulted from the withdrawal – a smaller area to defend, shorter lines of communication, better communications and radar coverage, and nearby maintenance facilities for all types of military equipment. The concentration of airfields facilitated more economical use of AA resources, particularly where HAA was concerned, lighter guns were redeployed around the airfields on a mutually supporting basis, and there was some transfer of AAA to the desert airfields from Egyptian bases.¹ Reinforcements reached the Nile Delta in growing quantity.² They included the first USAAF elements, at least some Spitfires for the WDAF fighter wings, and a standardised mobile radar – the Light Warning Set (LWS) – which could be erected in one hour. Within a short time, the RAF had adapted it for air portability.³

By contrast, Axis forces were confronted by an increasingly problematic situation in terms of both front-line strength and logistics. For the air forces, there were few reinforcements, and extended supply lines across the desert and the Mediterranean became ever more tenuous. The strain on aircrew and ground crew was acute.⁴ Forward airfields faced relentless attacks from the RAF.⁵ Thus, while they successfully mounted large-scale air strikes on Tobruk on 20 June, the Luftwaffe and the Regia Aeronautica proved incapable of sustaining such operations.⁶ As one German commentator wrote,

This, however (the air attack on Tobruk), was the last time when the Luftwaffe had any decisive influence on ground operations in North Africa. The intensity of its efforts during May and June had drained its resources and although losses had not been very high, serviceability was at a low level and crews were suffering from operational strain. The failure to send to the Mediterranean theatre adequate air forces to cover the many and varied duties involved had had its inevitable result.⁷

On 3 July, the date of Rommel's main offensive in the First Battle of Alamein, the Luftwaffe flew 203 sorties while the RAF flew approximately 1,000 – a decisive turning point in the air war, not only in North Africa but in the wider Mediterranean and European theatres.⁸ From this point onwards, as the Allies moved on to the offensive, their air forces largely retained air superiority. From the airfield defence perspective, this improved situation only lapsed temporarily

at the beginning of operations or campaigns when units had to be deployed to sites in former enemy territory and came under attack. Often, during this opening phase, the need to send aircraft forward in strength to a limited number of airfields caused crowding and reduced the scope for dispersal.

Once effective fighter cover was established over such areas, the Axis air forces typically confined themselves to intermittent hit-and-run strikes involving small formations of aircraft, normally at low level, and there were no longer sustained operations that might have denied airfields to the Allies completely. The threat largely ceased as the Allies consolidated their air defences over newly acquired territory, and attacks on their airfields became prohibitively expensive.

This basic pattern is illustrated by the Alamein offensive in October. By that time, Allied air superiority was supported by multiple radar units, LWS being deployed to cover the more westerly landing grounds while mobile COL stations were positioned in forward areas and employed for day fighter control. The campaign plan was simply to extend this system along the North African coast as Allied ground forces advanced. As MRUs usually had to transmit plots to the appropriate Filter Centres via W/T, the W/T plotting code was revised and simplified, and track numbering and identification procedures were improved. A standard Middle East Grid map was also adopted.⁹

By August 1942, the strength of the Army AA defences in Egypt was 220 heavy guns and 477 light guns. Of these, airfields in the Eighth Army area were assigned 32 heavy and 96 light guns. The greater vulnerability of forward airfields in the early stages of the offensive is reflected in the fact that these totals had risen to 56 heavy and 168 light guns by 30 November.¹⁰

RAF airfield defence measures were meanwhile being transformed following the government's decision to establish the RAF Regiment. The difficulties that this new initiative involved in the Middle East are not hard to imagine, and a lack of officers, equipment and infrastructure loomed especially large among the various resource constraints. An Officer Cadet Training Unit was established at Amman in Jordan in October. At the end of 1941, there were approximately 5,000 RAF ground defence personnel in Middle East Command,^k but drafts from the UK brought the total up to 8,000 in February and March 1942.¹¹ Preliminary instructions for organising personnel into RAF Regiment flights and sections were issued on 19 June, and Middle East Command released block numbers for RAF Regiment flights in September. By January 1943, the 8,100 RAF Regiment personnel in theatre had been organised into 225 flights. Some 3,410 personnel –

k. RAF Middle East Command was huge: by the beginning of 1943 it was responsible for Egypt, Libya, Aden, Cyprus, East Africa, Iraq, the Levant, Malta and Sudan.

95 flights – were assigned to forward squadrons in the Western Desert, including those of 201 Group (maritime support) and 205 Group (heavy bombers).¹²

The new RAF Regiment flights were in the early stages of formation and training when the battle of Alamein began, and this was never likely to be conducive to operational efficiency. During the subsequent advance, airfield defence was complicated by a variety of command, control and logistical problems, all of which stemmed from the fact that the flights were tied to their parent operational units. By the beginning of 1943, the solution was clear: the flights should be organised into independent RAF Regiment squadrons. The Air Ministry approved this further reorganisation in April 1943, but it did not take effect before the defeat of Axis forces in Tunisia in May.¹³

As for the Regiment's task, one official account supplies the following summary:

In the Middle East, where conditions were different from those in England, the functions of the RAF Regiment varied considerably. Airfields in this theatre for the most part were not static bases. They moved with the speed of an expeditionary force. In the Middle East and North Africa, therefore, the Regiment has regarded as its duty the performance of every possible service on the ground in the protection of the mobile squadrons of the RAF ... They advanced over the desert with the squadron convoys to protect them en route ... Once they had secured the landing grounds on the advance, the flights of the Regiment threw protective screens around them.¹⁴

For the anti-aircraft role, the Regiment at first retained their machine guns, which served as dual-purpose weapons in the aftermath of the Battle of Alamein, and captured Bredas were also used. Longer-term plans were based on re-equipment with Hispanos and Bofors guns.¹⁵ In the expectation of highly mobile operations in the aftermath of Alamein, about 30 Hispanos were mounted on RAF Regiment trucks; their first claims were for two enemy aircraft shot down near the Daba and Fuka airfields early in November.¹⁶

The nature of the air threat that now confronted the Allied air forces as they advanced and seized or constructed forward airfields is reflected in events at Hamraiet, Libya, in early January 1943. Positioned only 50 miles from the Axis front line at Buerat, the Hamraiet strips were tempting targets. On the day RAF Spitfires arrived, raids by two Me. 109 formations totalling 30 aircraft damaged a Spitfire on the ground, killed four New Zealanders and wounded 14 others. Air

defences in the area were already robust, and both Luftwaffe formations were intercepted in the air, but there were no RAF claims. However, the AAA demonstrated the value of layered air defence by shooting down three of the raiders. The following day witnessed further Me. 109 attacks, which caused no damage but inflicted more casualties on the ground. Again, Spitfires intercepted the German formations but shot down only one aircraft.

Yet by 11 January, the Spitfires were gaining the upper hand. That day, German and Italian aircraft attempted three fighter-bombers raids, two on the Hamraiet landing-grounds and one on Bir Zidan. All were intercepted in the air, two Me. 109s and two Macchi C.202s being shot down; AA gunfire accounted for another Me. 109. On the 12th (when the Allies launched their attack on Buerat), Axis air strikes on Hamraiet and Temet caused runway cratering and damaged five aircraft on the ground, but four Italian aircraft and one German fighter were shot down. This was the last Axis attempt to target the airfields at Hamraiet and Temet.¹⁷

Further west, following the Operation Torch landings in Algeria on 8 November 1942, the position was more complex. Broadly, the established offensive pattern continued, but it was complicated by the fact that the lessons of the Western Desert had not been studied by the participating British and American forces. Of note, they did not attempt to centralise air defence under a single Air Commander but divided the committed USAAF and RAF elements between western (American) and eastern (British) commands. They also possessed hardly any experience of amphibious warfare or expeditionary logistics.

The radar plan, for which COL and LWS were the primary capabilities, involved more static COL arrangements than the WDAF's and reporting to fixed operations rooms rather than mobile facilities. It was also more focused on the protection of ports and shipping than airfields.¹⁸ At this stage, only a trickle of hand-made LWS systems was emerging from the Telecommunications Research Establishment, and the Torch units arrived so late that there was minimal time to train RAF radar personnel in their use.¹⁹

The plan for the American sector of the operational theatre was thrown into disarray even before the Allied landings when much of their radar equipment was sunk in transit from the United States. The British units that landed in the US sector meanwhile experienced such acute unloading and assembly problems that the first LWS systems did not commence operations for six days, and COL was not operational until 18 November. After the landings, a period of nearly two weeks passed before the first effective reporting began from the radar units to a central filter room. Subsequently, the expansion of reporting and control in the American sector was hampered by transport shortages, equipment loss or damage,

inadequate maintenance provisions, the unfamiliarity of personnel – particularly American personnel – with LWS, and a host of other difficulties.²⁰

In the British sector, rough seas at first prevented the LWS and wireless stations from coming ashore, and there were long delays in the establishment of effective warning and control provisions to help protect key airfields such as Maison Blanche, Bone, Blida and Djidjelli.²¹ A report by Wing Commander P. Broad, who was sent to North Africa to investigate, recorded of LWS.

This set did not give satisfaction. This was easily explained by the fact that the signals personnel concerned had not only never operated together previously but had never seen a light warning set before being confronted with a jumble of packing cases on a beach. Under these circumstances, it is doubtful if even a sewing machine could have been made to operate successfully.²²

The airfields were rapidly secured, but the arrival of Allied aircraft stimulated an immediate response from the Luftwaffe involving high-level attacks by Ju. 88s and low-level raids by fighter-bombers. Due to the absence of radar warning, it became necessary to maintain standing fighter patrols over threatened areas.²³

The implementation of the signals plan was subsequently delayed by the shipping delivery schedule and logistical tracking failures at Algiers, while the ground offensive to the east was more rapid than expected, extending the area requiring cover. Eventually, the original plan was scrapped, and available radar units were sent where the need was greatest. Unfortunately, according to the official narrative,

This led to a high degree of chaos and confusion due to the inability of the operational and signals staff to agree on any one site. The RDF stations consequently had a worrying time dashing up and down the countryside in response to contradictory signals.²⁴

The situation only improved gradually, not least because strengthening Axis opposition and poor weather combined to halt the Allied advance between December 1942 and January 1943. Against this background, the arrival of more radar units in theatre and greater familiarity with the LWS allowed coverage to be extended, and the entire radar network was overhauled – and substantially improved – when air command and control was reorganised in February 1943 to create Mediterranean Air Command under Tedder.²⁵



Mobile radar - a Light Warning Set.



A Wireless Observation Unit in the Western Desert in March 1942; their primary optical equipment is not visible; hand-held binoculars were for the look-out role.



RAF Regiment gunners operating twin Browning machine guns fixed to a 3-ton truck at Bone, Algeria, in November 1942.



A static twin Browning AA position at Jemappes airfield, Algeria, alongside a Hurricane IIC of 253 Squadron.

Given the difficulties involved in orchestrating effective early warning and fighter control in Tunisia, GBAD had a particularly important role to play. Two RAF Regiment AA flights came ashore on D-Day with the objective of establishing at least some airfield protection at the earliest possible moment, three more flights were landed by the second and third follow-up convoys, and AA sections were also incorporated into the establishments of RAF headquarters, squadrons and other units. Base Sub-Area Commanders were responsible for deciding the most suitable layout and volume of AA defences, while operational control of the AA guns came under the AOC Eastern Air Command and was then delegated to fighter sector commanders, warnings of approach being received and filtered in RAF fighter sector operations rooms. In the absence of warning information – the prevailing situation in the early stages of the operation – AA gunners were permitted to open fire only on aircraft which were clearly recognised by their appearance or actions to be hostile.

After landing on 8 November, 4088 Flight assumed AA defence duties at Maison Blanche airfield, while 4089 moved on to Bone; 4088 subsequently relocated to Souk el Arba. Bone and its airfield witnessed the most intense combat, and the RAF Regiment Browning guns, which operated from their 3-ton trucks, were repeatedly in action. Contemporary records speak of gunners ‘ankle-deep’ in cartridges. Two days after their arrival, they faced a low-level attack by a mixed Italian and German formation, shot down one aircraft and contributed to the destruction of another. On the 18th they damaged two Ju. 88s.²⁶

However, on the 21st, 4089 Flight was on the receiving end. Their commanding officer, Flight Lieutenant JL Law, had taken to directing his units by moving from one to another by jeep. That day, during an air attack, he drove to a gun position which soon afterwards received a direct hit from an Axis bomb. Law died together with the gun crew, and their 3-tonner, its guns and the jeep were destroyed. Another RAF Regiment gunner was killed on 28 November. The attacks continued in December, when poor weather left Allied aircraft bogged down on their strips while the Axis air forces continued to operate from all-weather airfields in Tunisia. By January 1943, RAF Regiment AA flights were deployed at Bone, Maison Blanche, Souk el Arba, Canrobert, Souk el Khemis and subsidiary landing grounds, and their Brownings were being replaced by 20mm Hispanos.²⁷

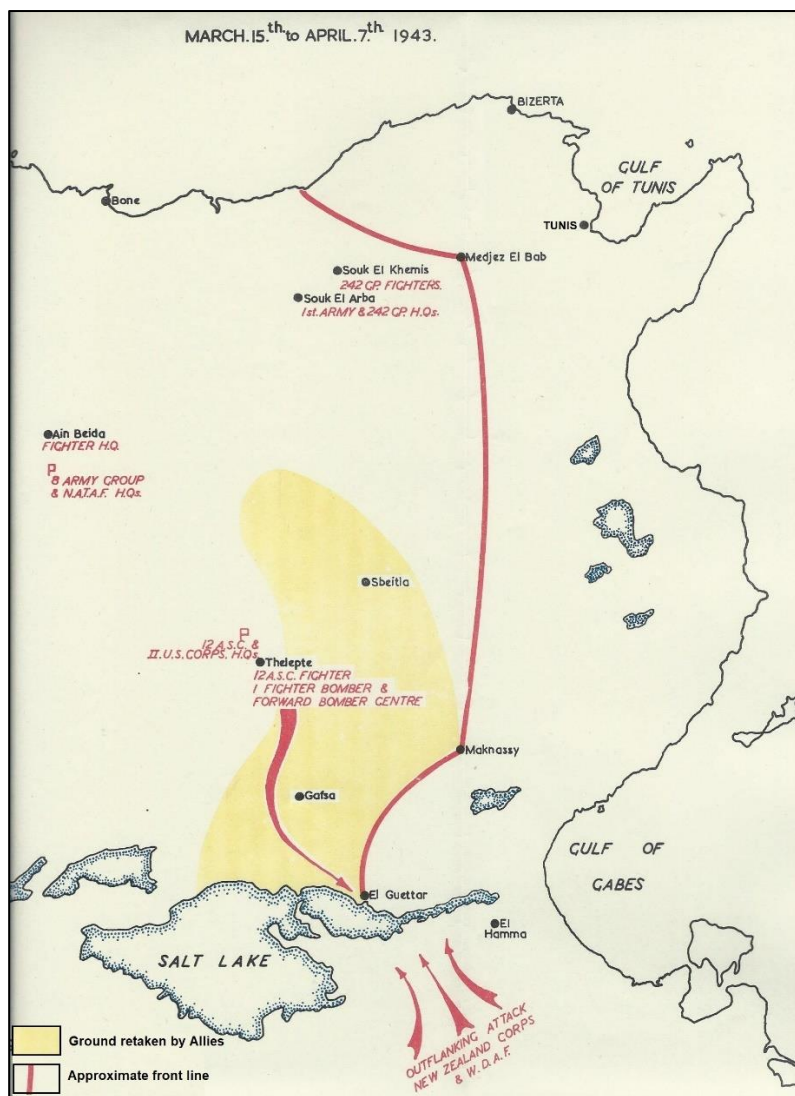
Otherwise, the provision of AA defences was an Army responsibility, and it was very poorly executed. Again, airfield defence batteries were frequently changed, sometimes within a matter of hours, one battery might leave before the next arrived, and positions were often swapped between American and British units. As Broad noted:

The result was that our airfields were seldom defended by AA batteries that were versed in the rather specialised art of airfield defence, or which had more than the most casual knowledge of the local layout. The rapid change-over of batteries meant that the RAF Regiment had to be continually adapting its own defence plans and had no time in which to establish adequate liaison. Further, there were frequent periods when our aircraft were devoid of defence other than that afforded by the RAF Regiment. The necessity for good AA defence of the airfields is borne out by the fact that on the morning of my visit to Souk El Khemis, a well defended group of three airfields, a bombing attack by 12 Fw. 190s destroyed 10 of our aircraft.²⁸

Station Commanders told Broad that the minimum defence for an airfield in the forward area was two HAA batteries and 24 Bofors guns, but he concluded that even these provisions would be largely ineffective unless the gunners were experienced in airfield AA defence, maintained close liaison with the RAF and were fully conversant with local conditions. In his view, 'the RAF Regiment, strengthened by heavier AA units, would provide the ideal airfield defence.'²⁹

This situation had still not been resolved when Mediterranean Air Command was formed, together with the Northwest African Tactical Air Force (NATAF) under Coningham, and, within NATAF, 242 Group under Air Commodore Kenneth Cross. Cross later wrote that AA defence had at first been 'the responsibility of the AA Commander of the Base Area in which the aerodromes were located. This was unsatisfactory.'³⁰ Elaborating later in his memoirs, he recalled that AAA was often deployed by Army officers who possessed little knowledge of the potential air threat. 'Worse still, having no continuous RAF contact to record the tracks of friendly aircraft movements, the Army repeatedly misidentified and fired on our own aircraft.'³¹

The irony here was that, meanwhile, 12 AA Brigade continued to operate in their specialised role of supporting 211 Group. A regimental group of one heavy and two light batteries was assigned to each new airfield, and the Brigade Intelligence Officer, with suitable communications, then moved forward with the leading echelons to report on conditions at new sites. Assuming they were favourable, the regimental group would be deployed, usually at night, to reach its destination before the main routes of advance became congested. Thus, during the New Zealanders' left hook around the Mareth Line in March 1943, a regimental group advanced to El Hamma along the Hallouf road 36 hours before it was officially opened to traffic.³²



Allied ground operations in March-April 1943 remained dependent on tactical air support mounted from exposed and vulnerable airfields.

At times, the Brigade's resources barely matched its commitments.³³ Before the attack on the Mareth Line, it provided protection to five fighter wings in the Medenine area, all within 20 miles of the front line, and faced repeated Luftwaffe attacks. After fighters moved up to Hazbub on 24 February, Axis aircraft mounted three raids on the airfield on the 26th, damaging one aircraft, killing one airman and wounding another. At Neffatia on 6 March, Me. 210s and Fw. 190s damaged eight fighters, killed three RAF personnel and wounded five others. Further strikes the next day destroyed a Hurricane, damaged another and wounded eight AA personnel. Hazbub was also targeted again.³⁴

Yet as usual the deterrent effect of consolidated air defence provisions around and above Medenine soon began to tell, and the threat steadily declined.³⁵ The system whereby 12 AA Brigade provided dedicated support to 211 Group proved its value again, and a second brigade, 22 AA Brigade, was therefore assigned to airfield defence in the 242 Group area.³⁶ Needless to say, this measure had significant resource implications, and Cross himself questioned the need for an enduring HAA presence at airfields once the fighter defences were established. Thereafter, daylight attacks were typically executed by fighter-bombers more vulnerable to LAA fire. High-level bombing was confined to the hours of darkness and could only be effectively countered by barrages generated by a significant concentration of guns. Since large numbers of heavy guns were rarely assigned to airfield defence, Cross suggested redeploying these weapons to expand AAA cover of other VPs as soon as the Air Commander was satisfied with the fighter defences.³⁷

By the end of the campaign in North Africa, the RAF Regiment AA Sections originally deployed after Operation Torch had been reorganised into flights, which substantially increased the number of independent Regiment AA flights in theatre. It was clear to the senior deployed RAF Regiment officer, Lieutenant Colonel HM Salmon (attached, like so many others, from the Army) that rationalisation was necessary, and consequently the flights were reorganised into 11 LAA squadrons in May and June, which were numbered from 2860 to 2870. Salmon also created the first RAF Regiment Wing Headquarters to co-ordinate the activities of two or more squadrons.³⁸

Notes

1. AHB, *Ground Defence*, Chapter 4, p. 73; Kreis, *Air Warfare and Air Base Air Defence*, p. 149; AHB narrative, *The Middle East Campaigns, Vol IV, Operations in Libya, the Western Desert and Tunisia, July 1942-May 1943*, pp. 6-8, 265.
2. AHB, *Middle East Campaigns, Vol IV*, pp. 99-104.
3. AHB, *Radar in Raid Reporting*, pp. 190-191.
4. AHB, *Middle East Campaigns, Vol IV*, p. 9.
5. *Ibid.*, p. 57.
6. *Ibid.*, pp. 9-11.
7. *Ibid.*, p. 197.
8. *Ibid.*, p. 37.
9. *Ibid.*, p. 191.
10. Pemberton, *Artillery Tactics and Equipment*, p. 152.
11. *RAF Mediterranean Review*, No. 4, July-September 1943, p. 78 (AHB, Siracourt archive).
12. AHB, *Ground Defence*, Chapter 4, pp. 87-89, 107.
13. *Ibid.*, pp. 106-111.
14. *RAF Mediterranean Review*, No. 4, July-September 1943, p. 78.
15. Oliver, *The RAF Regiment at War*, p. 11.
16. AHB, *Ground Defence*, Chapter 4, p. 93.

17. AHB, *Middle East Campaigns, Vol IV*, p. 452.
18. AHB, *Radar in Raid Reporting*, pp. 261, 275.
19. Ibid., p. 265.
20. Ibid., pp. 266-268.
21. Ibid., p. 269.
22. Operation Torch – Lessons Learnt: Report of Investigation Carried out in North Africa by Wing Commander P. Broad, 19 February 1943 (AHB, Siracourt archive).
23. AHB, *Radar in Raid Reporting*, pp. 270, 275.
24. Ibid., p. 271.
25. Ibid., pp. 275-278, 283.
26. AHB, *Ground Defence*, Chapter 6, pp. 8-9.
27. Operation Torch – Lessons Learnt: Report of Investigation Carried out in North Africa by Wing Commander P. Broad, 19 February 1943; AHB, *Ground Defence*, Chapter 6, pp. 13-15; AHB, *Middle East Campaigns, Vol IV*, p. 75.
28. Operation Torch – Lessons Learnt: Report of Investigation Carried out in North Africa by Wing Commander P. Broad, 19 February 1943.
29. Ibid.
30. Report on Air Operations by 242 Group RAF in support of 1st Army Tunisia, 1943, by Air Commodore KBB Cross, 18 February to 12 June 1943 (AHB, Siracourt archive).
31. Air Chief Marshal Sir Kenneth ‘Bing’ Cross with Vincent Orange, *Straight and Level* (Grub Street, London, 1993), p. 231.

32. Pemberton, *Artillery Tactics and Equipment*, p. 174.
33. Ibid.
34. AHB, *Middle East Campaigns, Vol IV*, pp. 490, 492, 493.
35. AHB, *Radar in Raid Reporting*, pp. 292-294.
36. Report on Air Operations by 242 Group RAF in support of 1st Army Tunisia, 1943, by Air Commodore KBB Cross, 18 February to 12 June 1943.
37. Ibid.
38. Oliver, *The RAF Regiment at War*, pp. 47, 49; AHB, *Ground Defence*, Chapter 4, pp. 106-111, Chapter 6, p. 17.

6. Sicily and Italy

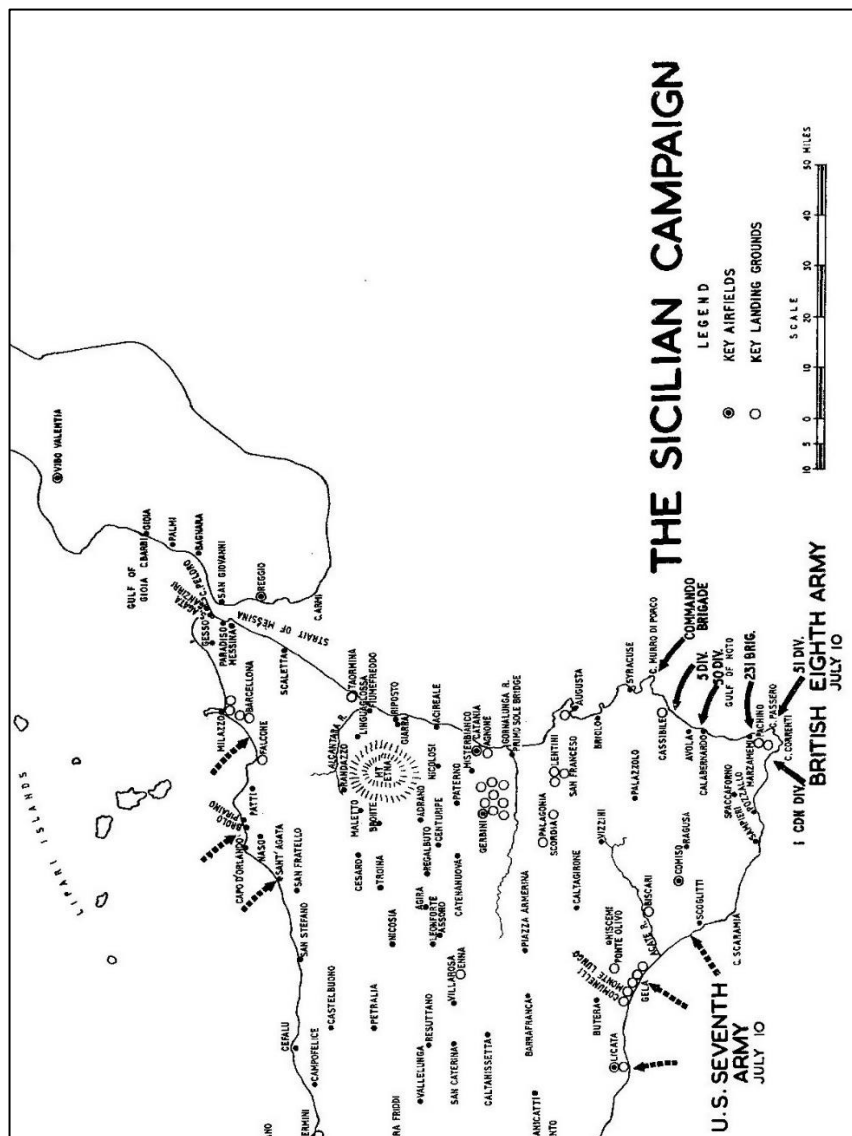
In the campaigns that followed the Allied victory in North Africa, Luftwaffe attacks on Allied airfields declined further in frequency and were rarely mounted on a significant scale. Before Operation Husky, the Allied landings on Sicily in July 1943, RAF and USAAF strikes on Axis air bases left their front-line strength and support infrastructure severely weakened. Their response to the landings was then divided between the invasion fleets, the beachheads, Allied ground units, communications targets and airfields. Within days, Allied fighters were operating from the island, and a strong fighter presence had been established over the beachheads.¹ Off-shore radar warning and control soon made way for provisions on Sicily itself, sustained by MRUs and mobile control facilities.²

Airfield LAA protection was spearheaded by RAF Regiment squadrons deployed from the UK. Of these, there were five; a sixth arrived from the Middle East. The squadrons in North Africa did not become involved until the end of Operation Husky. An Army brigade again supplied HAA for airfield defence. Two RAF Regiment LAA squadrons landed on Sicily on 10 July – the first day of the operation. Despite losses of vehicles and equipment en route or during the landings, both were deployed on Pachino airfield within 24 hours and saw action that day when it was attacked by a formation of five low-flying Me. 109s. However, it emerged that the guns of 2925 Squadron had faulty firing cables, and no claims were made. There were more raids over the following days, and 2855 Squadron submitted the first RAF Regiment claim when an enemy aircraft was shot down on the 13th. By that time, nearly 100 AA guns were defending the airfield, most of which were operated by the Army.³

By the end of July, RAF Regiment LAA squadron dispositions on Sicily were as follows:

RAF Unit	Airfield	RAF Regiment LAA Squadron
211 Group	Augusta	2856 Squadron
244 Wing	<u>Cassibile</u>	2855 Squadron
322 Wing	<u>Lentini/Agnone</u>	2858 and 2925 Squadrons
66 Squadron	<u>Scordia</u>	2857

Two RAF Regiment Wing Headquarters were established to control the deployed LAA and field squadrons.⁴



As the Allies expanded their air defences over Sicily, the threat from the Axis air forces faded, and airfield attacks were soon largely confined to low-level fighter-bomber missions – a tactical irritant rather than an operational threat. A strong raid on the Lentini and Agnone landing grounds on the evening of 11 August, which destroyed or damaged about 30 Allied aircraft and caused multiple casualties, was exceptional but demonstrated the continuing importance of GBAD and the danger of complacency. On this occasion, the AA defences were largely caught off-guard, and only a few Army Bofors guns fired in support of the RAF Regiment's Hispanos. To make matters worse, several Hispanos again malfunctioned after discharging only a few rounds. A total of 16 RAF Regiment personnel were killed in the attack or later died of their wounds, and 13 more were wounded.⁵

Otherwise, the Sicilian campaign raised capability issues of considerable importance for the future of LAA. One positive development was the expanded application of LWS, which could give AA units a local warning system of their own.⁶ More negatively, the operation laid bare the limitations of both the RAF Regiment's Hispano cannons and the Oerlikons operated by the surface forces when fired over congested beachheads, bases or assembly zones crowded with Allied troops and equipment. As their 20mm ammunition was not self-destructing, their use could bring a downpour of lethal rounds on to nearby areas, and 20mm fire caused casualties on airfields and damage to parked aircraft during Husky. Among those who witnessed this effect first-hand and only narrowly escaped death or injury were Coningham and Montgomery.⁷

In consequence, rigid restrictions were imposed on the use of the Hispano, and the Oerlikon was withdrawn from all Army units except trained AA elements.⁸ This was unfortunate, because the 20mm weapons were both sometimes better suited than Bofors guns for combating fast low-level attacks. In Cross's words, 'The Hispanos are much better as they can be "swung" on their flexible mounting.'⁹ However, efforts to improve the Bofors soon led to the development of a quick traverse mounting, and the difficulty of using the Hispano in congested areas encouraged the RAF to re-equip with Bofors those Regiment LAA squadrons bound for Normandy in the following year.¹⁰

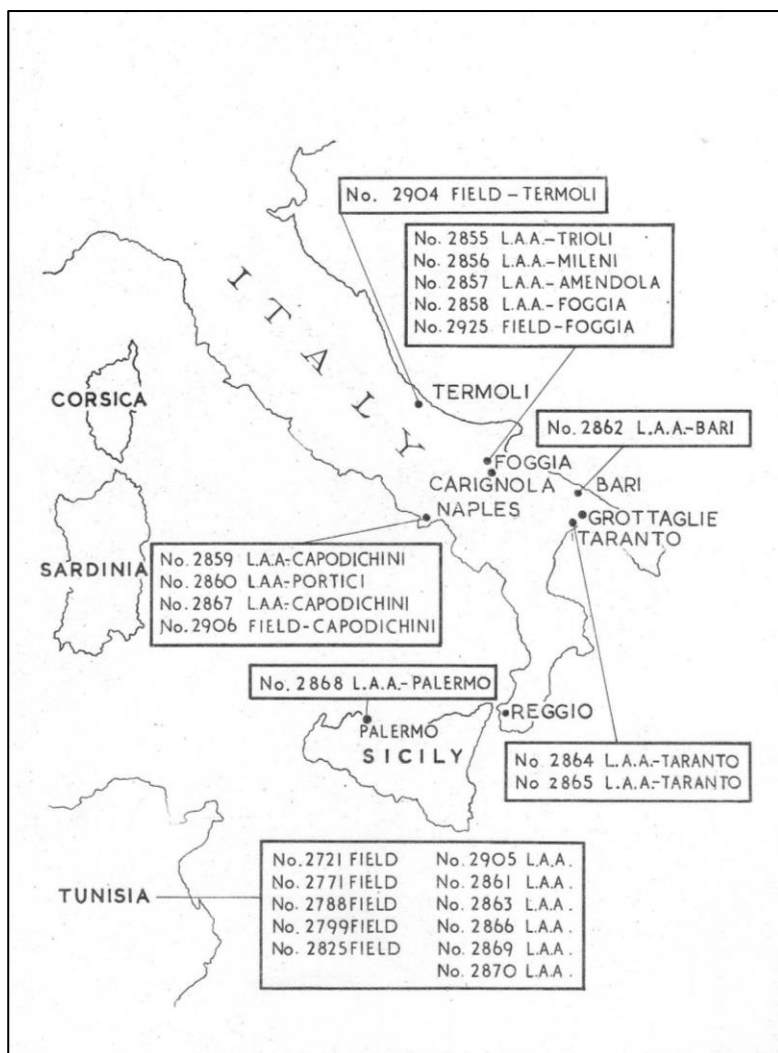
Other problems in Sicily involved combat identification and fire control. Many Allied anti-aircraft gunners serving with the surface forces were not trained to fight in close proximity to friendly aircraft and had no experience of doing so. Luftwaffe attacks on the invasion fleets subsequently encouraged the tendency to treat all aircraft as hostile with results described in the official narrative:

An unfortunate feature of D-Day and later days was the extent to which Allied ships fired on the patrolling fighters. Patrols had been ordered at 5-8,000 feet but at these heights the aircraft were continually engaged by AA fire. They were thus forced up to 10-14,000 feet. Even there, they were often fired upon. No Spitfire was known to have been shot down but a number were hit and damaged.¹¹

The AA guns also famously fired on Allied airborne formations heading for Sicily. Evasive action by troop carriers in response to friendly AA fire contributed much to the inaccuracy and dispersion of the first airlift on 8/9 July 1943, but worse was to follow on the 11th, when the guns shot down no fewer than 23 aircraft.¹²

In the ensuing campaign in Italy, the Allies assigned HAA and Bofors airfield defence to the British Army and US Army, while the RAF Regiment remained responsible for AA defence with lighter calibre weapons; some re-equipment with Bofors guns occurred over time. In the opening stages, two Regiment squadrons were assigned to each airfield. Only when the AAA was deployed in strength were flying squadrons authorised to occupy newly acquired bases.

After the first desperate ten days of fighting on the Italian mainland, the establishment of Allied forces in southern Italy was promptly followed by the arrival of the RAF and USAAF at captured or newly constructed airfields and the development of tactical integrated air defence provisions, including GBAD. Their deployment in late September and expansion throughout October proved more than enough to deter the Luftwaffe from anything but the most limited and fleeting airfield attacks, and only a few raids were mounted in significant strength. The reduced threat in Italy coincided with the build-up of Allied forces for the Normandy landings in 1944, and the RAF therefore withdrew several Regiment LAA squadrons to the UK.



RAF Regiment dispositions in Italy, Sicily and Tunisia, October 1943.

Notes

1. AHB narrative, *The Sicilian Campaign, June to August 1943*, pp. 62-65.
2. Radar reporting and fighter control during the Sicilian campaign is covered in AHB, *Radar in Raid Reporting*, Chapters 19 and 20.
3. AHB, *Ground Defence*, Chapter 6, pp. 46-48; Pemberton, *Artillery Tactics and Equipment*, pp. 184-185.
4. AHB, *Ground Defence*, Chapter 6, pp. 49, 50.
5. Ibid., p. 52.
6. Pemberton, *Artillery Tactics and Equipment*, p. 184; Brigadier AP Sayer, *The Second World War 1939-1945, Army, Army Radar* (War Office, 1950), pp. 93-96.
7. AHB, *Ground Defence*, Chapter 7, pp. 5, 65-66, Appendix 2.
8. Oliver, *The RAF Regiment at War*, p. 71; Pemberton, *Artillery Tactics and Equipment*, p. 184.
9. Report on Air Operations by 242 Group RAF in support of 1st Army Tunisia, 1943, by Air Commodore KBB Cross, 18 February to 12 June 1943.
10. AHB, *Ground Defence*, Chapter 7, pp. 5, 65-66, Appendix 2.
11. AHB, *The Sicilian Campaign*, p. 55.
12. Sebastian Ritchie, *Arnhem: Myth and Reality: Airborne Warfare, Air Power and the Failure of Operation Market Garden* (Robert Hale, Marlborough, 2019), pp. 50-51.

7. North-West Europe, 1943-1945

In the UK, in January 1943, the need for manpower economies resulted in a cut of some 25,000 personnel in the Army's Anti-Aircraft Command. Proposals then followed to transfer the Royal Artillery Bofors guns employed for airfield defence to the RAF Regiment. In March, the transfer was approved, and RAF Regiment personnel were trained to operate the Bofors by Royal Artillery instructors between May and October while Bofors flights were formed within Regiment LAA squadrons. Squadron structure was determined by the assessed threat to the airfield. The more vulnerable and higher priority UK sites numbered 146 and were defended by a combination of Bofors and Hispanos or by Hispanos alone. Airfields deemed less vulnerable or of secondary importance were allocated machine gun defence only.¹

For the Normandy campaign in the following year, the composition of the RAF Regiment component of Coningham's Second Tactical Air Force (2 TAF) was approved on 19 March 1944 and numbered 19 LAA squadrons at first; the total was subsequently raised to 25.² Once again, they were to be part of a layered and integrated air defence system that also involved radar warning and fighter control provided by mobile units, further warning provisions in the form of the 'Y' Service and visual observation, and extensive RAF and USAAF fighter cover.

At an early stage, Coningham insisted that RAF Regiment LAA squadrons assigned to airfields in the Allied lodgement area should be equipped with Bofors guns only and not Hispanos; his stance on this subject resulted directly from experience gained with 20mm cannon during the Sicilian campaign in 1943 (see above). The chief difficulty here lay in the supply of Bofors guns, which barely kept pace with demand during the pre-Normandy build-up. The War Office agreed to support an RAF request to re-equip more UK airfields with Bofors guns in the spring of 1944, but they balked at the prospect of supplying considerably more weapons to the Regiment squadrons bound for Normandy. Instead, they offered the 20mm Polsten gun as an alternative, stressing the tactical advantages of retaining a mix of 40mm and 20mm weapons for airfield AA defence.

However, since the appearance of the Bofors quick traverse mounting, these advantages were less pronounced, and the gun was also effective up to medium level whereas 20mm weapons were not. Furthermore, the Polsten was an unknown quantity, and the supply of self-destroying ammunition for it was uncertain. The RAF therefore turned down the offer and declared that, if no further Bofors guns were forthcoming from the War Office, they would be allocated to the 2 TAF squadrons from those originally deployed for airfield defence in the UK.³

GBAD planning before Normandy was based on the same assumptions that moulded other aspects of the air defence plan. The Allies overestimated the Luftwaffe's response to the landings on 6 June. In the words of the official War Office history,

The result was perhaps an over-insurance in the matter of AA protection. On "D" day, 23 per cent of the artillery to be landed was AA, and by "D" + 1 the proportion had risen to 42 per cent, at which level it remained for the next month or more.⁴

A further assumption was that, by day, the Luftwaffe could be dealt with by the fighters alone above 3,000ft. Below that altitude, the AA guns were responsible for air defence. By night, when only a small number of Allied night-fighters could be controlled at any one time, HAA barrages were considered necessary to protect vulnerable areas. As in earlier operations, an Army brigade made up of three HAA and three LAA regiments was tasked to protect the airfields of 83 Group – the first 2 TAF group to come ashore. This was 106 Brigade. The AOC 83 Group also controlled searchlights, balloons and smoke screens in his area of responsibility.⁵

The Normandy landings again required Allied aircraft to operate over anti-aircraft gunners who were in no sense air-minded and were never likely to fathom the complexity of the airspace above them. While fighter control during the landings was exercised afloat by ships known as Fighter Direction Tenders (FDTs), which were specially equipped and staffed for the task, wider warning responsibility was over-centralised in headquarters ships, and preparations for them to fulfil this function were inadequate. It would probably have been better exercised from the FDTs. On the night of 5/6 June itself, naval vessels fired on the RAF troop carriers bringing 6th Airborne Division to Normandy although 'The aircraft were so well illuminated by the tracer from the flak that the special markings [i.e. their black and white wing stripes] were easily distinguishable.'⁶ On board the responsible headquarters ship,

The Admiral was so incensed that he finally threatened to engage the next offending craft with the guns of HMS Largs. At least two Dakotas were shot down by naval gunfire. A naval staff officer was dispatched by boat to pass by word of mouth the order for the AA guns to cease fire.⁷

As well as bringing down the 46 Group Dakotas, friendly naval AA fire almost certainly played a part in scattering the troop carrier formations so that the resulting drops by the 3rd Parachute Brigade between Ouistreham and Cabourg were both inaccurate and widely dispersed. This substantially reduced their chances of achieving mission success.⁸

On several occasions over the following days, after a yellow warning had been issued in the British sector, German raiders bombed before red alerts had been given. As a result, any confidence that might have existed in the warning and tracking system quickly broke down, with predictable consequences.

AA gunfire control, both naval and military, from the anchorage and beaches, left much to be desired. Serious cases of firing at friendly fighter aircraft occurred in the British area. Usually, it was started by the gun-crews of smaller vessels, coasters, LSTs and LCTs, but once it had started, even visual recognition was completely ignored and the firing was taken up strongly by shore AA and naval guns of all classes of warships, including cruisers – even the well-disciplined gun-crews were quickly out of hand. The accuracy of gunfire from naval guns in the Eastern Task Force area was very poor, otherwise there would have been heavy casualties to Allied fighter and fighter-bomber aircraft.⁹

A later inquest revealed, among other things, a lack of R/T communications between headquarters ships and subordinate AA elements. ‘A broadcast R/T channel from the Controlling Ship, received by all ships carrying AA and operating in the assault area, was obviously necessary if full advantage were to be taken of the available radar information, and also so that on occasions when fire was opened on friendly aircraft, it could be immediately stopped.’¹⁰

Meanwhile, the RAF Regiment’s LAA squadrons came ashore and deployed to several sites where Advanced Landing Grounds (ALGs) were under construction. First to become operational was 2834 LAA Squadron, which was allocated to Brazenville airfield (B.2) and reached operational status with the six guns of ‘A’ Flight before midnight on 7 June; the guns of ‘B’ Flight became operational the following day. By 18 June, ten LAA squadrons had deployed to airfields in the British sector under Mobile Wing Headquarters control.



Spitfires at the first Normandy ALG.



In the open and unprotected: a fuel dump at an ALG.



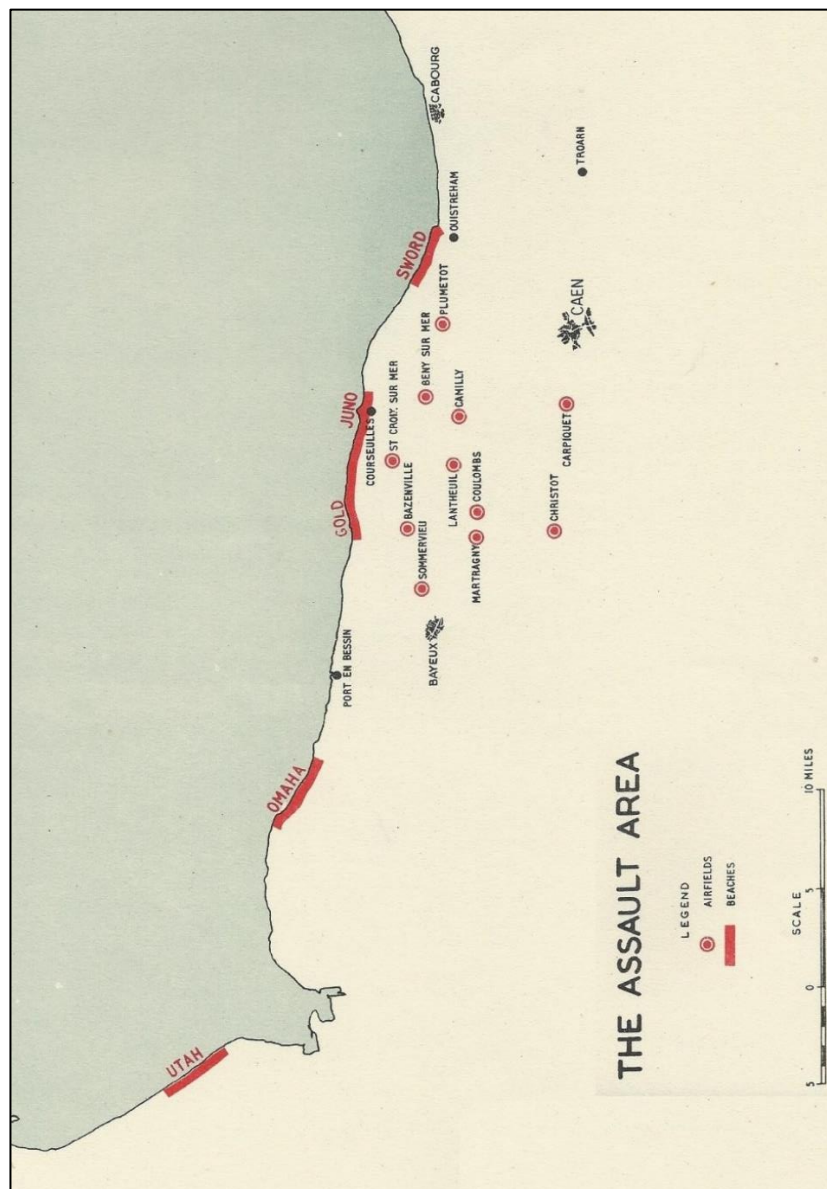
Ammunition – no less vulnerable or combustible.



RAF Regiment gunners digging in at a Normandy ALG.



A Royal Air Force Regiment Bofors gun at a Normandy ALG.



Wing	LAA Squadron	Location	Date of Landing
1305	2834	<u>Bazenville</u> (B2)	7 June D+1
1304	2809	<u>St Croix-sur-Mer</u> (B3)	7 June D+1
1309	2819	<u>Beny-sur-Mer</u> (B4)	7 June D+1
1300	2817	<u>Camilly</u> (B5)	8 June D+2
1302	2876	<u>Coulombs</u> (B6)	8 June D+2
1301	2703	<u>Martragny</u> (B7)	14 June D+8
1308	2794	<u>Sommervieu</u> (B8)	16 June D+10
1303	2736	<u>Lantheuil</u> (B9)	17 June D+11
1306	2734	<u>Plumetot</u> (B10)	17 June D+11
1307	2875	<u>Les Buissons</u> (B16)	18 June D+12

The Regiment squadrons were responsible for the close AA defence of airfields under construction until the arrival of the first 106 Brigade units, normally just before airfields commenced operations. Responsibility for close AA defence and operational control of the RAF Regiment LAA squadrons then passed to the local Anti-Aircraft Defence Commander, who was appointed by the commander of 106 Brigade.¹¹

The Luftwaffe's reaction to the landings fell far short of expectations, and the Allies immediately secured air superiority. Intermittent raids on the ALGs called the anti-aircraft gunners into action, and the RAF Regiment LAA squadrons claimed 14 aircraft destroyed and 13 damaged between 7 June and 15-16 July.¹² Yet the Germans reorganised their western air forces, and discussions between Jagdkorps II and Seventh Army produced a plan to protect supplies and reinforcements en route to Normandy, to provide tactical support to front-line troops, and to target Allied airfields.¹³

The RAF Regiment reported ten attacks by enemy aircraft on beachhead landing grounds between 1320 hours on 4 July and 0135 hours on the morning following. A total of about 50 enemy aircraft were concerned of which four Messerschmidt 109s were destroyed. There were few repetitions of these tactics during the next two days but during the afternoon, night and early morning of 7/8 July there were 11 attacks. The most active day was 14 July when 34 attacks were made on landing grounds, 19 of them

by single aircraft. A total of 17 enemy aircraft were shot down. On 16 July some 15 to 20 enemy aircraft carried out an elaborate attack on Carpiquet airfield just before midnight but except for three daylight attacks on 4 July, the other operations were carried out by very small numbers of aircraft and the damage done was negligible.¹⁴

The raids mounted on 14 July took advantage of bad weather, which substantially reduced the Allied air effort. One of the largest involved a formation of more than 50 aircraft, which attacked Martragny airfield (B7). The guns of 2703 LAA Squadron and units of 106 AA Brigade responded and afterwards claimed between them 14 destroyed – a figure that was officially confirmed. However, during this action, the LAA defences also fired on Allied aircraft. A subsequent enquiry exonerated the RAF Regiment squadron, but the airfield commander placed one detachment of Army gunners under arrest and charged them with ‘firing at friendly aircraft’.¹⁵

This was but one episode in a running inter-Service argument over the deconfliction of combat air power and AA activity. The Army naturally wanted the freedom to defend itself from air attack – a freedom that could not be exercised if there was a risk of firing on friendly aircraft. To address this situation, a system of Inner Artillery Zones (IAZs) and Gun-Defended Areas (GDAs) had been devised, one excluding aircraft entirely from a given area, the other excluding all aircraft except fighters and permitting AA fire subject to a raid warning, a lack of Identification Friend or Foe (IFF) from the target aircraft, and direct communication with a Gun Operations Room. Yet in the restricted airspace above the Normandy lodgement area, the employment of IAZs and GDAs imposed significant tactical constraints on the RAF and the USAAF, reducing their capacity to provide effective air cover and offensive support to ground forces.

The problem of aircraft recognition was subsequently addressed following a request from 21st Army Group by Observer Captain VO Robinson OBE, MC, of the Royal Observer Corps, and six experienced Royal Observer Corps officers who deployed from the UK. In August, they toured the Army’s AAA sites in France to assess the standard of aircraft recognition and suggest improvements. After visiting 65 different units – Brigade Headquarters, batteries and individual gun crews – they concluded that there was ‘a considerable variation of efficiency’ extending across the Royal Artillery HAA and LAA elements. There were three main reasons for this:

- 1) No standard was laid down.
- 2) No establishment of qualified aircraft identifiers existed.
- 3) Efficiency consequently varied with the attitude of the Commander of each individual unit to the subject. The opinion of the troops and battery commanders was the most important under the existing circumstances and organisation, and then that of the Regimental and Brigade commanders.¹⁶

Robinson and his team found that a very considerable knowledge of aircraft recognition existed but, 'owing to lack of standard establishment and qualifications and lack of status of the subject, also owing to inadequate organisation of regimental instructors and instructional material, that knowledge was quite haphazard in its distribution.' Some fire units were reportedly 'very poor', others 'very bad and certainly likely to make mistakes'. He recommended that there should be a minimum establishment of qualified instructors and that qualified aircraft identifiers should be provided down to the lowest tactical levels; of necessity, these identifiers should undertake recognised tests at regular intervals. He also urged improvements in the supply of instructional literature and proposed that the instructional vans then in use should be replaced by a larger type equipped with episcope, film projectors and accommodation for a class of up to 12 personnel.¹⁷

Eventually, in keeping with the trend observed in earlier campaigns, the Luftwaffe attacks declined as Allied forces enlarged their presence in the lodgement area and strengthened their air defences. Against this background, 83 Group requested the withdrawal of some 106 Brigade AAA cover, and both the IAZs and GDAs were substantially reduced in size. For 106 Brigade, daylight engagement beyond the revised GDA was made subject to authorisation by the 83 Group Control Centre. By night, all LAA guns were permitted to engage aircraft that were clearly hostile and were also allowed to employ barrage fire¹ against unseen targets with authorisation from the Anti-Aircraft Operations Room. If an airfield was directly attacked, this authorisation was automatically delegated. However, all barrage fire was subject to the approval of the airfield commander.

1. Due to the limitations of the HAA gun at low altitudes and to the lack of suitable radar equipment for laying the LAA gun, LAA barrages had become increasingly important. Barrage zones were calculated from radar information received by the LAA control nodes and passed to the guns.

The RAF Regiment LAA squadrons raised their claim to 19 aircraft destroyed and 13 damaged by the end of July, but the airfield AA guns were rarely called into action in Normandy thereafter.¹⁸

The Allied advance through France and Belgium, and into The Netherlands, involved the continuous movement of AAA elements from one airfield to the next. Ramp space was at a premium and the bases were often packed with aircraft, but the deterrent effect of the Allied air defences, in the context of the Luftwaffe's weakness, kept all but a few raiders away. As 84 Group consolidated their position on the continent in support of 1st Canadian Army, more RAF Regiment squadrons deployed, and a total of 18 AA squadrons had been incorporated into 83 Group and 84 Group by the end of August.

During Operation Market Garden in the second half of September, combat aircraft from 83 Group deployed into Eindhoven, Grave and Volkel airfields in The Netherlands. Close to the front line and at first benefiting from only limited radar coverage, all three were potentially vulnerable to air attack, and they were soon occupied by a total of ten RAF Regiment LAA squadrons;¹⁹ but growing Allied fighter strength over eastern areas of The Netherlands in late September and October eliminated much of the threat.²⁰ Eindhoven was visited by a lone Me. 109 on 27 September, which was driven off by a single gun, and four Ju. 88s ran into a storm of Bofors fire over Grave on the following day. The gunners subsequently claimed two hits.²¹

A new challenge first appeared on 2 October, when a formation of six Me. 262 jet fighter-bombers attacked Grave; they caused about 35 casualties but no aircraft sustained damage.²² Another two jets targeted Grave on the 6th, wounding three RAF Regiment personnel,²³ and there were further raids on 7, 11, 12, 13 and 21 October; five more Me. 262s bombed the airfield on the 22nd.²⁴ The Luftwaffe also attacked Volkel on 11, 12, 13, 14, 15 and 21 October. The second of two raids on the 11th left one Typhoon damaged, and three raids on the 12th caused both damage and casualties, including some fatalities. Between five and ten Me. 262s were reportedly involved on the 14th.²⁵ Yet the documents show that the airfield attacks virtually ceased in the second half of the month. It was in this context – and with radar coverage improving steadily – that the 83 Group visual observation capability was withdrawn. The observer units appeared to be serving no useful purpose.²⁶ November again witnessed only a few attacks on Volkel, Eindhoven and Grave, but the German aircraft largely maintained attack profiles that made them very difficult to engage, typically flying at altitudes beyond the reach of the Bofors guns or making single passes at high speed and very low level.²⁷



The main forward 2 TAF airfields in the Low Countries at the end of 1944.



A Royal Air Force Regiment Bofors crew in action during the winter of 1944-1945.



Loading Bofors ammunition in sub-zero temperatures without gloves.



The wreckage of the Me. 262 shot down by 2875 Squadron RAF Regiment on 26 November 1944.



This is believed to be the first jet aircraft in history to be shot down by ground fire.

However, on the 26th, 2875 LAA Squadron RAF Regiment, based at the newly constructed Helmond airfield, became the first ground unit in history to shoot down a jet aircraft – another Me. 262 – for a total ammunition expenditure of 32 rounds. The gunners apparently observed the Me. 262 formation bombing north-east of the airfield before they opened fire, and the aircraft was flying at around 2,000ft when it was hit – significantly higher than the typical Luftwaffe ‘hedgehoppers’ but well within the Bofors’ engagement envelope. An approach at this altitude would also probably have generated a radar-based warning of impending trouble.²⁸ Two days later, Regiment gunners engaged two more Me. 262s over Helmond and the lower aircraft, flying at about 1,000ft, was shot down during the discharge of 21 Bofors rounds.²⁹

After the Germans launched their offensive in the Ardennes on 16 December, the 83 Group airfields faced a renewed challenge. Eindhoven and Volkel were among the targets of some nine attacks on the 17th, when RAF Regiment AA squadrons fired no fewer than 1,679 rounds and claimed five enemy aircraft damaged. There were further attacks the next day, and Helmond was targeted by a pair of Me. 262s on the 23rd. On the 25th, the Luftwaffe struck Eindhoven, hitting the Communications Flight dispersal, destroying four Austers and wounding five airmen. None of the attackers were shot down, but another Me. 262 was destroyed during a raid over Heesche airfield.³⁰

At the end of December 1944, the capacity of the forward Allied airfields was particularly stretched. With the Ardennes battle still raging, the pressure on ramp space was acute, and by no means every airfield in Allied hands was suitable for all-weather operations. Theoretically, 2 TAF policy was that no more than one flying wing should be assigned to each base, but this restriction had proved impossible to maintain in practice, forward deployment being essential to maximise aircraft endurance over the battle front and beyond.³¹ And along with all the aircraft crammed into the main Dutch and Belgian bases came vast quantities of munitions and aviation fuel. The airfields were of course heavily defended by fighters and by RAF Regiment and Army LAA units, although the scale of Army cover had been cut and RAF Regiment reductions were under consideration.³² Radar coverage from the Low Countries into north-western Germany was excellent by this time, and, as always, the ‘Y’ Service supplied further intelligence for warning and tracking purposes. However, as we have seen, visual observation no longer formed part of the air raid reporting system.

It was against this background, and in conditions of the utmost secrecy, that the Luftwaffe planned Operation Bodenplatte to target the more easterly 2 TAF and IXth Air Force airfields. Ranking as the largest single German counter-airfield operation since the invasion of the Soviet Union, Bodenplatte was eventually

launched on New Year's Day 1945. Between 790 and 870 fighters were involved, and the inclusion of a training formation within this force suggests that all available aircraft were committed. Few such operations could better illustrate the importance of layered air defence. Luftwaffe preparations were missed by Allied intelligence (layer 1); the German fighters evaded radar (layer 2) by flying at ultra-low level; unobserved by radar, they also evaded fighter interception (layer 3); they rendered themselves invulnerable to 'Y' (layer 4) by maintaining strict radio silence; and they were not reported by observers (layer 5) because visual observation in 83 Group had ceased.

Yet layer 6, AAA batteries along the Luftwaffe ingress and egress routes and those at or near the airfields, could not be evaded. Moreover, Allied fighters became involved on an increasing scale as Bodenplatte progressed. The Germans secured near-complete tactical surprise, but their achievement in terms of Allied losses has proved difficult to establish with certainty. Many airfields were left in a state of chaos, strewn with wrecked aircraft and shrouded in smoke and flames; early calculations of around 300 Allied aircraft destroyed or damaged³³ have been raised in some recent histories, and innumerable bomb dumps and fuel depots also went up in smoke. Yet the Allies escaped with relatively few personnel casualties. By contrast, Luftwaffe losses on 1 January 1945, originally estimated at between 210 and 220 aircraft destroyed or damaged, may also have been higher, and German aircraft losses were matched by aircrew casualties killed and captured. Inexperienced or under-trained, or both, many of the German pilots lingered for too long at low altitude near the Allied flak guns.³⁴

Predictably, over-claiming was rife. While the Allied fighter forces claimed a total of 92 aircraft destroyed, Royal Artillery gunners claimed 122 and US Army gunners 194. There were doubtless many occasions when one aircraft was engaged by several guns. The RAF Regiment, positioned on the target airfields, claimed a more modest 43 destroyed and 28 damaged, but this was the highest number of claims submitted by the Regiment on a single day throughout the war by a substantial margin. Details of attacks by some 335 aircraft against 11 airfields are as follows:³⁵

Uphoven (US Sector). This airfield was attacked between 0915 and 0955 by 55 aircraft, including Fw. 190s, Me. 109s and Me. 262s flying at altitudes between 50 and 2,000 feet. They were engaged by the guns of 2876 and 2794 LAA Squadrons, which fired 705 rounds and observed 23 hits. Claims were submitted for a total of four aircraft destroyed. There were no RAF Regiment casualties.

Eindhoven. This airfield was attacked by approximately 70 aircraft between 0915 and 0950. They were engaged by the guns of 2703, 2817 and 2773 LAA Squadrons, which fired 2,750 rounds. Claims were submitted for six enemy aircraft destroyed. RAF Regiment casualties were two killed and seven wounded.

Volkel. Volkel was attacked between 0925 and 0945 by more than 20 aircraft. In the initial attack, the guns of 2834, 2809 and 2874 LAA Squadrons held fire to allow RAF aircraft to take off, and because other friendly aircraft were overhead. The squadrons went into action at 0930, when 188 rounds were fired, and claims were afterwards submitted for five enemy aircraft destroyed. There were no RAF Regiment casualties.

Helmond. A total of 31 enemy aircraft attacked the airfield between 0919 and 1026 and were engaged by the guns of 2873, 2875 and 2881 LAA Squadrons; 1,937 rounds were expended, and claims were submitted for six aircraft destroyed and five damaged.

Heesch. At 0920 hours, 31 enemy aircraft approached this airfield at tree-top height and were engaged by the guns of 2734 and 2819 LAA Squadrons, which fired 344 rounds. Claims were submitted for seven enemy aircraft destroyed and two damaged.

Antwerp-Deurne. This airfield was attacked at 0925 by 16 enemy aircraft, which were engaged by one flight of 2880 LAA Squadron. It was attacked again at 0940 by 14 enemy aircraft and again at 1000 by three enemy aircraft; 120 rounds were expended, and claims were submitted for one damaged aircraft. One airman was wounded.

Gilze Rijen. Intermittent attacks were made on this airfield between 0922 and 1005 by 20 or more Luftwaffe aircraft using cannon and machine gun fire, and anti-personnel bombs. They were engaged by 2895 LAA Squadron and one flight of 2736 LAA Squadron; 806 rounds were expended, and the squadrons claimed three enemy aircraft destroyed (including one Me. 262)

and five damaged. RAF Regiment casualties were one officer and two other ranks wounded by cannon fire.

Woensdrecht. This airfield was attacked at 0925 by eight enemy aircraft, which were engaged by 2872 LAA Squadron; 44 rounds were expended and claims were submitted for two enemy aircraft destroyed and one damaged.

Grimbergen. There were no flying wings located at Grimbergen when, at 0920, the deserted airfield's installations were attacked by 24 enemy aircraft. They were engaged by Bren guns on armoured vehicles belonging to two flights of 2777 Armoured Squadron and the Bren guns of one rifle flight of 2719 Rifle Squadron; 2,300 rounds of small-arms ammunition were expended, and claims were submitted for three enemy aircraft destroyed and two damaged. Three pilots who baled out of their aircraft were also captured. There were no RAF Regiment casualties.

Brussels-Evere. This airfield was attacked by 40 or more aircraft, which were engaged by 2800 LAA Squadron; 350 rounds were expended, and claims were submitted for three enemy aircraft destroyed and eight damaged.

Brussels – Melsbroek. Attacks were made by at least 25 aircraft on this airfield between 0919 and 0945 hours, which were engaged by guns of 2701 LAA Squadron; 300 rounds were expended and claims submitted for four enemy aircraft destroyed and four damaged.

One Regiment gun commander at Melsbroek was Sergeant George Daniel Toye. According to the *London Gazette*,

In January, 1945, Sergeant Toye was in command of a detachment which had been withdrawn from action for airfield patrol duties. The gun had been left in a position ready for action. At about 09.25 hours another airman, who was on sentry duty, warned Sergeant Toye of the approach of between 36 and 50 enemy aircraft. Sergeant Toye immediately ordered his men to

‘take post’ and in spite of the automatic loader being filled with AP^m ammunition, got the gun into action with such speed that he was able to engage the first of six Me. 109s which came in to attack a nearby dispersal ground. Immediately afterwards four Fw. 190s and two Me. 109s attacked Sergeant Toye’s gun post. Cannon shells and machine gun bullets struck all around and casualties were sustained. Undeterred, Sergeant Toye continued to instruct his men and engaged the attackers as they dived low to attack; one after another in rapid succession. The deliberate attack against the gun post was temporarily abandoned. Sergeant Toye then engaged a Me. 109 which was coming in to attack aircraft on the ground; a hit was obtained and the enemy aircraft was observed to go down omitting black smoke. A further two Fw. 190s then came in to attack the gun post.

Sergeant Toye remained unperturbed and engaged the aircraft as they came in to attack almost simultaneously from different angles. One of the attackers was hit and set on fire. This was the first occasion on which the detachment had been under enemy fire. Sergeant Toye’s outstanding courage, initiative and leadership inspired his comrades and contributed largely to the success achieved.³⁶

Toye was subsequently awarded the Military Medal. Another recipient was Leading Aircraftman Hugh Adair of 2876 Squadron (Eindhoven), who likewise continued firing from a Bofors position that was under direct air attack.³⁷

It is unlikely that the statistical discrepancies generated by Operation Bodenplatte will ever be fully resolved, but they are not especially important. The key issue is that, in the context of front-line strength, reserves and logistical capacity, the losses inflicted on the RAF and the USAAF were sustainable, whereas those incurred by the Luftwaffe were not. Indeed, they were disastrous. The Germans sacrificed aircraft and aircrew that they could not hope to replace.

m. AP – Armour Piercing; the Bofors gun could be used in a ground role, and some guns had been supplied with AP rounds after the Germans launched their offensive in the Ardennes.



A destroyed Dakota at Brussels-Melsbroek airfield.



Another victim of Operation Bodenplatte.



A Lancaster that may just have survived...



And one that certainly did not.



A Luftwaffe Fw. 190 shot down during Operation Bodenplatte.



The burned-out remains of a Me. 109.

In the aftermath, Coningham initiated a review of 2 TAF orders for the protection of airfields and there was some reallocation of aircraft between bases to improve dispersal; on-airfield dispersal drills were similarly revived, and 2 TAF reversed their plans for cutting AAA protection. By 18 February, there were 28 RAF Regiment LAA Squadrons on the continent. But Bodenplatte would never be repeated, and these enhanced air defence measures were barely tested before the Second World War in Europe ended.³⁸

Throughout the inter-war years, UK GBAD remained desperately weak, despite the emergence of significant air threats in Europe, the Mediterranean and the Far East. Anti-aircraft defences proved easy to reduce after the First World War but difficult to enlarge in the 1930s. The diminutive scale of airfield anti-aircraft defence on the outbreak of war in 1939 was part of this broader deficiency. Its true significance would only become clear when, on the very first day of the conflict, the Luftwaffe set out to destroy the Polish Air Force on the ground. With warfare now firmly established in three dimensions, airfields had become a primary target for air attack.

In the early wartime period, the UK had no realistic alternative but to assign a preponderant airfield AA role to the Army, leaving RAF personnel to provide extremely limited LAA defence with machine guns. Yet the Army had many other commitments, and it was inevitable that, in the heat of battle, cover for airfields should often have been inadequate. The most effective protection was achieved by integrating GBAD with other air defences on the UK mainland or by assigning Army AA brigades to deployed air formations such as the WDAF. When Army AA elements were not integrated with the RAF in this way, airfields were often left without effective defences. Similarly, efforts to improve air defence rarely delivered satisfactory results if they were too narrowly focused. Genuine advances in one sphere, such as GBAD, were often linked to broader developments in areas such as radar, fighter protection and passive air defence. Significant progress was difficult to achieve without accepting that air defence was a multi-faceted entity.

The creation of the RAF Regiment in 1942 promised to eliminate many of the problems that had previously arisen in the field of airfield AA defence at the air-land interface, and the RAF's dependence on the Army for AAA also declined for other reasons. With RAF and USAAF fighters increasingly dominating the skies at medium-to-higher altitudes, there was less need for the Army's heavy AA guns by 1943. But any hopes of an airfield AA defence solution provided by RAF fighters at high altitude and RAF gunners lower down were to prove unrealistic. Neither the manpower nor the Bofors gun resources were available. It was not possible to establish the RAF Regiment on the scales originally envisaged, and, while Bofors guns replaced the Hispanos in north-west Europe and Italy, there

were never enough for the Far East. Thus, for the remainder of the war, airfield AA defence was a joint affair.

For the Allies, the Second World War in Europe ended with a salutary lesson in the dangers of reducing airfield air defence. After a long period of pinprick hit-and-run attacks on forward Allied bases, a major Luftwaffe strike seemed so unlikely by December 1944 that 2 TAF had reduced dispersal measures and withdrawn 83 Group's visual observation capability. The scale of Army AA defences had been reduced, and RAF Regiment LAA cuts were also under consideration when, on 1 January 1945, the Luftwaffe delivered the sucker punch of Operation Bodenplatte. After the German fighters skilfully evaded multiple Allied countermeasures and reached the target airfields in the Low Countries and France, their only remaining adversary was the anti-aircraft gun.

Notes

1. AHB, *Ground Defence*, Chapter 5, pp. 30-33.
2. Oliver, *The RAF Regiment at War*, p. 104.
3. AHB, *Ground Defence*, Chapter 7, Appendix 2. The balance for airfield defence in the UK totalled 192 guns; for 25 LAA squadrons in 2 TAF, each assigned 12 guns, the total would have been 300 without any provision for replacements.
4. Pemberton, *Artillery Tactics and Equipment*, p. 219.
5. Ibid; AHB, *Radar in Raid Reporting*, p. 420.
6. Report by Group Captain WG Tailyour, Air Staff Officer, Force S, 19 June 1944, Appendix IV/36, Notes on the Planning and Preparation of the Allied Expeditionary Air Force for the Invasion of North West France in June 1944, Appendices to Chapters I-IV (AHB Siracourt archive).
7. Ibid.

8. Of the 750 men assigned to Lieutenant Colonel TBH Otway's 9th Parachute Battalion to seize the Merville Battery, he was able to assemble just 150. See Ritchie, *Arnhem: Myth and Reality*, p. 68.
9. AHB, *Radar in Raid Reporting*, pp. 429-430.
10. Ibid.
11. AHB, *Ground Defence*, Chapter 7, p. 10.
12. Ibid.
13. AHB narrative, *The Liberation of Northwest Europe, Vol IV, The Break-Out and the Advance to the Lower Rhine, 12 June-30 September 1944*, p. 29.
14. Ibid., p. 30.
15. AHB, *Ground Defence*, Chapter 7, pp. 10-12.
16. AHB narrative, *The Royal Observer Corps*, pp. 168-169.
17. Ibid.
18. AHB, *Ground Defence*, Chapter 7, pp. 10-12.
19. Ibid., pp. 20-21, 28.
20. AHB narrative, *The Liberation of Northwest Europe, Vol V, From the Rhine to the Baltic, 1 October 1944-8 May 1945*, p. 30.
21. AHB, *Ground Defence*, Chapter 7, pp. 33-34.
22. 83 Group Intelligence Summary, 3 October 1944 (AHB, Siracourt archive).
23. 83 Group Intelligence Summary, 7 October 1944.
24. AHB, *Ground Defence*, Chapter 7, pp 33-34; 83 Group Intelligence Summary, 22 October 1944.

25. 83 Group Intelligence Summaries of 12, 13 and 15 October 1944; Air Ministry War Room ASO Summary 1423, 14 October 1944 (AHB, Siracourt archive); AHB, *Ground Defence*, Chapter 7, pp 33-34; 83 Group Intelligence Summary, 22 October 1944.
26. AHB, *Radar in Raid Reporting*, p. 455. The withdrawal applied to 83 Group, but Wireless Observation Units continued to operate in at least one other Group – 85 Group – five units being present in the Ardennes at the time of the German offensive in December.
27. 83 Group Intelligence Summaries of 4, 5, 7 and 11 November 1944.
28. TNA AIR 29/1118, 1309 Mobile Wing RAF Regiment Operations Record Book, November 1944; 83 Group Intelligence Summary, 26 November 1944.
29. 83 Group Intelligence Summary, 28 November 1944.
30. 83 Group Intelligence Summaries of 17, 18, 23 and 25 December 1944.
31. AHB, *The Liberation of Northwest Europe*, Vol V, p. 102.
32. AHB, *Ground Defence*, Chapter 7, pp. 49-50.
33. AHB, *The Liberation of Northwest Europe*, Vol V, p. 101.
34. AHB, *The Liberation of Northwest Europe*, Vol V, p. 101; John Manrho and Ron Pütz, *Bodenplatte: The Luftwaffe's Last Hope* (Stackpole, Mechanicsburg PA, 2010), pp. 460-462. Manrho and Pütz estimated that the Allies lost 290 aircraft on the ground and that 180 more were damaged. One contemporary German estimate based on air reconnaissance imagery was that 479 Allied aircraft were destroyed on the ground and in air combat, and 114 were damaged; see Operation Bodenplatte, translation AHB5/234, Attack on Allied Airfields on 1st January 1945 (AHB Box 485). Manrho and Pütz record that the Luftwaffe lost 271 single-engined fighters, that 65 more were damaged and that 13 Ju. 88s were also destroyed or damaged. No fewer than 143 German pilots were listed killed or missing after Bodenplatte, 70 were taken prisoner and 21 were wounded.

35. AHB, *The Liberation of Northwest Europe, Vol V*, p. 102; AHB, *Ground Defence*, Chapter 7, pp. 46-49. HQ 2 TAF Intelligence Summary, 2TAF/30256/1/Int dated 8 January 1945 confirms this figure of 43 destroyed. However, Regiment in Action Report No. 34 dated 2 July 1945 states that the Regiment gunners shot down 27 enemy aircraft and damaged a further 59.

36. *London Gazette*, 10 April 1945 (citation dated 13 April 1945).

37. *London Gazette*, 1 January 1946 (citation dated 4 January 1946).

38. AHB, *The Liberation of Northwest Europe, Vol V*, pp. 102-103; AHB, *Ground Defence*, Chapter 7, pp. 49-50.

8. Post-War Postures

The Second World War witnessed the emergence of a fundamental and enduring difference in the GBAD doctrine of the RAF and those Army anti-aircraft forces that existed to protect manoeuvring ground formations, their lines of communication and static Army facilities, rather than defending bases or operating within the wider IADS. For them, anti-aircraft defence was a simple two-way process between the gun and the attacking aircraft in which other aspects of the air battle were unimportant. By contrast, for the RAF and Army elements assigned to the IADS and airfield defence, GBAD was part of a broader air effort to protect friendly territory and military installations. This implied that the GBAD mission would be executed in environments characterised by more dense and complex airspace utilisation and friendly as well as hostile air activity. For this reason, the problem of combat identification came to feature more prominently in RAF than Army tactical doctrine and, as we have seen, Army (and Navy) gunners unaccustomed to close cooperation with the RAF regularly fired on their own aircraft.

After the war, UK GBAD evolved along more polarised lines, the Army becoming overwhelmingly focused on the protection of fielded forces while the RAF concerned itself largely with airfield defence. Such ties as had originally existed between the Services in the GBAD sphere were substantially severed, and the doctrinal gulf between them grew wider still. In 1946, the Air Ministry decided that the RAF Regiment should continue to exist as a permanent part of the Service, with some 667 officers and 5,191 airmen organised into 21 squadrons and one independent flight. The Regiment's wartime LAA gunnery school survived and settled at its long-term home at Watchet in July 1947.¹

However, the Regiment's LAA capability was cut to a single squadron, the remaining 20 being field squadrons – rifle squadrons and armoured car squadrons – which were based in West Germany or the Middle East.² Thus, when Royal Egyptian Air Force (REAF) Spitfires attacked Ramat David airfield in Palestine on 22 May 1948, just before it was taken over by the Israelis at the end of the British Mandate, they were confronted not by the Bofors guns of an LAA squadron but the Bren guns of 52 Rifle Squadron. While the REAF destroyed three aircraft on the ground and damaged seven more, they lost five of their own, one of which was shot down by Bren gun fire. At the time of writing, this remains the last aircraft shot down by an RAF ground weapon in a live combat scenario.³

In 1949, rising East-West tensions led to four field squadrons in West Germany being converted to the LAA role, and a further 16 LAA squadrons were raised in

the UK and dispatched overseas between July and December 1951. By the end of 1952, 20 LAA squadrons were based in West Germany and nine in the Middle East.⁴ The RAF Regiment also generated a strategic reserve that included two air-portable LAA squadrons. They were first tasked to defend American air bases in 1950, after the deployment of strategic bombers to Mildenhall, Lakenheath and Sculthorpe.⁵

Nevertheless, for the Regiment, the LAA capability hung in the balance for several years. The War Office pressed to regain the airfield AA role, and the Chiefs of Staff actually agreed in 1950 ‘that the Army should be responsible for the LAA defence of airfields and ancillary units at home and overseas, with the exception that the RAF should provide this defence at certain overseas stations outside an Army LAA defence layout.’⁶

However, in 1951, the War Office revealed that the regular Army could not provide LAA defence for airfields in West Germany and the Middle East in peacetime. It could only fulfil this function in time of war, following the mobilisation of Territorial Army (TA) LAA batteries. The Chief of the Air Staff, Marshal of the Royal Air Force Sir John Slessor, was unable to accept this position. Experience had shown that the risk of low-level attacks on airfields was at its greatest in the early stages of a war – before there was time to mobilise Army reserve units. He maintained that RAF LAA was cheaper than Army LAA and argued that the failure of Poland’s Army to provide adequate airfield defence in 1939 had been a central factor in her defeat. In his view, if the regular Army could not take responsibility for airfield defence in peacetime, the RAF would have to do so by employing its own resources. Slessor’s arguments prevailed.⁷

By the end of 1955, 18 RAF Regiment LAA squadrons were based in West Germany, four more were in the Middle East, and two were in the UK. The squadrons based in the Suez Canal Zone were withdrawn to Cyprus in 1954 and assigned to airfield defence at Akrotiri and Nicosia during the Suez crisis in 1956, when the two airfields were crowded almost to bursting point. Their strength was bolstered by a supporting deployment of Army LAA batteries, which were placed under the command of the Regiment wings. While the Army’s report on this part of the operation emphasised the problems that confronted the Royal Artillery in the unfamiliar airfield defence role, it praised the efficiency and high standards of aircraft recognition demonstrated by the Regiment.⁸ RAF Regiment LAA squadrons also provided LAA defence for the bomber squadrons that deployed to Malta during the crisis.⁹



The RAF Regiment providing a Bofors gun demonstration in West Germany, probably in the early 1950s.



RAF Regiment Bofors guns in the Suez Canal Zone.



Return to Hal Far: Canberras lined up in the open at the Malta base during the Suez crisis.



A Royal Air Force Victor at Akrotiri in 1959; Canberras and a single Shackleton are visible in the background.

The Defence White Paper of 1957 and its accompanying assumption of nuclear conflict heralded a significant reduction in the RAF Regiment's front-line strength. Many of the West Germany-based LAA squadrons had disbanded by the end of the year, and the Gunnery School at Watchet closed, leaving LAA training to be undertaken at Army facilities. The Regiment's final Middle East LAA commitment – at Amman, Jordan, to protect Venom fighters deployed under the Anglo-Jordanian defence treaty – also ceased.¹⁰

However, the Cyprus task proved far more enduring. In April 1955, the UK had signed the so-called Baghdad Pact, creating the Central Treaty Organisation (CENTO) with Turkey, Iraq and Pakistan. No other CENTO air forces possessed a bombing capability at that time, so the UK offered to provide an RAF force of four Canberra light bomber squadrons and one photographic reconnaissance squadron in theatre. This became known as the Near East Strike Force and deployed to Akrotiri in stages between February and November 1957.¹¹

At first, other RAF flying activity from Cyprus – air transport and rotary wing – was based at Nicosia. There was no resident fighter squadron in the later 1950s due partly to the prevailing low threat assessment and partly to the fact that fighters could rapidly be deployed forward if they were needed. However, from 1961 onwards, the Strike Force acquired a tactical nuclear capability, and the RAF then reassessed the island's air defences. The Hunters of 43 Squadron were based at Nicosia from 1961 to 1963, when 29 Squadron's Javelins took their place. RAF LAA squadrons were based at both airfields throughout this period, having exchanged their L40/60 Bofors for the superior L40/70 version of the gun in the late 1950s.¹²

Thus, protecting Cyprus by 1961 the RAF fielded a basic layered air defence system comprising the highly capable radar facilities on Mount Olympus, RAF Regiment visual observers,ⁿ a squadron of fighters and extensive LAA protection. Beyond this, the Near East Strike Force had a deterrent role and was not sedentary. It expended a considerable effort on developing and maintaining the ability to operate away from the Akrotiri base from airfields across the CENTO area, although the only specific necessity for dispersal occurred in response to ground threats during the EOKA insurgency, when El Adem in Libya was used. Aircraft from the Strike Wing were regular visitors to the former WDAF base and often employed the El Adem bombing range.¹³

n. All RAF Regiment LAA squadrons had so-called Control and Reporting Flights.

Notes

1. *Short History*, p. 34.
2. *Ibid.*, p. 32.
3. Oliver, *Through Adversity*, p. 185.
4. *Short History*, pp. 33-34.
5. *Ibid.*, p. 34.
6. Oliver, *Through Adversity*, p. 212.
7. *Ibid.*
8. *Short History*, p. 38.
9. History of 63 Squadron RAF Regiment (short card history, AHB Box 208).
10. *Short History*, p. 39; Oliver, *Through Adversity*, p. 218; Air Chief Marshal Sir David Lee, *Wings in the Sun: A History of the Royal Air Force in the Mediterranean, 1945-1986* (HMSO, London, 1989), p. 140.
11. Lee, *Wings in the Sun*, p.173.
12. *Ibid.*, pp. 176-177, 184, 187. Among other things, the L40/70 offered double the rate of fire.
13. AHB narrative, *The Bomber Role, 1945-1970*, pp. 69-70.

9. Protecting the V-Force

Meanwhile, a new chapter in the history of UK GBAD had commenced independently of the RAF Regiment. In 1953, the Air Ministry assumed responsibility from the War Office and the Ministry of Supply for the development and operation of surface-to-air guided weapons. A series of Air Ministry and Fighter Command studies then led to the formulation of plans under a new directorate within the realm of the Assistant Chief of the Air Staff (Operations) designed to integrate the new system into the UK air defence organisation from 1958. The essential training for technical personnel involved in trials and maintenance of the missile began in 1954, although courses for many operational personnel were deferred until development was more advanced.

The primary focus of the development programme was a missile code-named Red Duster. Red Duster employed a semi-active radar homing system and was designed to engage targets flying at altitudes between 10,000 and 60,000ft at 20 miles range. Two Thor ram jets powered the missile, four short-burning rocket-boost motors also providing acceleration up to a cruising speed of Mach 2. Its payload was a high-explosive warhead triggered by a proximity fuse. The missile, as inherited from the Ministry of Supply, displayed several serious limitations, including lack of resistance to electronic countermeasures, lack of low-level capability and short impact range. At first, therefore, the Air Ministry doubted Red Duster's value for anything beyond service trials.

However, it subsequently became clear that the ram jets could be developed to produce a longer-range weapon. The Air Ministry therefore decided to develop the missile in two stages, the first being an enlarged trial scheme to build experience in the RAF pending the introduction of the more capable Stage 2 weapon. Soon afterwards, the missile was renamed Bloodhound. The first Bloodhound sites were located near the east coast to form a defensive barrier between the Thames and the Humber, but the barrier plan was then dropped in accordance with the provisions of the Defence White Paper of 1957. Subsequently, Bloodhound would be used for point defence, to defend strategic nuclear deterrent bases and associated dispersal sites.¹

As part of the UK IADS, the Bloodhound capability relied on an extensive ground infrastructure. Direct support came from a tactical control radar, which acquired the targets and allotted them to firing sites, and a target illuminating or guidance radar, which trained on selected targets to produce a reflected radar response that the missiles homed on to. The missiles and their associated radars were brought to readiness after the early-warning radar chain detected and

identified a potential target and the responsible Sector Operations Centres and their controlling Master Radar Stations (MRS) decided that it should be engaged by missiles rather than fighters. A Tactical Control Centre (TCC) was responsible for the selection of missile sites for the engagement and for passing information supplied by the MRS on the target's position, height, course and speed to the launching site. Once the illuminating radar had acquired its assigned target, the missile could be launched. The measures instituted for the rapid transmission, processing, display and exchange of information at all levels between the early warning stations and the launch control points exploited radar, datalinks and computers to an extent that was revolutionary by the standards of the day.

Employed for point defence, the original plan was to construct nine missile sites to defend the V-Force airfields in eastern England and provide a degree of protection to some of the USAF's Thor Intermediate Range Ballistic Missile complexes. Eventually, after further technical development, it proved possible to reduce the number of firing units at each site and to redeploy the spare units to form two additional sites. The increased total of 11 sites was employed to defend all the projected Thor bases, the V-Force bases and dispersal airfields.

The Bloodhound I Surface-to-Air Missile (SAM) system was organised into four wings, each consisting of a TCC and its associated missile squadrons. The first was formed in July 1958 with its TCC at North Coates. This became 148 (AD) Missile Wing. Satellite stations were subsequently positioned at Dunholme Lodge and Woodhall Spa. The Wing thus provided cover to the V-Force bases at Scampton, Waddington and Coningsby, as well as the Thor facility at Hemswell. Operating with a TCC at North Luffenham, 151 Wing defended the bases further south, 24 Wing (TCC Watton) covered those in East Anglia and 2 Wing (TCC Lindholme) extended SAM protection to the more northerly deterrent sites.²

The creation of this force in Fighter Command necessitated an extensive programme of works. Although some units were based at established RAF stations, most were at isolated and disused wartime airfields and required new or refurbished technical and domestic accommodation. For personnel training, a SAM Operational Training School was established. By September 1960, three squadrons with 96 missiles were operational, and the deployment of all 11 squadrons (352 missiles) was completed in July 1961. The incorporation of Bloodhound into Fighter Command's Order of Battle coincided with early steps to rearm the Command's fighter squadrons with the supersonic Lightning.³

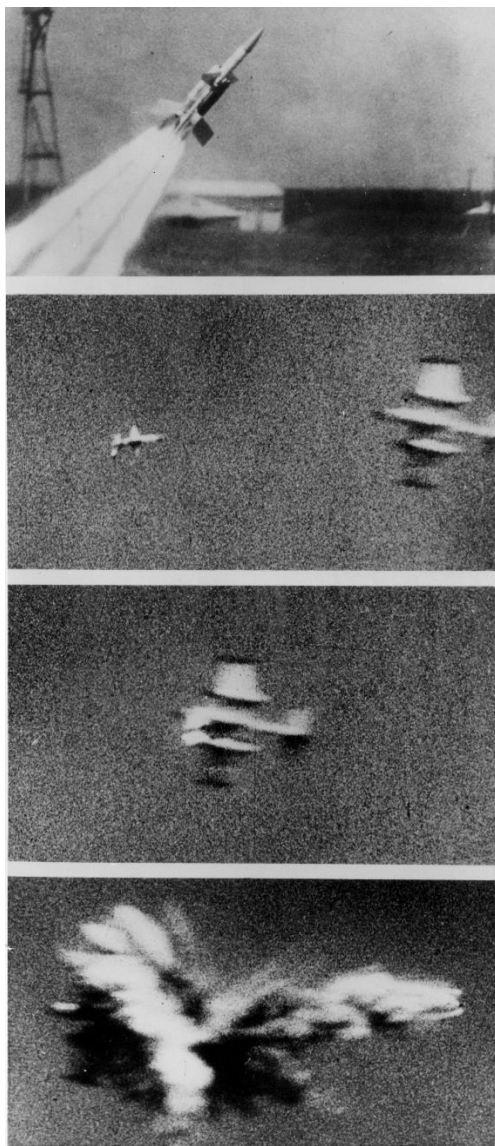
The improved version of the missile meanwhile remained under development. Originally, RAF plans were based on the procurement of a missile named Blue Envoy, but it was cancelled for financial reasons in 1957 – a decision with significant long-term consequences for SAM development in the UK. Bloodhound

II was less technologically advanced but exploited work undertaken for Blue Envoy. It promised greater speed and a maximum intercept range of around 75 NM. It was also deployable.⁴

While radar warning was critically important to all UK air defence measures, and conventional fighter defences were deployed as well as Bloodhound, these active capabilities must be considered in conjunction with passive air defence provisions. On-base dispersal was naturally maintained at the V-Force airfields, but the force was also developed in parallel with elaborate off-base dispersal plans. At the end of the Second World War, the RAF controlled approximately 252 UK airfields. Of these, at least 90 had been relinquished by 1950, and many of those still in service by the late 50s were not suitable for V-Force operations. Nevertheless, via a significant programme of capital investment and by employing aerodromes operated by the Ministry of Aviation and the Royal Navy, it was possible to generate the necessary dispersal capacity.

By May 1959, six V-Force stations were using ten dispersal sites ranging from Lossiemouth in the north to St Mawgan in the south.⁵ However, the force's growth and the mounting threat from the Warsaw Pact resulted in expansion from 1960, when the Treasury agreed to Air Ministry proposals for a network of 36 dispersal airfields to minimise the force's vulnerability to large-scale missile attack and allow enough aircraft to fly clear of their bases at virtually no notice.⁶ The new dispersal sites included airfields in Northern Ireland such as Ballykelly, Valley and Llanbedr in Wales, St Mawgan in Cornwall and, on the west coast of Scotland, Machrihanish. The Air Ministry argued that these more westerly sites would benefit from longer warning periods than bases in the east and that this justified the cost of adapting them for V-Force operations.⁷

The final V-Force dispersal plans were designed to disperse 75 per cent of the force within 24 hours of a strategic warning of Warsaw Pact attack.⁸ Batches of four aircraft were to deploy away from their normal bases, and their capacity to do so was underpinned by an arduous and intensive series of rehearsals throughout the force's history. Typically, aircraft held at reduced readiness states would be bombed up and then dispatched to the dispersal airfields, where they would be refuelled, serviced and prepared for scramble take-offs. These were also practised repeatedly until the actual scramble occurred, and the aircraft returned to their parent base.⁹



Bloodhound test firing, Woomera range,
Australia, 1958.



The Bloodhound tactical control radar at RAF North Coates, Lincolnshire, October 1958.



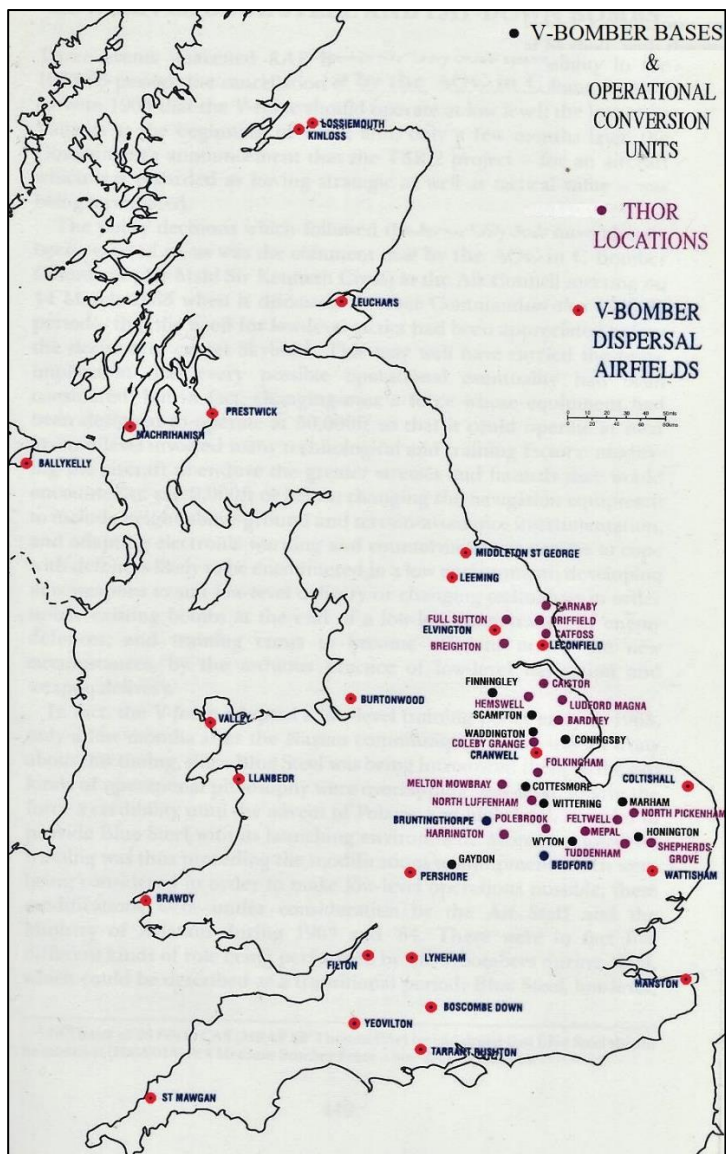
The target illuminating radar at the same base.



A Vickers Valiant at RAF Marham in May 1961; in the background are Bloodhound SAMs of 242 Squadron.



Bloodhound IIs of 85 Squadron at RAF West Raynham in 1976.



V-bomber bases, dispersal sites and Thor missile sites.

While the RAF maintained this dispersal regime until responsibility for the strategic nuclear deterrent passed to the Royal Navy at the end of the decade, the concept of employing SAMs to defend V-Force and other strategic air and weapons bases did not endure, and this resulted in substantial cuts to the RAF's Bloodhound force in the early 1960s. The four TCCs, which had been found susceptible to jamming, were withdrawn in January 1963, leaving the SAM squadrons to be regrouped under MRSs at Pattrington and Bawdsey. At the end of the year, an accelerated drawdown of the Bloodhound force began, and all the squadrons had been disbanded by 30 June 1964. Fighter Command was left with an aircraft strength of five Lightning and two Javelin squadrons. Planning for the Bloodhound II force was based on a strength of five squadrons, only two of which would be based in the UK.¹⁰

Notes

1. AHB narrative, *Developments in Air Defence, 1945-1970*, pp. 21-22; Richard Vernon, 'Bloodhound,' *Royal Air Force Historical Society Journal*, No. 62 (2016), pp. 48-49.
2. AHB, *Air Defence, 1945-1970*, p. 22.
3. Ibid., pp. 21-23; Vernon, 'Bloodhound,' pp. 48-49.
4. Vernon, 'Bloodhound,' pp. 57-64.
5. AHB, *The Bomber Role*, pp. 83-84.
6. Ibid., p. 43.
7. Ibid., p. 110.
8. Ibid., p. 108.
9. Ibid., p. 41.
10. AHB, *Air Defence, 1945-1970*, p. 27.

10. The Indonesian Confrontation

The requirement for overseas GBAD capabilities, previously considered in the context of Cyprus, next emerged in the Far East. In detail, the origins of the Indonesian Confrontation lie beyond the scope of this history, but it stemmed from British decolonisation plans for Singapore, Malaya and Borneo, which were incompatible with Indonesia's aspiration to exercise hegemony in the region; the transformation of Malaya into Malaysia was particularly contentious.¹ The geographical aspects of this situation must be fully appreciated: the British territories were enclosed by the Indonesian islands to the west, south and east and were thus extremely difficult to defend. Yet Singapore was still of considerable importance to the UK. The RAF's Far East Air Force (FEAF) maintained several airfields on the island, and it served as a vital supply hub for British forces in Borneo. Additionally, far to the north-west in the territory that was to become Malaysia, Butterworth was by this time serving as a base for the RAAF.

During 1962 and 1963, the confrontation was confined to Borneo, hundreds of miles east across the South China Sea, but the threat of Indonesian military action against Singapore increased significantly following the proclamation of Malaysia in September. After a series of incursions over Eastern Malaysian territories in Borneo by the Indonesian Air Force, FEAF declared an Air Defence Identification Zone (ADIZ) in the region and deployed Hunter and Javelin fighters to Borneo to police it. This represented a considerable burden and raised questions about the potential vulnerability of Western Malaysia and Singapore, given the reduction of fighter defences. Moreover, while radar coverage was inevitably far better than in 1941, a low-level gap remained on the exposed western coast, beyond the reach of the stations at Butterworth and Bukit Gombak, on Singapore island.²

Under British defence policy since 1957, conventional air defence provisions had been substantially reduced, and, despite the pressure on FEAF's fighter force, no additional aircraft could at first be made available from other theatres.^o UK GBAD resources were also stretched. Bloodhound I was being withdrawn, but Bloodhound II was not yet operational; the RAF Regiment had shrunk to 11 squadrons by September 1963, four of which were LAA squadrons, and all of these were assigned to Cyprus. The Regiment's contribution to FEAF comprised three field squadrons numbered 1, 15 and 63.³

o. With the Fighter Command's conversion to the Lightning in progress, most of the more deployable RAF fighter squadrons equipped with Javelins and Hunters were already committed to Germany, Cyprus, Aden and FEAF.



Gunners of 63 Squadron RAF Regiment at Tengah, Singapore, with a Bofors L40/70 in 1965.



A Belvedere helicopter of 66 Squadron deploying a Bloodhound II to Kuching, Borneo.



A Bloodhound II of 65 Squadron at Seletar, Singapore, in 1966.



The same location, but with other deployed missiles visible in the background.

The growing threat to Western Malaysia and Singapore led to the conversion of 63 Squadron to the LAA role at Tengah in December 1963; 1 Squadron also assumed LAA duties at Butterworth from February 1964, when the Regiment LAA defences were further reinforced by the deployment of 26 Squadron from Cyprus to Changi. Nevertheless, more guns were needed to provide adequate protection for the airfields and other RAF sites. For this reason, a Royal Artillery light air defence regiment deployed from West Germany to augment the RAF Regiment resources, positioning batteries at Changi and Tengah. At Butterworth, the Royal Australian Artillery assumed a similar role. The joint LAA defences at each station were fully integrated under the local RAF Regiment commander.⁴

While the priority allocated to Singapore and Western Malaysia made sound strategic sense, it left no LAA available for the Borneo airfields, and improvisation proved necessary. The Royal Navy provided surplus stocks of Oerlikon 20mm cannon from the Singapore naval base, and Navy instructors trained RAF Regiment NCOs to use them. The NCOs and the guns were then airlifted to Borneo so that personnel at airfields such as Labuan and Kuching could be trained to operate them in an emergency.⁵

On 2 September 1964, an Indonesian Air Force C130 dropped 96 paratroops near Labis in northern Johore (the most southerly state of Western Malaysia), successfully evading the RAF's defences – although it subsequently crashed. The implications of this incursion were far-reaching: if a transport aircraft could accomplish such a mission, the threat posed by Indonesian combat aircraft had to be taken far more seriously, and there was every reason to expect that an attack, if it materialised, would target the RAF and RAAF airfields. HQ FEAF responded by placing all combat aircraft in theatre on alert. The County Class cruiser, HMS Kent, was deployed to the Malacca Strait in an air defence role to close the radar gap, and Fleet Air Arm Gannets disembarked from HMS Victorious and joined the RAF and RAAF aircraft on patrol over Western Malaysia. An additional eight Javelins from 64 Squadron deployed from the UK to Tengah.⁶

All the LAA guns were deployed: in other words, they were sited in their correct defensive positions and maintained at constant readiness. The RAF Regiment guns were continuously manned by 60 per cent of squadron personnel, while the remainder held at 48 hours' notice.⁷ The gunners maintained this gruelling deployment from September 1964 to August 1966.⁸ Additionally, 65 Squadron had arrived in theatre early in 1964 to undertake tropical trials with Bloodhound II, and it was also incorporated into the FEAF defences in September with orders to bring one missile section to immediate operational readiness at Seletar, Singapore.⁹ Actual or threatened violations of the Borneo ADIZ in 1965 led to one of 65 Squadron's mobile sections being deployed forward to Kuching

late in 1965, and two Bloodhound II sections of 33 Squadron became operational at Butterworth at about the same time. By April 1966, 33 Squadron had positioned all four of its SAM sections there.¹⁰

Behind all these measures, the key objective was deterrence. They should be considered in conjunction with the further expansion of the fighter force in 1965, when 64 Squadron joined FEAF in its entirety (delaying the Javelin's retirement in the process), and with the deployment of V-bombers into theatre throughout the confrontation.¹¹ The aim was to send the clearest possible message to Indonesia that it would be extremely unwise to target Malaysia or Singapore from the air. To this extent, the fact that the RAF's defences were not tested during the Confrontation does not mean that they were unnecessary or extravagant; it means that they were successful.

Yet we should not underestimate the costs involved. For the RAF Regiment, increased commitments during the mid-1960s (which included field squadron deployments in Borneo, Aden, Cyprus and Africa) had to be covered from a shrinking resource base. At the beginning of 1961, the strength of the RAF Regiment was authorised as 274 officers and 5,743 airmen, of whom 2,095 were gunners. By mid-1964, although the formation of one new squadron had been approved, the Regiment's establishment was 240 officers and 4,389 airmen. Year-long unaccompanied tours became the norm and, in addition to the extended periods of separation endured by personnel at overseas locations, many were reduced to an expectation of just four months' service in the UK between the end of one foreign tour and the beginning of another. As Kingsley Oliver has written, 'Maintenance of morale in these conditions was a pressing task for the officers and NCOs of the front-line squadrons.'¹²

The drawdown of air defences in FEAF began soon after the Bangkok Agreement of August 1966 brought the Indonesian Confrontation to an end. Meanwhile, in Cyprus, the RAF's presence had been substantially concentrated at Akrotiri due to Nicosia's development as a civil airport. The potential challenges to the RAF in the eastern Mediterranean region ranged from Warsaw Pact activity to action by unfriendly Middle Eastern states, to friction between Turkey and Greece over Cyprus despite their NATO membership. The specific threat to airfields was underlined by the 6-day Arab-Israeli war of June 1967: the Arabs lost 416 aircraft during the first 48 hours of the conflict, 393 on the ground.¹³ In 1969, when the Canberras were withdrawn from Akrotiri and replaced by a bomber wing of 16 Vulcans, Colonel Gaddafi's take-over in Libya denied RAF aircraft access to El Adem, which had previously been their most readily available dispersal option.¹⁴



A Royal Air Force Regiment Bofors position, Cyprus.



The Bloodhound IIs of 112 Squadron at Episkopi.

In these circumstances, any reduction of RAF air defence provisions in Cyprus – including a significant GBAD presence – was unthinkable. During 1967, when 56 Squadron's Lightnings replaced the Javelins of 29 Squadron at Akrotiri, the Bloodhound II missiles of 112 Squadron were positioned on the coast ten miles to the north-west at Episkopi, while 3 Wing RAF Regiment controlled two L40/70 Bofors squadrons (out of five in the Regiment) at the base, providing the final air defence layer. From their site on Mount Olympus, 280 Signals Unit maintained an excellent standard of high and low-level radar warning and tracking information, which was fed to their Control and Reporting Unit at Cape Gata, responsible for coordinating the fighters, missiles and guns.¹⁵ Beyond this, even without El Adem, the Vulcan force retained at least some of the agility of the Near East Strike Force, undertaking detachments away from Akrotiri to such locations as Teheran, Ankara and Masirah.¹⁶

Notes

1. Air Chief Marshal Sir David Lee, *Eastward: A History of the Royal Air Force in the Far East, 1945-1972* (HMSO, London, 1984), p. 192.
2. Ibid., p. 212.
3. RAF Order of Battle, 1 September 1963 (AHB Box 347); the LAA squadrons were 27 and 34 at Akrotiri and 26 and 28 at Nicosia.
4. Oliver, *Through Adversity*, pp. 226-227.
5. Ibid., p. 227.
6. Lee, *Eastward*, p. 212.
7. History of 63 Squadron RAF Regiment, pp. 7-8 (long multi-page history, AHB Box 208); *Short History*, p. 44.
8. Ibid. The sources differ on when the readiness state ended; the 63 Squadron history gives the date as June 1966 although the Confrontation ended with the Bangkok Agreement in August 1966.

9. AHB, *Air Defence, 1945-1970*, p. 32.

10. Ibid.

11. Ibid; AHB, *The Bomber Role*, p. 116; No. 228 OCU (which had closed in August 1961) was reopened in July 1965 at Leuchars to train reinforcements. It closed again in December 1966 after the Confrontation ended.

12. *Short History*, p. 44.

13. Ibid., p. 45.

14. Lee, *Wings in the Sun*, pp. 157, 177-178.

15. Ibid., p. 188.

16. AHB, *The Bomber Role*, p. 75.

11. Reorientation: NATO and Central America in the 1960s and 70s

By the later 1960s, as British decolonisation neared its end, NATO governments and senior military staffs were increasingly calling the ‘tripwire’ concept of massive nuclear retaliation into question. In 1968, NATO adopted a new strategic principle known as Flexible Response, which accepted the possibility that a nuclear exchange might be preceded by a period of conventional war.¹ This change of direction helped to secure the future of RAF GBAD for the next three decades. On 10 May 1968, a NATO Ministerial Meeting tasked SACEUR to investigate the survivability of the alliance’s nuclear strike and conventional air attack capability. The result, completed in November, was a study that ‘unequivocally demonstrated the critical vulnerability of ACE’s^p tactical air forces to the Warsaw Pact air force threat’ and declared: ‘It is doubtful that ACE air forces at present could survive a major enemy attack in sufficient strength to be an effective force.’²

The following measures were proposed to reduce the vulnerability of ACE’s strike and attack air forces:

1. Continued planning toward better dispersal of aircraft and their supporting elements.
2. Physical passive defensive measures on air bases consisting of semi-hard aircraft shelters, hardening or semi-hardening support facilities, camouflage, on-base dispersal, tone-down,^q redundant runways/taxiways or a rapid runway repair capability.
3. Physical active defence measures consisting of anti-aircraft rockets and guns on or adjacent to airfields.³

NATO’s Military Committee accepted the study’s findings and concluded that there was an urgent military requirement to plan and implement the airfield defence measures proposed by SACEUR, although this would require

p. ACE – Allied Command Europe.

q. In camouflage and concealment, tone-down is the process of making an object or surface less conspicuous by reducing its contrast to the surroundings and/or background.

‘considerable funds ... from both national and NATO forces’. NATO’s Defence Planning committee was instructed to take all necessary action ‘to ensure the implementation of a programme for the physical protection of airfields along the lines of SACEUR’s survivability improvement proposals’.⁴

The RAF’s posture in West Germany by the late-1960s provides some context for the Programme for the Physical Protection (PPP) of airfields. After the 1957 Defence Review, RAF Germany (formerly 2 TAF) was reduced to 12 flying squadrons operating from four ‘clutch’ airfields – Laarbruch, Bruggen, Wildenrath and Geilenkirchen – west of the Rhine, and Gutersloh further east. All RAF Regiment LAA squadrons were withdrawn from West Germany, and Bloodhound was not deployed there.

In 1968, RAF operations from Geilenkirchen ceased. However, as there was no parallel reduction in the number of squadrons, the remaining airfields grew more congested, increasing the difficulty of effective on-base dispersal.⁵ Off-base dispersal typically involved deployment to the airfields of other NATO air forces, which manifested many of the same vulnerabilities that so concerned SACEUR.⁶ The RAF retained two squadrons of Lightning fighters in West Germany in the late 1960s and benefited from other alliance air defence provisions, including NATO’s integrated air defence system, known at first as the NATO Air Defence Ground Environment (NADGE), and later as the NATO Integrated Air Defence System (NATINADS), and its associated control and reporting nodes; but PPP substantially raised the profile of airfield protection, necessitating more active and passive measures.

The RAF addressed the lack of airfield GBAD by reassigning two RAF Regiment field squadrons to LAA, which now became known as Low-Level Air Defence (LLAD), and by deploying them to West Germany along with 1 Squadron and 26 Squadron in 1970. One LLAD squadron was allocated to each of the four airfields.⁷ The Regiment squadrons were still equipped with Bofors L40/70s; however, active GBAD at the clutch airfields was strengthened by the deployment of Bloodhound II. Suitably enlarged, 25 Squadron deployed six sections to Bruggen, Laarbruch and Wildenrath during 1970 and 1971.⁸

Meanwhile, in 1966, the MOD had acquired three launch units for a short-range SAM, which had been privately developed for foreign markets by Short Brothers as a land-based version of their Seacat naval missile. Known as Tigercat and guided by Command Line-of-Sight (CLOS) via a UHF radio-link, this system was subsequently issued to the RAF Regiment to bring into service, the task being allocated to 48 Squadron. The squadron also provided sales support teams and demonstrators to help secure multiple contracts for Tigercat from overseas buyers, although no more were ordered by the UK.⁹ Thus did the RAF become the first air

force in the world to be equipped with a missile for local air defence, although Tigercat, as a one-off purchase, generated an unwelcome logistical and training burden and reduced 48 Squadron's availability for roulement tasking.¹⁰

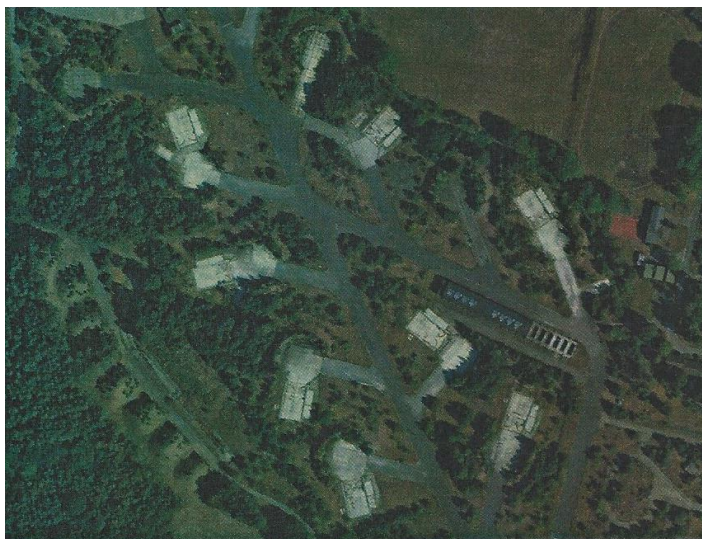
In 1970, the RAF gave 48 Squadron an emergency reinforcement role in West Germany, where it was to deploy to Gutersloh – the most exposed airfield. Tigercat represented a very limited capability. Although deployable and mobile, it lacked an associated radar system and relied for tactical warning and reporting on a screen of 12 remote observation posts. The missile has nevertheless been referred to, for the RAF Regiment, as 'a valuable foot-in-the door for the acquisition of the next generation of guided weapon – Rapier.'¹¹

As always, such measures should not be considered in isolation from other active and passive air defence initiatives. In 1970, the RAF established the first Harrier squadron in West Germany at Wildenrath, and two more squadrons had been formed there by 1972. VSTOL-capable, the Harrier's introduction was accompanied by an entirely revolutionary approach to off-base dispersal. During transition to war, the Harrier force would disperse from Wildenrath to predetermined tactical sites from which they would subsequently operate. Typically, these locations were each to support six aircraft, and the Harrier dispersal plan thus required the provision of infrastructure, engineering and supply, command and control, and force protection. The dispersal plan was exercised three times a year and could involve aircraft movement from primary to secondary dispersal sites. The final exercise of the year was normally accompanied by NATO Tactical Evaluation (TACEVAL).¹²

On-base, the RAF Germany airfields featured widely spaced dispersal sites that might have provided a measure of protection against isolated conventional air attacks but little more. They would have been very vulnerable to heavier strikes or NBC weapons. During the mid-1970s, the RAF implemented plans to construct hardened concrete shelters on the dispersal hard standings, most of which were designed to accommodate one aircraft and its associated ground equipment. Although not proof against direct hits or NBC attacks, they promised to provide considerably more protection from blast damage than uncovered pens or revetments. Another passive measure involved extensive toning-down of the most visible horizontal surfaces on each of the clutch stations to blend into the heavily wooded environment. 'Buildings, vehicles and ground equipment were similarly darkened. The result was effective, and the stations were difficult to identify clearly, particularly during a fast approach on a dull, misty winter's day.'¹³



Jaguars of 14 Squadron taking off from RAF Bruggen; in the background are the Bloodhound IIs of 25 Squadron.



Built to last: Google Earth imagery of hardened aircraft shelters still standing at the former RAF Bruggen.



A novel approach to dispersal: a Harrier GR1 emerges from its hide during a field exercise in 1972.



In such locations, under camouflage nets, the Harriers would have been invisible from the air.

These initiatives were expensive – particularly the hardening programme. NATO infrastructure funding was available, but only on a *quid pro quo* basis. From late 1975, Bloodhound II was again deployed in the UK to provide low-level SAM cover for several USAF and RAF airfields. This Low-Level Missile Engagement Zone (LOMEZ) was at first generated by 85 Squadron, with flights based at West Raynham, North Coates and Bawdsey.¹⁴ Construction work on the hardened aircraft shelters in West Germany began at about the same time.¹⁵

Rising east-west tensions and the development of more offensive air postures and capabilities by the Warsaw Pact maintained the profile of NATO airfield defence in the later 1970s, fuelling the perception that an equivalent hardening programme was essential in the UK. The relentless process of base closure had reduced the number of RAF airfields capable of supporting flying operations to around 40 by 1977; the RAF was more heavily concentrated than in earlier years, and there was less scope for dispersal to alternative locations from which operations could be sustained. In 1979, the government announced an extensive hardened aircraft shelter construction programme at bases including Honington, Marham, Wattisham, Coningsby, Lossiemouth and Leuchars. Three years later, to illustrate the importance of NATO infrastructure funding, the government revealed that the alliance was providing £24 million out of the £29 million bill for hardening at three RAF bases.¹⁶

With medium-range SAM coverage now adequately provided by other members of the alliance on the continent, SACEUR's requirement for improved active defences to maintain NATO infrastructure funding also focused on the UK. Consequently, 25 Squadron's Bloodhound IIs returned from West Germany to extend the LOMEZ.¹⁷ Yet with Bloodhound scheduled for retirement in 1985, the RAF had to consider the acquisition of a new medium-range SAM. The cancellation of Blue Envoy after the 1957 Defence Review had all but halted land-based medium-range SAM development in the UK, so a search began for off-the-shelf alternatives. However, the only realistic option – the US Patriot system – proved unaffordable.¹⁸ As a short-term alternative, Bloodhound II received a stay of execution made possible by upgrades to the Launch Control Posts, computerised and networked command and control provisions, surplus British Army and Swedish Air Force Type 86 radars, and Swedish missiles and launcher spares. The two remaining squadrons merged into one – 85 Squadron – in 1989.¹⁹

If any hopes existed after the British withdrawal from east of Suez that all GBAD might be concentrated in the UK and West Germany, they were to prove optimistic. While air defence measures were steadily improved across the NATO area, the RAF remained committed to CENTO and therefore to base defence at Akrotiri, and a new colonial challenge emerged at the beginning of 1972, when

the territorial integrity of British Honduras in Central America was threatened by Guatemala. Forewarned, the British government announced ‘a major amphibious exercise in the Caribbean area’ involving ‘substantial Army forces’ and a ‘reinforcement exercise’ in British Honduras.²⁰ This rendered critically important the country’s single airfield – always referred to as the airport. To defend it from attack by the Guatemalan air force, 48 Squadron’s Tigercats were deployed at short notice on 29 January. One member of the squadron later described his arrival in theatre in terms that recall Malaya or Burma in the Second World War.

I carried out the initial deployment reconnaissance of Airport Camp^r in preparation for No 48 Sqn’s deployment ... The mangrove swamps, secondary jungle and frequently impassable tracks meant that the W&R^s screen was spread over a 70-mile ring, which made alerting very challenging ... I hired a Cessna 180 aircraft to test the W&R capability; however, the pilot – ex-WWII Luftwaffe – was well versed in hedgehopping and crop-spraying and I don’t recall us being reported by any of the OPs.²¹

Fortunately, these rudimentary warning provisions were soon augmented by radar, and the build-up of British forces in the region proved enough to deter Guatemalan aggression. The British garrison was subsequently enlarged, and 37 Squadron relieved 48 Squadron on 7 April, deploying conventional Bofors L40/70s to defend the airport. Thereafter, 37 Squadron alternated with 16 Squadron to maintain GBAD provision.²²

British Honduras gained its independence as Belize in 1973, and the tension with Guatemala subsided over the following 12 months, allowing the LLAD force to be reduced to a care-and-maintenance basis. The Turkish invasion of Cyprus in the same year meanwhile killed off CENTO. Ironically, after years of practice deployments, 34 Squadron’s guns were briefly placed at operational readiness around RAF Akrotiri during the crisis, but all fixed-wing aircraft and GBAD were withdrawn from the island soon afterwards; the multi-layered IADS disappeared, leaving only the radar behind.²³ However, further tension between Belize and Guatemala in 1975 revived the airport defence task, and the deployment of four Harriers and Puma helicopters on what became an enduring commitment necessitated the re-establishment of an LLAD detachment in theatre consisting of six L40/70 guns.²⁴

r. Airport Camp was the main British forces base in Belize.

s. W&R - Warning and Reporting, i.e., visual observation.

The L40/70 was a simple and readily deployable weapon, and it might still have protected the Belize airfield against Guatemalan aircraft that were obsolete by the 1970s, judged by NATO standards. Yet its utility in northern Europe was limited by this time. The future of effective short-range anti-aircraft defence lay with the guided missile. Back in 1961, the British Aircraft Corporation had started a new private short-range SAM venture known as Project Sightline, which drew on earlier experimental work for the British Army. At this stage, the armed forces were banking on re-equipment with an American mobile SAM system – the General Dynamics MIM-46 Mauler – but Mauler ran into insuperable problems in the early 1960s. Consequently, Project Sightline acquired both Army and RAF support, and development proceeded with government funding from 1963. The missile system was renamed Rapier. Test firing commenced in 1966, and Rapier was cleared for production in 1969.

Trials and Testing were undertaken on a joint basis under Royal Artillery and RAF Regiment supervision and included hot and cold-weather operation under Joint Services Trials Units numbered 21 and 23.²⁵ No. 21, the Royal Artillery unit, was responsible for hot-weather trials in Australia and Malaysia, while 23, the RAF Regiment unit, tested Rapier successfully at Primrose Lake in Canada at temperatures as low as -40°C.²⁶ Rapier was first deployed operationally by 63 Squadron RAF Regiment at Gutersloh in June 1974. Two years later, RAF Regiment Rapier squadrons, each with eight fire units, had also been positioned at Laarbruch, Bruggen, Wildenrath and Leuchars, the squadrons in West Germany being subordinated to Headquarters 4 Wing, RAF Regiment. At each base, the Rapier squadron became an integral part of the operations wing, squadron commanders being directly responsible to the station commanders for high-readiness SHORAD.²⁷

In 1977, due to a sharp rise in tension between Belize and Guatemala, the RAF Regiment again deployed Tigercat to reinforce the Belize L40/70 detachment, but this was the swansong for both weapons in RAF service. Quite apart from their capability limitations, the detachments could no longer be sustained in the field when Regiment LLAD squadrons were otherwise entirely equipped with Rapier. In July 1978, the Belize commitment passed to Rapier squadrons from RAF Germany and the UK – Rapier's first ever operational deployment outside the NATO area. Tigercat and the L40/70 were withdrawn from service, but 48 Squadron was re-equipped with Rapier to bring the total number of RAF Regiment Rapier squadrons to 6.²⁸ The term LLAD meanwhile evolved into SHORAD – Short Range Air Defence.



Rapier cold-weather trials at Primrose Lake, Canada.



The Rapier tracker unit during the Primrose Lake trials.



A Royal Air Force Regiment Bofors L40/70 in British Honduras in 1972.



Tigercat's final deployment to Belize in 1978.



Rapier finally replaced the RAF Regiment's Bofors guns and Tigercat missiles in Belize in 1978.



A Harrier GR3 at a camouflaged dispersal site in Belize.

The Rapier detachment in Belize comprised four fire units, a command post and combat service support at Airport Camp, which was the main British base. The permanent positioning of one fire unit on a site near the runway and the airport terminal acted as a publicly visible deterrent, but the other fire units were held at very high readiness to deploy to several prepared sites around the camp and the airport.²⁹ There were also contingency plans to deploy to other airstrips in Belize.²⁹

In its first incarnation, Field Standard A (FSA), Rapier incorporated an optical tracker unit, but the system also included a search radar with a range of about 13km and IFF; four missiles were mounted on each fire unit, and one unit could be moved between sites by two LWB Land Rovers.³⁰

However, the limitations of the optical tracker were clear long before Rapier entered service, and BAC therefore developed a second version of the system equipped with the Marconi DN 181 Blindfire mobile tracking radar. In this form, the Rapier system gave the operator the option of engaging the target manually or automatically, employing the radar tracker. Rapier thus evolved into a day-and-night all-weather capability.³¹ The logistical disadvantage of adding an entirely separate unit to the Rapier system was offset by the degree of capability improvement. Based at Leuchars, 27 Squadron assumed a lead role in conversion to the Blindfire Rapier from January 1978, and all RAF Rapier squadrons had reached operational status with FSA Blindfire by the end of 1981.³² Further upgrades to the system produced Field Standard B (FSB), which entered service in 1983.³³

The replacement of older weaponry with new, more sophisticated and far more potent ordnance increased the importance of training in the RAF Regiment. The late 1970s witnessed the introduction of Rapier Annual Categorisation Boards for individual proficiency in the deployment, operation and command of RAF Rapier, drawing on the RAF's aircrew categorisation model. In addition to formal trials and exercises, Rapier basing at front-line stations provided practical training opportunities in collaboration with combat air and tactical reconnaissance squadrons, which could fly against their own SHORAD to test its proficiency.³⁴

Another enduring training issue was aircraft recognition. While significant advances were taking place in electro-optical imaging technology, glass optics were still important, and visual target identification actually gained in significance

t. During the 1980s the permanently deployed fire unit was at five minutes Readiness To Fire (RTF), two other fire units were at six hours RTF and the fourth fire unit was to be RTF as soon as possible. In 1991 this was reduced to the permanently deployed fire unit being at six hours RTF, two other fire units at 12 hrs RTF and the 4th RTF as soon as possible.

in this period due to the increased lethality of the SAM systems coming into service when compared with older weapons such as the Bofors gun.

Yet aircraft recognition training standards in both the RAF Regiment and the Royal Artillery at the end of the 1970s bring to mind the comments of the Royal Observer Corps in Normandy in 1944. The official military recognition tools consisted of First World War-style aide-memoires of aircraft silhouettes, and three black-and-white slides of each aircraft. Not surprisingly, with such a small number of images, unrepresentative of what a missile operator or gunner might see in an operational scenario, slide recognition rather than aircraft recognition became the order of the day. The more enthusiastic instructors strove to obtain better pictures and so, across many units, individuals devoted their parallel energies to copying aircraft images from aviation journals to increase the scope and scale of their training material. The units with the best aircraft recognition standards were those whose instructors had amassed the greatest collection of pictures. They guarded their positions of superiority jealously and there was little lateral distribution of material – just more and more wasteful parallel effort.

In 1979, the aircraft recognition test pass mark in the British Army and the RAF Regiment was 95 per cent. While this might sound impressive, the challenge was substantially lowered by a lack of uniformity in the testing process and by the limited and uneven standard of the available imagery. Moreover, a 95 per cent pass mark meant that five per cent of the identifications were wrong. In an operationally deployed unit consisting of multiple SAM launchers or guns, these errors combined exponentially to increase the probability that an over-flying aircraft might be misidentified.³⁵

Such was the situation when an RAF Regiment officer, Squadron Leader Michael Fonfé, became the senior RAF Rapier instructor at the Royal School of Artillery. Having reported on the poor standard of aircraft recognition training at the school, Fonfé was tasked by the Colonel Chief Instructor to resolve the issue, which he did by inventing an entirely new aircraft recognition training system that took his name and presented targets on 35mm slides at exactly the same size in 94 different flight attitudes and with varying external stores configurations, just as they would be seen in Rapier (and in the Army's man-portable Blowpipe system) optics. The test pass mark was raised to 100 per cent, but trainees were allowed to declare up to ten per cent of the targets as 'Not Recognised'.³⁶ In an operational setting, the responsible command and control organisation would then confirm whether there were friendly aircraft in the weapon engagement zone. If none were present, the 'Not Recognised' call was unimportant; if there was a friendly presence, engagement authorisation could be withheld pending positive identification of the aircraft as hostile.³⁷

The next question was how long an operator should be allowed to look at a picture. Training allowances at the time ranged from one to five seconds and were entirely arbitrary, so Fonfé went back to basic principles.

How long was actually available? Rapier optics were found to have x 10 magnification. Typical radar detection ranges of low-level targets in most operational deployments were found to be about 10km. The Rapier missile system needed to open fire at a 500-knot target at about 9km in order to achieve a first intercept at maximum missile range. At 500 knots, an aircraft will cover one km in four seconds. Any more time than this spent on aircraft recognition would eat into the missile's operational envelope, so four seconds became the time allowed. All that was left was to settle how big would the aircraft image be. With x 10 magnification, an aircraft seen at maximum typical, as opposed to absolute maximum, acquisition range at 10km gave an image in the optics equivalent to an aircraft seen with the naked eye at a range of one km, just over half a mile. An examination of MANPADS^u optical sight magnification, maximum missile range and likely unaided target acquisition, gave the same four seconds and one km answer.³⁸

Such were the key features of the Fonfé system, subsequently adopted not only by the UK Armed Services but some 13 other countries. In his words:

Aircraft recognition moved from a few hundred home-made random 35mm slides to a structured package of four to six thousand slides shown through calibrated projectors. NATO GBAD bought into the system and 35mm slide production ran into millions of slides, for which I received a handsome royalty and a major MOD inventor's award.³⁹

Nearly a decade later, an assessment of this system by one US-UK-Canadian-Australian research body concluded that it had produced the only recognition material available to teach SAM operators to recognise aircraft in visual conditions that mimicked those likely to be encountered on operations.⁴⁰

^u. MANPADS – Man-Portable Air Defence Systems.



A Rapier unit at Gutersloh; personnel are wearing Nuclear, Biological and Chemical (NBC) protective clothing.



A Rapier unit at RAF Leuchars; co-location with flying squadrons provided excellent training opportunities.



Hardened aircraft shelters under construction at Marham in 1981.



The same facilities remain very much in evidence (Google Earth).

Meanwhile, SACUER's requirements for enhanced GBAD in the UK had been extended to SHORAD, confronting UK-based USAF forces with an apparently intractable problem. While their bases in West Germany could rely on the US Army to provide SHORAD, there was no US Army presence in the UK, and the USAF possessed no SHORAD capability of its own. The British government, for its part, was keen to secure foreign markets for Rapier, and the concept of selling the missile to the Americans apparently emerged in the summer of 1979.⁴¹ However, even if the Americans bought Rapier missiles to defend their UK bases, the simple fact remained: the USAF did not have personnel to operate them.

Deliberations over this issue were intertwined with far higher profile discussions on the UK purchase of Trident nuclear missiles to replace the Polaris system. It was in this context that the UK tabled a new proposal, which the Parliamentary Undersecretary of State for Defence Procurement first revealed in a statement to Parliament at the end of November 1979:

During my recent visit to the United States of America, I discussed with the United States authorities ... the possible purchase of the Rapier surface-to-air missile system by the United States Air Force for use at its bases in this country. I made clear my disappointment that it had not yet taken a decision to purchase Rapier. In an effort to make further progress I offered that if the USAF would procure Rapier and fund it operationally, we would examine constructively the possibility of the RAF manning the system, on repayment, at seven USAF bases in the United Kingdom. A detailed proposal, giving indicative costs, is being sent to the United States this week.⁴²

According to one source, the RAF Regiment itself had no knowledge of this offer until it was made public.⁴³

Negotiations over the following months led in July to a formal agreement between the UK and US governments on the British purchase of Trident and confirmed, as part of the deal, 'the manning by the United Kingdom of Rapier air defence of the United States Air Force bases in the United Kingdom'.⁴⁴ On 13 February 1981, the two governments signed a memorandum of understanding covering the purchase of Rapier by the United States.⁴⁵

We should not underestimate the challenges involved for the RAF Regiment in fulfilling this new commitment in the absence of any preparatory studies or assessments. Their air defence personnel resources could not possibly be extended quickly to generate the three additional Rapier squadrons required and, as early as

July 1981, the RAF was investigating the possibility of deploying Royal Auxiliary Air Force Regiment reserves on Rapier units at its own bases.⁴⁶ From 1982, as well as its NATO and Belize commitments, the Regiment had also to fulfil another enduring airfield defence task in the Falkland Islands (see below). For RAF Germany, Headquarters 4 Wing took responsibility for basic Rapier training after the Royal School of Artillery exhausted its capacity to train all Army and RAF operators.⁴⁷ In the end, a dedicated Rapier Training Unit was established at RAF West Raynham consisting of one RAF and one USAF training flight of four fire units each. They were also assigned responsibility for providing Base Defence Zones (BDZs) at Kinloss/Lossiemouth (RAF – shared with 48 Squadron RAF Regiment) and Woodbridge (USAF).⁴⁸

Ultimately, the Regiment force comprising Headquarters 6 Wing and 19, 20 and 66 Squadrons was not fully deployed at the USAF bases until 1987 – the result of a truly Herculean effort.⁴⁹ Yet there was no dilution of standards. The commander of the USAF's Third Air Force reported to the Pentagon in 1989 that he assessed the Rapier squadrons to be the best assets under his command for discipline, deportment, efficiency and combat readiness. They provided an example to all ranks of the USAF under his command.⁵⁰

The unconventional nature of these arrangements led predictably to questions about command and control and particularly to operational and tactical command arrangements. In 1983, the Parliamentary Under-Secretary of State for the Armed Forces released the following details to the House of Lords.

As far as operational command is concerned, the responsibility, in peace and war, falls to the Commander-in-Chief Royal Air Force Strike Command, acting in his NATO capacity as CINCUKAIR. He is responsible to the Supreme Allied Commander Europe for all air defence operations within the United Kingdom area and for the command of all NATO air defence forces in the United Kingdom. It is he who orders the deployment and state of readiness of all United Kingdom Rapier squadrons. If called on to act, these units follow NATO rules of engagement, common to all our air defence forces.

It has been suggested that these Royal Air Force Regiment forces are in some degree under the operational command of the United States, and that this offends against our sovereignty and territorial rights. I wish to reassure your Lordships that this is in no way the case. The Commander-in-Chief under whom they act

is a British commander, and will always be so. The chain of command is both a British and a NATO command. There is no sense in which the wing commander in charge of the United States base protected by Rapiers could or would issue instructions which conflict with those of the Commander-in-Chief. The role of the United States wing commander in the scheme of things is exactly the same role as is assigned to a Royal Air Force station commander whose base is protected by a Rapier squadron ... His function is to ensure the effective local airspace management in the vicinity of his base; in other words, in simple language, to prevent his air defence forces from shooting down friendly aircraft.⁵¹

Notes

1. AHB, *Air Defence, 1945-1970*, p. 29.
2. Memorandum for the Members of the Military Committee, 7 March 1969, Survivability of SACEUR's Nuclear Strike and Conventional Attack Capability (AHB E-Vault).
3. Ibid.
4. Ibid.
5. AHB narrative, *The Royal Air Force in Germany, 1945-1978*, p. 26.
6. Ibid; AHB, *The Bomber Role*, pp. 63, 65.
7. *Short History*, p. 50.
8. AHB, *Air Defence, 1945-1970*, p. 34.
9. Wing Commander Lee Taylor, 'Air Defence in the RAF Regiment,' *Royal Air Force Historical Society Journal*, No. 67, 2018, p. 77.

10. Wing Commander Martin Hooker, 'Short Range Air Defence – Tigercat,' *Royal Air Force Historical Society Journal*, No. 62, 2016, pp. 79-85.
11. Hooker, 'Tigercat,' pp. 79-85.
12. Wing Commander David Caddick, 'The RAF Regiment Contribution to the RAF Germany Harrier force,' *Royal Air Force Historical Society Journal*, No. 67, 2018, pp. 50-62.
13. AHB, *Royal Air Force in Germany*, p. 31.
14. Vernon, 'Bloodhound,' p. 67.
15. AHB, *Royal Air Force in Germany*, p. 31.
16. *Hansard* Vol 973: 6 November 1979; *Hansard* Vol 24: 20 May 1982; *Hansard* Vol 960: 16 January 1979.
17. *Hansard* Vol 974: 26 November 1979.
18. Vernon, 'Bloodhound,' p. 68, n. 63.
19. *Ibid.*, pp. 67-68.
20. *Hansard*, 28 January 1972.
21. Hooker, 'Tigercat,' pp. 83-84.
22. *Short History*, p. 47.
23. Lee, *Wings in the Sun*, p. 180; Vernon, 'Bloodhound,' p. 66; 34 Squadron RAF Regiment Squadron History, 1951-2020, p. 17 (AHB Box 207).
24. 'Harriers in Belize,' *Air Pictorial*, June 1981, p. 227; *Short History*, p. 52; *Statement on the Defence Estimates, 1976* (HMSO, London, 1976), Annex C, p. 88.
25. Oliver, *Through Adversity*, p. 248.

26. Wing Commander (Retd) Michael Fonfé to the author, 27 February 2023; Cold Climatic Trials of Rapier Optical GW System, Primrose Lake Evaluation Range, Alberta – Canada – January-March 1974, Final Report, Rapier Cold Trials Unit, 27 June 1974.
27. Taylor, 'Air Defence in the RAF Regiment,' p. 77; *Short History*, p. 58.
28. *Short History*, p. 52.
29. HON/2251/5/GBAD, RAF GBAD Operations since 1982, 30 January 2004 (AHB E-Vault).
30. Wing Commander Simon Openshaw, 'Short Range Air Defence – Rapier,' *Royal Air Force Historical Society Journal*, No. 62, 2016, pp. 86-87.
31. Openshaw, 'Rapier,' pp. 86-87.
32. *Short History*, p. 58.
33. HON/2251/5/GBAD, RAF GBAD Operations since 1982, 30 January 2004.
34. Wing Commander (Retd) Michael Fonfé to the author, 15 May 2023.
35. Wing Commander MDC Fonfé, 'Aircraft Recognition – An Operational Approach,' *Joint Services Recognition Journal*, December 1988, p. 356.
36. Wing Commander (Retd) Michael Fonfé to the author, 27 February 2023.
37. Fonfé, 'Aircraft Recognition,' p. 357.
38. Ibid.
39. Wing Commander (Retd) Michael Fonfé to the author, 27 February 2023.
40. Fonfé, 'Aircraft Recognition,' p. 356.
41. It was first discussed in Parliament in June 1979; see *Hansard*, Lords Chamber, Volume 400: debated on 26 June 1979.

42. *Hansard*, Rapier Missiles, Volume 974: debated on 27 November 1979.
43. Air Commodore MS Witherow, 'The Royal Air Force Regiment, 1967 to the Present,' *Royal Air Force Historical Society Journal*, No. 15, 1995, pp. 52-53.
44. TNA PREM 19/417 f161, US Secretary of Defense to Francis Pym, Secretary of State for Defence, 14 July 1980.
45. *Hansard*, Written Answers Volume 999: 25 February 1981, Rapier.
46. *Hansard*, Missile Cover, Volume 8: debated 6 July 1981.
47. *Short History*, p. 69.
48. HON/2251/5/GBAD, RAF GBAD Operations since 1982, Appendix 2, Annex A. Virtually co-located, Kinloss and Lossiemouth were covered by a single BDZ.
49. Oliver, *Through Adversity*, pp. 248-249.
50. Witherow, 'The Royal Air Force Regiment, 1967 to the Present,' p. 53.
51. *Hansard*, RAF Regiment: US Bases, Volume 445: debated 1 December 1983.

12. From the Falklands to the Gulf, 1982-1991

As we have noted, the demands imposed on the RAF Regiment in the 1980s were substantially increased by the Falklands conflict of 1982. Originally, Royal Artillery GBAD elements were deployed to provide Rapier support to the British Task Force, but two more requirements soon emerged – the defence of the Harrier Forward Operating Base (FOB) and, later, Port Stanley airfield. The FOB task stemmed from a request from the Commander Task Force for additional forces for follow-up operations; the longer-term requirement arose in late April when the Chiefs of Staff were considering the future of the British garrison in the Falklands after the assumed recapture of the islands. Early in May, 63 Squadron RAF Regiment (then based at Gutersloh) was extracted from an exercise in West Germany and rapidly prepared for deployment. To minimise the effect on NATO, 27 Squadron, based at Leuchars, came to readiness to deploy to Gutersloh within 48 hours. On 12 May, 63 Squadron set sail for the Falklands on the QE2. After a week at sea, the squadron assumed responsibility for local air defence of the ship.

Although 63 Squadron was initially placed under 5 Infantry Brigade, Rapier was soon declared a Force Asset and directly subordinated to the Commander Land Forces Falkland Islands. Before landing at Port San Carlos, the Squadron was dispersed between four different vessels, which offloaded their cargoes over the period 1 to 3 June in confused if not chaotic circumstances reminiscent of Operation Torch in 1942.

The goal, once on dry land, was to provide SHORAD for the Harrier FOB, taking over this duty from the Royal Artillery as they redeployed to Bluff Cove. On 2 June, 'A' Flight and two fire units of 'B' Flight deployed, the remainder following the next day. No reconnaissance was possible before deployment, and six of the eight Rapier sites required helicopter support as they were not accessible from the ground, although the squadron had no experience of helicopter operations. By 3 June, 63 Squadron was fully deployed around the Harrier FOB, with six fire units on the surrounding hillside and two in the valley. The first Harrier landed at Port San Carlos on the 5th, and RAF GR3s and Royal Navy Sea Harriers made regular use of the FOB thereafter.

The Officer Commanding 63 Squadron and the FOB commander developed strict procedures to ensure that the Rapier units did not engage friendly aircraft, including agreed approach and departure directions and a Weapons Control Order (WCO) that normally prohibited missile launches unless target aircraft were positively confirmed as hostile ('Weapons Tight'). No friendlies were engaged, whereas the Argentines shot down two of their own jets during the conflict. Rapier

operations were complicated by constant rotary-wing activity. Many of the deployed British helicopters lacked IFF or flew with it switched off. With the fire units at Battle Stations (immediate readiness to fire), it was necessary to continually use the system's Selector Engagement Zone, which provided tactical information to inform situational awareness and decision-making, to prevent Rapier from locking on to friendly helicopters. Periodically, when three or four helicopters were airborne in the area at the same time, the gunners had to turn off their radars.¹

By the time 63 Squadron deployed, the number of Argentine air attacks had declined considerably from the levels witnessed earlier in the conflict, and no RAF Rapiers were launched in anger before the ceasefire. After the ceasefire, the squadron remained at Port San Carlos until 30 June, when it was moved by sea to Port Stanley. By 3 July, all eight fire units were positioned around RAF Stanley, providing 24-hour SHORAD of the airfield at five minutes readiness to fire. So began the RAF Regiment's extended Falkland Islands air defence commitment, under which the deployed squadron became known as the Resident Rapier Squadron (RRS).

In May 1986, the RRS relocated to the newly built airfield at Mount Pleasant.² To protect the base, the RAF constructed an IADS that was frequently tested during intensive training. The RRS commitment was at first assigned to fully formed squadrons that had all achieved NATO TACEVAL standard, and live-firing practice was a feature of every RRS Falkland Islands tour in the 1980s and 1990s. As the Rapier missiles were deployed ready to fire off their launchers, they weathered severely and required regular replacement. This generated a steady supply of 'expired' missiles that could be launched in realistic training scenarios and without the inhibitions normally imposed in the UK.

The RRS also regularly practised so-called Base Defence Zone procedures and there were frequent simulated air attacks (as well as other air scenarios), which were executed by a wide variety of resident and visiting aircraft and which provided excellent training for both command and fire unit personnel. In the joint arena, the detachment practised air defence co-ordination procedures with Royal Navy ships when they were in the area and integrated operations with the British Army infantry companies that maintained rolling deployments to provide ground defence of Mount Pleasant, including the use of Rapier fire unit thermal imagers as part of the Surveillance and Target Acquisition Plan.³

In the later 1980s, a relaxation of postures allowed UK-based RAF Regiment squadrons (27 Squadron at Leuchars and 48 Squadron at Kinloss/Lossiemouth) comprising eight fire units to be divided equally between the Falkland Islands and Belize tasks. The UK squadrons also covered a single one-off mission, Operation

Toucan, which began on 17 April 1986. Toucan was mounted alongside the American operation, El Dorado Canyon, which targeted Libya in the aftermath of a terrorist attack in West Berlin in April that caused dozens of US military casualties.

The majority of USAF aircraft committed to El Dorado Canyon flew from RAF Mildenhall, Fairford, Lakenheath and Upper Heyford. The UK's unequivocal support for the operation contrasted sharply with the opposition it encountered from the governments of France, Spain and Italy, all of which refused American overflight requests. Operation Toucan addressed the possibility of Libyan retaliation against RAF Akrotiri via the deployment by 48 Squadron RAF Regiment of five Rapier fire units with appropriate command, control and support provisions; four units were positioned around the base, while the 5th functioned as a reserve. The task ceased on 5 May, and 48 Squadron duly returned to the UK.⁴

In Operation Toucan, we again encounter the link between offensive and defensive action that emerged before the siege of Malta in 1940, during the Suez crisis in 1956, when the Near East Strike Force formed at Akrotiri in 1957, and when it became nuclear-capable in 1961. The governing principle was simple. Offensive air strikes – or greater threats of offensive air action – were likely to increase the possibility of retaliation or pre-emptive air attacks. The presence of GBAD at potential target locations was likely to serve as an effective deterrent and, if it failed to deter, as an active air defence element. In August 1986, a terrorist group attacked RAF Akrotiri in retaliation for the UK's support for El Dorado Canyon, but the raid was poorly executed and thankfully only three people were injured.⁵

After the Falklands War, in addition to the developing Rapier coverage for USAF bases and the Leuchars and Kinloss/Lossiemouth commitments, there remained an unresourced NATO GBAD force objective for at least two further UK bases that played a critical role in air defence: these were RAF Waddington, the intended home of the Nimrod AEW3 Airborne Early Warning force,^v and RAF Coningsby. Against a background of tight financial restrictions, in which the only funding for additional Rapiers had been pre-allocated to the RRS, an alternative solution was promoted by the same RAF Regiment officer who had previously revolutionised UK military aircraft recognition training, Squadron Leader Fonfé, with the support of Air Plans at the MOD. Fonfé's interest lay in about £30 million worth of captured Argentine all-weather Skyguard radar-directed Oerlikon twin

v. The Nimrod AEW3 project was eventually cancelled, and the RAF acquired the E-3D Sentry instead.

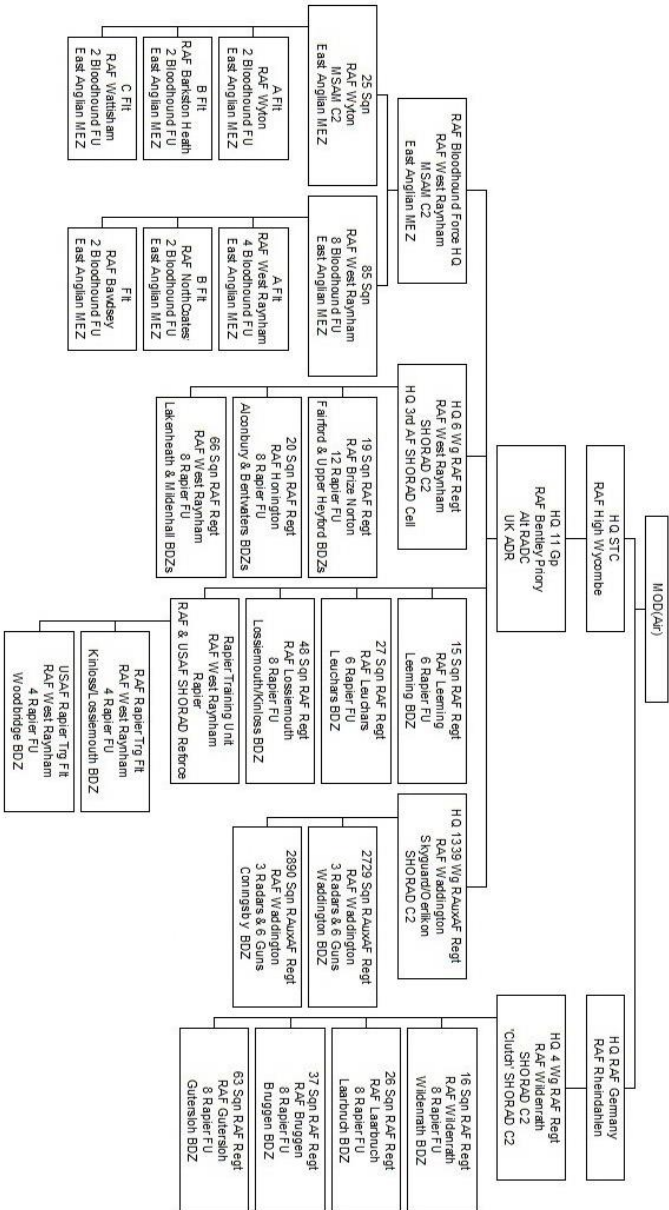
35mm AA guns – weapons that had presented a significant threat to RAF and Royal Navy Harriers during the 1982 conflict.

Ordered to investigate the Skyguard Oerlikons in his own time, on top of his primary staff oversight of the RAF Rapier force, Fonfé obtained the sponsorship of Air Plans for a so-called feasibility study under which he secured the allocation of the captured weapons to the RAF, ordered their recovery from the Falklands, gathered in all the guns and radars that had been seized by Falklands garrison units and brought back to the UK or West Germany as trophies, and concentrated them all at RAF Waddington. By bartering £100,000 worth of British-made ammunition out of a captured Argentine stockpile worth £2 million, Fonfé arranged for Oerlikon's Swiss manufacturer to conduct a factory-level full strip-down assessment of all the captured equipment to establish what was needed to return it to operational service. The answer was that just £1.25 million would provide refurbishment to as-new, fully warrantied equipment, including ten years of logistic support and training of engineers and RAF Regiment personnel by Oerlikon factory staff – who also operated the same equipment in Switzerland and supported sales in 40 other customer countries. In summary, employment of the captured equipment had the potential to double the number of all-weather SHORAD-defended RAF bases in the UK at miniscule cost.

Having secured the necessary funding at the eleventh hour, Fonfé became the de facto Operational Requirements leader, budget-holding Project Manager and Principal Staff Officer with responsibility for seeing the entire Skyguard-Oerlikon system through the MOD Procurement and Air staffs and up to the Air Force Board for approval and introduction into service. He was then given command of 2729 Squadron, which was to be equipped with Oerlikons. The employment of Royal Auxiliary Air Force Regiment personnel to operate the new weapons effectively mirrored the militia-based system used very effectively in Switzerland. The new squadron attended its first live-firing camp in just nine weeks and was declared operational to NATO after two years. Apart from introducing the Oerlikon into RAF service, it broke new ground by admitting women into all operational gun and radar posts on the premise that it was a Home Defence unit.

After promotion to wing commander, Fonfé became the senior RAF Regiment staff officer in the MOD's Department of Air Defence and presided over the purchase of two additional Skyguard radars. This allowed a second Oerlikon squadron numbered 2890 to be formed under 1339 Wing Royal Auxiliary Air Force Regiment. Thus, it was possible to provide all-weather radar-directed SHORAD at Waddington under 2729 Squadron and at Coningsby under 2890 Squadron. Each could boast six times the firepower of the last six-gun Bofors squadrons in RAF service.⁶ Briefly, in 1989, the RAF GBAD ORBAT was:

Royal Air Force GBAD Order of Battle, October 1989





Rapier SHORAD deployed at Port San Carlos, the Falklands, in 1982.



Members of 2729 Squadron Royal Auxiliary Air Force Regiment training on their captured Oerlikon 35mm AA gun.

In the winter of 1989 and the spring of 1990, world affairs were dominated by the collapse of the Warsaw Pact and the end of the Cold War. Statesmen across the world heralded a new era of peace, and there was a headlong scramble to collect the so-called peace dividend – substantial savings in public expenditure based on defence cuts. The RAF and the other Armed Services nervously waited for the axe to fall. Then, without any warning, they were committed to their largest operation since the Suez crisis – the First Gulf War, known in the UK as Operation Granby. Ultimately, as part of a US-led coalition formed in response to Iraq's invasion of Kuwait at the beginning of August, the RAF's deployed force in the Gulf would number 157 aircraft, including 49 Tornado GR1s, 12 Jaguars, and 18 Tornado F3 fighters.⁷

For the RAF Regiment, the initial requirement for air base GBAD once again emerged at Akrotiri, where 20 Squadron deployed four Rapier FSB fire units on 15 August. However, this was only temporary. On the 31st, the squadron moved forward to the RAF DOB at Muharraq, Bahrain. An assessment of host-nation GBAD then resulted in the number of fire units being doubled to eight during October. Of this total, four were deployed at off-base sites at 30 minutes readiness to fire, while two were held at three hours readiness and two were kept in reserve. The squadron even went so far as to build a causeway into the sea to ensure optimal fire unit positioning. The Muharraq task was taken over by 66 Squadron RAF Regiment in November, when a further two fire units were deployed off base and held at 30 minutes readiness. On 16 January 1991, all deployed fire units were brought to five minutes readiness and then to Battle Stations.

Meanwhile, in November, 26 Squadron deployed seven more fire units to the RAF DOB at Tabuk, Saudi Arabia. Of this number, four were initially placed at 30 minutes readiness to fire, and two more assumed this status on 12 January. All fire units were brought to Battle Stations in the period 17 to 29 January, after which their posture was relaxed slightly, and they only periodically returned to Battle Stations in response to specific incidents that raised the threat assessment.⁸

The Granby GBAD task ceased during the second week of March. Throughout the operation, the formidable array of fighter defences and coalition GBAD deployed to protect Saudi Arabia and other Gulf allies proved more than enough to deter offensive action by the Iraqi Air Force. The only threat came from Scud missiles. Although the Iraqi Scud launches were very inaccurate, some of the coalition airfields, notably Dhahran in Saudi Arabia, were vast. Scud attacks on Dhahran were recorded throughout the first week of Operation Desert Storm, and a total of 11 missiles hit the base. Some were intercepted by US Patriot SAMs, and others broke up in flight.

While the outcome of Operation Granby can only be deemed successful from a broad air defence perspective, it did not necessarily bode well for the future of UK GBAD. To repeat, the essence of all defence – especially air defence – is deterrence. At their most effective, defences will deter aggression; they will not be tested because of their perceived strength, and this was substantially what happened in the Gulf. And yet it was all too easy for uninformed observers to conclude that, if defences were not used in anger, they were not needed. This was not, paradoxically, an argument commonly employed to challenge the concept of strategic deterrence. Rather, it was reserved for tactical capabilities – particularly in the air defence domain. Furthermore, it appeared in the 1990s that the Gulf War had inaugurated a new era of US-led coalition operations in which adversaries were unlikely to challenge American air power. Fighting alongside the US, British forces would be protected by a shield of exceptionally advanced fighters and SAMs. Why, then, did the RAF still need to field these capabilities?

Granby also called other key tenets of air defence doctrine into question. The Precision-Guided Munitions (PGMs) on display provided the means to achieve a single-shot direct hit on a hardened aircraft shelter, which was normally enough to penetrate the concrete; it was even possible to target the vulnerable points of Iraqi shelters, such as doors and ventilation shafts. As one RAF air defence squadron commander put it, ‘No one who saw the burning oil fields will ever forget. Neither will the devastation of hardened aircraft shelters create confidence in our current ‘hardened’ posture at home.’⁹

Although the RAF dispersed across multiple bases during the conflict, this was primarily to find ramp space, which was in very high demand. The bases themselves were crammed with coalition aircraft, which would have been very vulnerable had Iraq been capable of fielding more potent offensive air power or surface-to-surface missile systems. The scope for effective on-base dispersal was limited, and most dedicated dispersal sites were soon accounted for. At Dhahran, the RAF’s Tornado F3 detachment developed its own dispersal plans despite the scepticism of the Saudi base commander, Prince (Brigadier General) Turki bin Nasser bin Abdul Aziz Al Saud.

Eventually, the detachment persuaded Prince Turki to allow a dispersal exercise to demonstrate the efficacy of their plan, which he attended himself. He was satisfied, and dispersal exercises thereafter became a regular feature of the detachment’s activities. They employed such sites as compass-swing pans and engine-running bays, putting a pair of aircraft on each with a small handling team. The sites would not have been suitable for holding alert states because of their lack of communications (aircraft radios apart), but this was not a requirement. They were entirely adequate for the actual task, which was to support the flying

programme. Although not hardened, the sites were spread out, and they rendered the aircraft far less vulnerable to random surprise attacks than they had been on their usual apron, where just one strafing pass could have damaged the whole line. Yet across the coalition as a whole, few detachments planned or rehearsed on-base dispersal. Protective measures were largely confined to the erection of concrete splinter protection units and the construction of revetments and sandbag walls.¹⁰

In a history of airfield air defence, it would be wrong to move on from Operation Granby without considering the subject briefly from an Iraqi perspective. At the beginning of the coalition air campaign, airfields were key targets. The UK Targeting Directive issued by CDS on 12 October 1990 identified seven primary military target categories and placed airfields at the top of the list.¹¹ The Iraqis, in their turn, expected their air bases to be attacked and established formidable GBAD provisions for their protection consisting of dense SAM arrays and multiple AAA batteries.

This was not enough to deter coalition air strikes; indeed, the Iraqis lost more than 250 aircraft on the ground during the operation. But the strength of their defences made the low-level tactics initially employed by the RAF prohibitively expensive. The early Tornado GR1 missions against Iraqi airfields resulted in the loss of four aircraft and eight aircrew – four killed and four captured. Iraqi GBAD played a major part in pushing the GR1 force up to altitudes at which they were neither trained nor equipped to operate, and their medium-level bombing remained very inaccurate until precision capabilities became available in the Gulf early in February 1991. Even at medium level, coalition aircraft were not immune from the Iraqi SAM threat. The RAF lost a 17 Squadron GR1 to SAMs during a medium-level mission against Al Taqaddum airfield on 14 February 1991, and GBAD accounted for nearly all coalition fixed-wing aircraft losses during the conflict.¹²

Notes

1. AHB narrative, *RAF Operations during the Falklands Conflict, 1982*, Chapter 8, pp. 8-14.
2. HON/2251/5/GBAD, RAF GBAD Operations since 1982.
3. Ibid; Wing Commander (Retd) Michael Fonfé to the author, 27 February 2023.

4. HON/2251/5/GBAD, RAF GBAD Operations since 1982.
5. 'Cyprus attack seen as work of new terror group,' *New York Times*, 7 August 1986, accessed 3 January 2023 at:
<https://www.nytimes.com/1986/08/07/world/cyprus-attack-seen-as-work-of-new-terror-group.html>
6. Wing Commander (Retd) Michael Fonfé to the author, 27 February 2023; 2729 Squadron Royal Auxiliary Air Force Regiment Operations Record Book, April 1985; 'Great Guns: Captured Argentine anti-aircraft guns will equip new RAuxAF Regt squadron,' *RAF News*, 614, January 11-24 1985; 'New RAF regiment gets set to fight,' *Lincolnshire Echo*, 3 July 1985; 2729 Sqn/TF1, Skyguard Squadron Formation Landmarks, by Squadron Leader MDC Fonfé; all in slip folder, 2729 Squadron Royal Auxiliary Air Force Regiment (AHB Box 213).
7. RAF press release, 'Operation Granby – Fact Sheet,' 9 May 1991, pp. 2-4 (AHB E-Vault).
8. HON/2251/5/GBAD, RAF GBAD Operations since 1982; Openshaw, 'Rapier,' p. 95.
9. AHB narrative, *The Royal Air Force in Operation Granby, The First Gulf War, 1990-1991, Tornado F3*, p. 31.
10. AHB, *The Royal Air Force in Operation Granby: Tornado F3*, p. 16.
11. AHB narrative, *The Royal Air Force in Operation Granby, The First Gulf War, 1990-1991, Command and Control*, p. 30.
12. *Statement on the Defence Estimates, 1992* (HMSO, London, 1992), p. 75.

13. The 1990s Defence Cuts

After Granby, successive defence reviews were initiated by *Options for Change* in 1990 and culminated in the *Strategic Defence Review* of 1998. In real terms, between 1990 and 2002, UK defence expenditure fell by more than 20 per cent; defence spending absorbed around 4 per cent of GDP at the beginning of this period but about 2.5 per cent at the end. The RAF's front-line force shrank from 63 squadrons to 43; the number of RAF personnel was reduced from 88,000 to 53,000.¹ Squadrons were disbanded, and bases closed. Reductions in scale did provide scope for improving the standard of equipment; one Conservative Defence Secretary championed the concept of 'smaller but better' in the early 1990s.² Yet this was only true to a limited extent; many defence capabilities associated with the Cold War disappeared altogether.

Unsurprisingly, where GBAD was concerned, the post-Cold War axe first fell on Bloodhound II. Of questionable utility even a decade earlier, the missile had nevertheless been retained in service beyond its original retirement date, and it was never likely to survive for long after the disintegration of the Warsaw Pact: 85 Squadron began to disband in 1990 and completed the process in the following year. Deliberations over a replacement medium-range SAM had continued intermittently since the end of the 1970s, and in 1991 the MOD still planned to equip the RAF with a new off-the-shelf missile within a period of four or five years.³ However, the Statement on the Defence Estimates published in 1993 read as follows:

Bids were invited from industry for systems capable of entering service at any time between 1995 and 2005. After careful consideration of these bids, and having taken account of the reduction in the threat of an air attack on the United Kingdom and our other priorities for defence, we have concluded that there is insufficient requirement in the near-term for a MSAM.^w We are now considering the nature and timing of any longer-term requirement for such a capability.⁴

One contributory factor in this decision was the withdrawal of the NATO-mandated requirement for GBAD at SACEUR's UK airfields.⁵

w. MSAM – Medium-Range Surface to Air Missile.

In 1998, the Strategic Defence Review cited the effectiveness of Eurofighter – which became the Typhoon – and ‘the current stage of development of systems to counter ballistic missiles’ as reasons for not procuring a new medium-range SAM.

We will, however, monitor developments in both threat and capability closely, participate in work in NATO and with Allies, and have established a technology development programme to keep this option open should the balance change significantly – for example if a new ballistic missile threat to this country were to emerge.⁶

This bombastic pronouncement drew a terminal line under the RAF’s association with medium-range SAM systems at a time when many other countries – both allies and potential adversaries – were still investing heavily in missile defence technologies. It also massively understated the difficulties that would be involved in re-establishing a medium-range SAM capability (in both qualitative and quantitative terms) if changing threat assessments or shifts in the strategic balance strengthened the case for so doing.

For the RAF Regiment, the short-term consequences of the drawdown were also quite predictable. The three squadrons that provided SHORAD at the USAF’s bases all disbanded in the mid-1990s. Less visible were procurement decisions that would have a significant impact on the front line in due course. In the late 1980s, work had started on an extensive Rapier upgrade – virtually a redesign – which became known as Field Standard ‘C’ (FSC), and which entered service with the RAF Regiment and the Army in 1996. The MOD originally envisaged a purchase of some 250 FSC units but reduced its post-Cold War requirement to just 57,⁷ or enough for both Services to maintain operational fleets of 24 fire units each. At first, this translated into four regular RAF Regiment squadrons of six fire units; at the same time, the Oerlikon capability was withdrawn to leave two squadrons – 27 and 48 – operating on a cadre basis with the RAF version of the Rapier FSB, correctly known as FSB1(M), which offered an enhanced battle-management capability compared with the Royal Artillery’s FSB system. This arrangement lasted for two years and helped to maintain the RAF Regiment’s unbroken high-level proficiency NATO declaration status while the four regular squadrons were re-equipping with FSC.⁸ Otherwise, for the Army, 24 FSC fire units equated to a single regiment, which left a second Rapier regiment with FSB.

For the regular squadrons, the reduced number of fire units per squadron was partly offset by the enhanced capability and reliability provided by FSC. The system incorporated far more advanced surveillance and tracking radars and a

thermal tracker that could track both target and missile by day and night. Radar and thermal tracking could be used simultaneously against two targets. The number of missiles per launcher doubled from four to eight, and the missile itself was upgraded to Mark II standard, with Mark II B fielding a laser proximity fuse matched to a blast-fragmentation warhead to ensure lethality against small and manoeuvring targets.⁹

It was perhaps somewhat easier for the RAF Regiment to embrace the ‘smaller but better’ concept and accommodate the transition to post-Cold War postures than the Royal Artillery. The Regiment only operated one GBAD system – Rapier – and its squadrons were more manageable than the Army’s much larger regiments, with their individual traditions and idiosyncrasies. RAF Regiment GBAD squadrons could also focus on their specialisation, whereas Army units were often deployed out of role, and, while the Belize commitment ceased in 1994, the RAF Regiment continued to provide the RRS for the Falkland Islands. In other words, it fulfilled an enduring operational commitment that offered excellent training opportunities.

In June 1996, the MOD’s Directorate of Operational Capability (DOC) produced an audit of UK ground air defences. It reported that the Army’s 7 Air Defence Brigade retained four regular air defence regiments, two of which provided point defence to its two deployable divisions. These were in the process of re-equipping from the Javelin system to the High Velocity Missile (HVM). The other two regular regiments provided limited area defence using different versions of Rapier. The RAF’s four regular squadrons were at this stage all converting to Rapier FSC.

The DOC noted RAF plans for RAF Regiment squadrons to gain access to a Recognised Air Picture (RAP) – a hugely important advance – but that there were no funded plans for the Army to obtain this capability. The DOC also found the RAF squadrons manned to a level consistent with the readiness requirements demanded by the MOD’s Departmental Plan.

By contrast, the Regular Army units are heavily cadreised and generally undermanned. This combination of factors would seriously undermine the ability of Army units to meet their readiness criteria and reduce the number of weapon systems which could be deployed.¹⁰

It was hard to see how the Rapier FSC or HVM regiments could be brought up to their war establishment levels of manning without months of additional training. The DOC audit continued.

Notwithstanding restructuring, conversion to Rapier FSC and the Falkland Island commitment, the RAF has managed to maintain a full and varied training programme at Squadron level. The Army's experience has been somewhat different; the combination of re-equipment programme, equipment deficiencies, unit moves, the Operational Tour Plot [OTP],^x the lack of adequate training areas over which to practise regimental deployments and the more varied nature of the tasks placed upon Army air defence units have conspired to reduce the level of collective training markedly. As a consequence, each regiment would require considerable additional training before it could be considered fully capable.¹¹

The RAF's role normally involved operating at squadron scale – six fire units – which was usually sufficient for the defence of one main operating base or FOB. The Royal Artillery GBAD role was to prevent enemy air forces from interfering with the conduct of land operations. The RAF's role implied that operations would probably be conducted in complex air environments – hence the importance of the RAP. This was generated through Link 11, which the RAF Regiment squadrons could access through the Read Only Link Eleven system. Regiment squadrons also had access to Airspace Control Orders issued by Combined Air Operations Centres through their command and control systems, and they disseminated WCOs through a simple tactical data entry device, the Rapier Control System. In short, they were moving steadily towards network-based command and control processes and procedures. On the other hand, the Army had traditionally allowed its batteries the autonomy to engage any target in its area of operation provided the WCO allowed it.

Better early warning would improve situational awareness at command posts, improve effectiveness by increasing the chance of a first-time engagement at maximum range, would reduce the chance of fratricide and reduce crew fatigue.¹²

An associated issue was aircraft recognition training. The DOC described accurate and early aircraft recognition as 'one of the most important skills which has to be mastered by air defence weapon operators'. The RAF had a basic

x. The Operational Tour Plot or OTP involved the employment of regiments out of role on operational tasks at locations such as Cyprus and Northern Ireland.

recognition list of 20 aircraft in 1996, which had to be mastered during training, and an advanced list of 60 aircraft. Operators were required to be able to recognise these 60 aircraft as a prerequisite to the achievement of Operational Performance Standard (OPS). However, the Royal Artillery's recognition training list contained only 40 aircraft, of which just 35 were common to the RAF advanced list. This was presumably all that remained of the Fonfé system acquired in 1979. A new computer-based recognition trainer had recently been introduced, but most units considered that the software did not meet their requirements: it was heavily oriented to vehicle recognition and its thermal images did not replicate the sights of air defence systems.

DOC audits were required to produce an executive assessment of operational capability. In this instance, their assessment read as follows:

The Regular Army cannot fulfil all its commitments for the provision of land-based air defence units as required by the Departmental Plan. In particular:

- A fully capable Tracked Rapier Regiment could not be generated in less than 60 days (R6) as opposed to the Departmental Plan target of 30 days (R5).
- A fully capable Rapier FSB2 Regiment could not be generated in less than 60 days (R6) as opposed to the Departmental Plan target of 10 days (R3)...
- The RAF Regiment Squadrons could each individually generate the operational capability required of them by the Departmental Plan within the laid down readiness times.¹³

There can be no doubt that these findings influenced the conclusions of the Blair Labour government's Strategic Defence Review (SDR) in 1998. Yet the review did not accurately reflect on the DOC audit's position. Instead, it represented the differences identified by the DOC as evidence of a general failure affecting all UK GBAD, when in fact the DOC had confirmed that the RAF Regiment was achieving all that British defence policy required of it. SDR Essay 8 read:

Our deployed forces continue to require low-level air defence cover to protect manoeuvring ground troops and key static installations such as logistic sites and air bases. Until now, both the Army and the Royal Air Force have maintained separate capabilities using different variants of the Rapier short-range air defence missile system. Each used their own operating procedures, command and control systems, maintenance support chains and training organisations. This has been operationally inflexible and wasteful ... In the future, Rapier training will be conducted jointly at RAF Honington and the differing variants of the system will be phased out and replaced by a common standard by 2006. This will allow a Joint Air Defence Headquarters to contribute specialist staff to the joint commander of air defence operations, and to organise training and support. These measures will ensure that joint deployments will have a properly integrated and flexible low-level air defence coverage, as well as achieving greater efficiency, particularly in Rapier training and support.¹⁴

The recommendations contained in SDR had very little to do with military capability and were primarily intended to save money in the training and support spheres. Among other things, SDR's declaration that the two Services operated different variants of Rapier was disingenuous. In fact, while they certainly operated different versions of Rapier FSB, plans had been ongoing for several years to re-equip the RAF Regiment and the Royal Artillery with Rapier FSC, as we have seen. Different versions of Rapier *were* used by the two Royal Artillery regiments, but only the RAF cadre squadrons were using FSB by 1998, and their GBAD role was withdrawn that year. It no longer functioned as a front-line system in the RAF.

Presumably, the decision to task joint training to RAF Honington was influenced by the DOC audit, and it would certainly have been very difficult to assign it to an Army establishment given the DOC's findings. Equally, the audit hardly established a strong case for placing a Joint GBAD Headquarters under HQ Land. Yet this was originally the proposal. Not surprisingly, the Chief of the Air Staff (then Air Chief Marshal Sir Richard Johns) rejected it out of hand, and a subsequent study by the Directorate of Joint Warfare led to a recommendation by the then Vice Chief of the Defence Staff (VCDS), Admiral Sir Peter Abbot, that the Joint GBAD HQ should be formed in Headquarters Strike Command (HQ STC). This proposal reflected the fact that 'the RAF had the organisation,

infrastructure and expertise to develop GBAD into an integrated joint capability.¹⁵ It should be noted that, at this time, the RAF was in the process of developing an operational headquarters within HQ STC, which was at first known as the UK Combined Air Operations Centre (CAOC) but which soon evolved into the Joint Forces Air Component Headquarters (JFACHQ – under a Joint Forces Air Component Commander, or JFACC).¹⁶ However, in October 1999, the General Staff succeeded in blocking the plan, creating an impasse for which there was no obvious solution. Eventually, the Secretary of State for Defence decided that the headquarters was not required.¹⁷

Meanwhile, the Kosovo conflict generated another volume of air lessons that may not have been directly applicable to UK GBAD but which were relevant to the subject of airfield air defence in the post-Cold War era. On the one hand, the conflict did not generate a requirement for RAF or broader NATO GBAD; on the other, it did involve extensive targeting of airfields by NATO, and the Federal Republic of Yugoslavia (FRY) therefore deployed extensive GBAD in their defence and in the defence of other potential point and area targets.

Relative to Iraq in 1991, the FRY was far less successful in terms of interceptions and lost more than 100 fixed and rotary-wing aircraft on the ground. Nevertheless, the threat from FRY GBAD compelled NATO aircraft to operate at medium altitude and above the dense cloud formations that covered southern Serbia and Kosovo for much of the campaign. From above the clouds, it was impossible for NATO aircraft to employ laser-guided bombing, and such unguided bombs as were released in these conditions fell very inaccurately. An early observation on the operation by Air Chief Marshal Johns was that ‘The enforcement of altitude ceilings to reduce significantly the threat to Allied aircraft, has clearly limited both its effectiveness and to some extent its credibility.’¹⁸

Notes

1. AHB research paper, *The Royal Air Force and the First Gulf War, 1990-91: A Case Study in the Identification and Implementation of Air Power Lessons*, p. 14.
2. *Statement on the Defence Estimates, 1992*, p. 32.
3. ‘RAF Bloodhound retirement leaves four-year missile gap,’ *Flight International*, 1-7 May 1991, p. 10.

4. *Statement on the Defence Estimates, 1993* (HMSO, London, 1993), p. 70.
5. Vernon, *Bloodhound*, p. 68.
6. Command Paper 3999, *Strategic Defence Review* (July 1998), Chapter 7, para 145.
7. Openshaw, 'Rapier,' p. 89.
8. Wing Commander (Retd) Michael Fonfé to the author, 27 February 2023.
9. Openshaw, 'Rapier,' pp. 90-91.
10. CAS 4/20/1 Pt C, DOC Operational Audit 04/96, *Air Defence (Land)*, 1 August 1996.
11. Ibid.
12. Ibid.
13. Ibid.
14. Command Paper 3999, *Strategic Defence Review*, Supporting Essay 8, Joint Ground Based Air Defence, paras 33 and 34.
15. CAS 3/23 Pt C, DOC Operational Audit 01/02, *Air Defence*, 25 June 2002.
16. AHB monograph, *Royal Air Force Command and Control, 1982-2014* (MOD, 2022), pp. 69, 70, 89-90, 105-106.
17. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: DAS/Strat/GBAD, 21 May 2004, GBAD – Further Work – Brief for Key RAF Players; CAS 3/23 Pt C, DOC Operational Audit 01/02, *Air Defence*, 25 June 2002.
18. AHB monograph, *The Royal Air Force and UK Air Power over Iraq and Kosovo, 1997-2000* (MOD, 2022), p. 123.

14. 2001-2003: Operational Capability

One of SDR's initiatives involved the creation of the Joint Rapid Reaction Force (JRRF). The JRRF was a group of specialised units from all three Armed Services tasked with rapid deployment worldwide at short notice, and it included an RAF Regiment Rapier squadron. On 11 September 2001, when Al Qaeda infamously mounted a series of terror attacks in the United States, 15 Squadron RAF Regiment was holding the JRRF commitment. In the Gulf, where RAF detachments had long been committed to Operation Southern Watch (UK Operation Resinate South), the threat level was raised, and one particular focus of concern was the security of Ali Al Salem air base, Kuwait, where the RAF's Tornado GR4s were based.

On 14 September, 15 Squadron was ordered to deploy a Fire Group of three fire units to provide SHORAD at Ali Al Salem. Of these, two were deployed at on-base sites at high readiness by the 19th, while the third functioned as a reserve. The RAF SHORAD capability was closely integrated with the USAF's Control and Reporting Centre (CRC) and with US Army Patriot batteries in theatre. On 24 November, the Ali Al Salem task passed to 16 Squadron RAF Regiment, which in turn handed over to 26 Squadron the following January. Each deployed squadron simultaneously held the Falkland Island RRS commitment, just as single 'split' squadrons had previously covered both the Falklands and Belize. In mid-March 2002, the coalition reduced their threat assessment in the Gulf, allowing the Rapier detachment to be withdrawn.¹

During this period, the DOC was tasked to undertake an operational audit of air defence, and their report, completed in June, again considered the operational capability of UK GBAD. The Army's Rapier element by this time consisted of 16 Regiment Royal Artillery, with three batteries of Rapier FSC, and 22 Regiment, with four batteries of the older FSB2. Both regiments were assigned to the Allied Rapid Reaction Corps (ARRC) under the Operational Command of 7 Air Defence Brigade.^y

The RAF Regiment retained four fully regular GBAD squadrons and a GBAD Headquarters located at Honington. The RAF Rapier FSC force continued to operate on a scale of six fire units per squadron, one squadron per MOB or FOB, each capable of independent operations from well-found, austere, or bare bases. They were capable of vital point, high-value asset, area and route defence and were required to be rapidly deployable to support air operations worldwide.

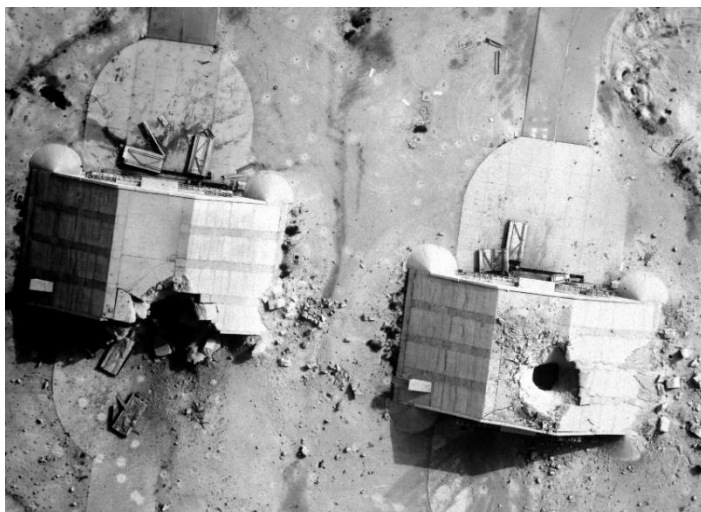
y. One 22 Regiment battery came under the Operational Command of the Royal Marines.



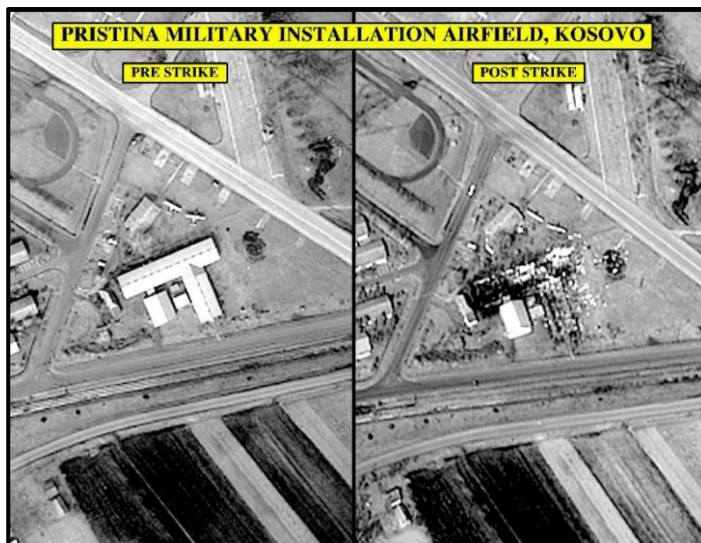
A Royal Air Force Regiment Rapier fire unit at Muharraq airbase, Bahrain, during Operation Granby.



Rapier FSC being tested in the Falkland Islands.



Hardened aircraft shelters demolished by single coalition PGMs during Operation Granby (US DOD).



Airfields were also repeatedly targeted by NATO during the Kosovo conflict in 1999 (US DOD)

In the Army regiments, the manning problems identified by the DOC in 1996 had not been rectified; 7 Air Defence Brigade Headquarters was also severely understaffed, and its expansion for operational deployment was heavily dependent on augmentees. The DOC observed that, for a medium-scale war-fighting task, the regiments would require considerable augmentation, but it was not clear how this would be achieved. It would be difficult to transfer personnel from one regiment to the other because they were trained on different standards of Rapier, and the second Rapier regiment – 22 Regiment – was in any case threatened by Army savings plans. The problem was still exacerbated by out-of-role OTP commitments. Royal Artillery units were required to spend three months working up for a 6-month UN tour and required retraining in their core air defence role when they returned.

In the training sphere, SDR's aspiration to achieve inter-Service harmonisation through the Joint Rapier Training Unit (JRTU) at Honington had proved difficult to realise because of the extent to which the role and doctrine of RAF and Army GBAD diverged. 'The absence of jointly endorsed tactical doctrine and procedures has resulted in the Army and the RAF providing different inputs to training objectives and syllabi, leading to the JRTU providing a number of separate courses specific to each service.'²

The DOC suggested that there was considerably more scope for integration and jointery. However, its consideration of single-Service training activity sheds further light on this complex issue. For example, it noted that there were no standardisation teams for Army GBAD, that some units were unclear what Collective Performance (CP) levels they were expected to achieve, and that there were discrepancies between the CP level units believed themselves to hold and the levels recorded by 7 Air Defence Brigade Headquarters. A combination of re-equipment programmes, personnel shortfalls, equipment deficiencies, unit moves and other commitments (including OTP and Military Aid to Civil Authority tasks) had conspired to reduce markedly the level of Army GBAD collective training. The Royal Artillery units lacked sufficient all-arms training at battle group level, and many formation-level exercises failed to encompass and highlight the utility of air defence.

By contrast, the RAF's GBAD squadrons were trained and evaluated to the same standard, used common tactics, techniques and procedures, Standard Operating Procedures (SOPs) and weapon system drills, and conformed to the same doctrinal processes. According to the DOC,

The RAF have managed to retain a full and varied training programme at squadron level by the implementation of a 16-

month readiness and training cycle. The cycle has been running for a number of years and retains units in role for both training and operational deployments. The units hold the R3 and R2 commitments for 4 months at a time, before holding R1 prior to taking over the FI^z commitment for 4 months. RAF GBAD sqns have recently exercised in Norway, Malaysia and the UK, taking part in national, multi-national, joint and combined exercises.³

A very similar picture emerged in the sphere of tactical doctrine. The DOC found that Army GBAD elements possessed little common doctrine relating to the tactical employment of HVM and Rapier and no common SOPs. Standard Operating Instructions (SOIs) had been developed separately by each air defence unit: 'This variety of SOIs and their ongoing development restricts implementation of current thinking, doctrine and best practice.'⁴

RAF GBAD elements, on the other hand, had a unifying force ethos, which had enabled greater harmonisation and interoperability between the squadrons. The RAF GBAD force had its own SOPs, and commonality of doctrine and procedures ensured interoperability between units and other air assets, and the ability to interchange elements within the squadrons at will. As for tactics, 'The Tactical Development branch at AWC^{aa} provides a lead focus for tactics issues, with the AWC GBAD tactics manual serving as a 'bible' whose rolling programme of updates provides an effective corporate memory.'⁵

Where command and control was concerned, the DOC found in the Army GBAD community 'discordant approaches'. The command and control of Army GBAD units was complex, with several organisations involved in the provision of capability. Operational command arrangements were dispersed, and tactical control arrangements were even less well defined. 'There is no common doctrine and CONOPS for the integration of Army GBAD within higher-level formations, and the infrequent inclusion of AD^{bb} units on formation-level exercises perpetuates the inertia. These issues may be symptomatic of the low priority afforded to AD.'⁶

The DOC recommended the development of common doctrine and operational concepts for the integration of Army GBAD within higher-level formations as a matter of urgency. It also noted that RAF GBAD units had 'clearly established procedures for the integration of C2 on an airfield or other point target'. The

z. FI – Falkland Islands.

aa. AWC – the Air Warfare Centre, now the Air and Space Warfare Centre.

bb. AD – Air Defence.

difficulty of integrating Army units with other force elements, particularly in the air domain, was further highlighted by the fact that they could still neither access nor contribute to the RAP, whereas the RAF Regiment was in the process of trialling the system of access based on Link 11, with the assistance of 1 Air Control Centre.

The DOC audit also addressed the issues of deployability and logistical support. Rapid deployability was particularly important because, as we have seen, air threats had a pronounced tendency to present themselves at the beginning of operations or conflicts, and its significance had been underlined by SDR, which described the JRRF's first-echelon forces as 'always held at very high readiness for early entry operations'. This sent out an unambiguous message about readiness, requiring these forces to be ready to conduct operations on deployment. The DOC judged that the RAF could achieve this requirement, but this was 'generally not the case for most Army FE'.^{7cc}

As for logistical support, the DOC recorded that Army GBAD units suffered from a shortage of lift capacity to carry spares and fuel, but the shortfall was difficult to quantify because they lacked established sustainment figures. In other words, they did not know how much support they would require. By contrast, yet again, the RAF Regiment had established and rehearsed procedures that applied across their GBAD squadrons.

RAF GBAD sqns will normally locate with a RAF Deployed Supply Group (DSG) and will deploy with 10-day Priming Equipment Packs (PEPs). Logistic requirements are contained in GBAD force SOPs, and the DSG will provide spares, fuel, rations and water to sustain deployment, organised through the STC A4^{dd} role office in co-ordination with the GWSS IPT^{ee} for spares. Sqns deploy with one RAF supplier from the organic engineering flight to ensure rapid and smooth integration with the DSG. The system has been tried and tested in the FI by every RAF GBAD sqn and works well. RAF sqns employ integrated support for smaller numbers of FU and can manage a step-up or step-down in level of capability if required.⁸

cc. FE – Force Elements.

dd. A4 – Air Logistics.

ee. GWSS IPT - Guided Weapons Systems Support Integrated Project Team.

Perhaps the DOC's most important conclusion was that the UK could not at short notice field anything like the GBAD forces implied by the Armed Services' notional GBAD strength. As the audit stated:

It is by no means clear that the UK's GBAD capability is sufficient to match the scale or range of the UK's expeditionary aspirations, both in terms of quantity and performance. OA^{ff} on future threats appears to contradict extant UK and NATO policy documents. In these documents, scenario ROE restrictions appear to discount the enemy attacking friendly airfields, thereby failing to acknowledge the benefit of having a GBAD capability deployed to protect them.⁹

The RAF GBAD role was clearly defined and directly linked to the scale of the force. It encompassed the provision of SHORAD for RAF assets deployed worldwide, either as a national contingency, as in the Falkland Islands, or as part of a coalition. The established strength of the force could support operations at two DOBs and one Forward Mounting base for medium-scale war-fighting scenarios. However, the provision of Army GBAD units was based on fielding a number of force elements at readiness rather than on a defined end effect, and both equipment and manpower shortfalls also limited their capacity to provide mandated SHORAD capability. The DOC noted 'a marked difference between the extant endorsed planning assumptions and the capability that can be demonstrated'. It also recommended that the quantity of GBAD required to provide adequate force protection should be defined in conceptual and doctrinal terms. Notwithstanding the apparently terminal pronouncements of SDR, the DOC argued that the UK's lack of a medium-range SAM represented a capability gap and that another potential deficiency was Theatre Ballistic Missile Defence.

The DOC audit drew attention to the lack of collective interoperability between the RAF and Army GBAD units, which were regarded as separate entities for the purposes of JRRF deployments, and argued that their respective cultures should be interoperable and interchangeable to maximise the flexibility and effect of the total force. Both RAF and Army GBAD should, the DOC maintained, be capable of carrying out dual-role operations, with harmonised doctrine, training and equipment. The impossibility of such harmonisation, given the problems afflicting Army GBAD, were only too obvious, and it is therefore not surprising that the DOC's executive summary ran as follows:

ff. OA – Operational Analysis.

It is assessed that the current full manning on RAF GBAD squadrons, allied to their clearly identified force ethos, permanent participation on operations in-role and harmonised training and procedures, provides the clearest example of best practice.¹⁰

The prospect of any immediate action faded during the build-up to the Second Gulf War (UK Operation Telic) in the following year, when the US Area Air Defence Commander highlighted the coalition's lack of GBAD capability against small low-level targets – between the target categories appropriate for engagement by the medium-range Patriot and the man-portable Stinger system. Consequently, 16 Squadron returned to Ali Al Salem, deploying three Rapier fire units: one was placed at Battle Stations, while the others maintained high readiness. Once more, they were integrated into the coalition IADS, this time under the tactical control of a co-located US Army Patriot brigade.¹¹

The second Gulf War was profoundly different from the first. In 1991, a 6-week air campaign had preceded a short coalition ground operation; in 2003, extensive 'shaping' air strikes were executed in support of the southern Iraq No-Fly Zone mission but there was otherwise no preparatory air offensive. The leading role in the coalition campaign to oust Saddam Hussein was assigned to ground manoeuvre, with combat air power substantially employed to provide tactical air support to the Land Component.

At the opening of the conflict, the Iraqis launched surface-to-surface missiles (SSMs) against Kuwait, but there were no conventional air attacks, and it is regrettably not for this aspect of air base GBAD that the operation will be remembered. Instead, it was again the problem of ground-to-air fratricide that reared its ugly head. On 22 March, the RAF's Combat Air Wing, based at Ali Al Salem, contributed two Tornado GR4s, call-signs Yahoo 75 and 76, to a coalition package that included other GR4s, B2s, EA6Bs and F16CJs. During the mission, operating in the SEAD role, they each released four of their five ALARM missiles.

On their return, they were approaching Ali Al Salem when a US Patriot battery misidentified Yahoo 76 as a hostile incoming Anti-Radiation Missile (ARM) and launched against it. Yahoo 75 recorded receiving Patriot indications and SA-2 missile guidance warnings and the pilot then spotted the incoming missile and manoeuvred hard. However, for Yahoo 76 there was no escape: the Patriot detonation destroyed the aircraft, and the 9 Squadron crew, Flight Lieutenant Kevin Main (pilot) and Flight Lieutenant Dave Williams (navigator), were killed.

This tragic incident resulted from a combination of factors; there was no single explanation. From the RAF's perspective the critical cause was the failure of

Yahoo 76's IFF equipment, and the Patriot battery would not have engaged the aircraft had its IFF been functioning properly. Yet the IFF's failure should not alone have left it vulnerable to such disastrous misidentification. The fact that it did so had also to be addressed in subsequent investigations. The Patriot system identified hostile missiles using a range of criteria programmed into its computer. These were predominantly based on the many different anti-radiation missiles in service worldwide, and were therefore very broad; additionally, one concerned the presence or otherwise of a valid IFF return in mode 1, 3 or 4. There is no doubt that some of the criteria were too general and that they should have been based specifically on the characteristics of known threats from Iraq; they were modified immediately after the incident. The American Board of Inquiry into the shoot-down remarked:

This step should be taken prior to the onset of hostilities. In future conflicts, a rehearsal with all tactical directors should occur which includes threat capabilities and characteristics, as well as friendly aircrew tactics.¹²

The battery operators themselves appear to have been responsible for one of the critical failings in this respect. A preliminary software test had required the Patriot system to be able to demonstrate a capability to intercept the AS-17 ARM – a weapon that was not in the Iraqi inventory. In the test, a track could be identified as an ARM with an approach angle as low as ten degrees. Following the test, the system should have been reset to prevent ARM identification being based on a track approach angle lower than 20 degrees, but the Patriot crew omitted to do so. Yahoo 76 would not have been classified as an ARM if the correct 20-degree setting had been employed.

Apart from the programmed criteria used to identify hostile missiles, the ROE required the Patriot operators to determine that the ARM was directly threatening their unit. If they decided that it was, they were cleared to engage it in self-defence without authorisation from any higher authority in the command chain. In ideal circumstances, aircraft returning from missions over Iraq would have been routed around friendly GBAD. Unfortunately, in the early stages of Operation Telic, airspace constraints were such that returning aircraft often had to fly directly over the Patriot battery that shot down Yahoo 76. This contributed to the battery operators' belief that they were being directly targeted. Furthermore, the ROE permitting self-defence actions against ARMs took no account of the total inactivity of the Iraqi air force following the onset of hostilities. It was afterwards concluded that the Patriot ROE had at this time been too loose. Once again, they

were immediately tightened after the shoot-down, autonomous self-defence engagements of ARMs and cruise missiles being prohibited altogether.

In the hands of thoroughly trained and experienced Patriot operators equipped with the RAP and in close contact with higher command echelons, the ROE might have proved sufficiently robust to save Yahoo 76. The missile launch occurred ten seconds after the radar contact was categorised as an ARM, whereas the crew actually had about one minute to decide whether to engage. Although Patriot training emphasised the need to fire early, more experienced operators might have delayed launching their missiles for longer, and the radar contact would then probably have been reclassified as its flight path changed. However, according to the US Board of Inquiry, the battery crew was 'ill-trained and inadequately equipped'.

The fundamental construct of PATRIOT autonomous and independent operating modes requires IFF and engagement determinations to be made with little or no outside C2 and at the lowest possible level. These identification and engagement decisions are tasked to the most junior officers and NCOs, the Tactical Control Officer (TCO) and the Tactical Assistance Officer (TCA), who can act without sufficient outside cross-checking of their conclusions ... The investigation also highlighted deficiencies in training, and a lack of situational awareness and enemy order of battle within PATRIOT crews.¹³

Furthermore, their battery was only partially equipped at the time of the engagement: some of its communications suite was still in transit. It did not have its own digital communications, nor was it co-located with a battery command post. Its sole voice communications comprised an FM radio link with a 'sister' battery, which did possess voice and data links to and from their battalion headquarters.

On identifying the apparent ARM, the TCO had radioed the sister battery, which had contacted the battalion headquarters, which had in turn contacted the CRC. Procedurally there was no requirement for the TCO to seek higher approval to engage an ARM in self-defence, so it is possible that there was in fact some uncertainty that the track was indeed an incoming ARM. Radar operators at the CRC, the battalion headquarters and the sister battery, all of whom possessed the RAP, did not detect the reported ARM contact. Nevertheless, within seconds of reporting the contact and without direction from any of the other authorities, the TCO took the decision to launch. It should perhaps be added that the engagement

took place in a tense situation: the battery had successfully engaged an SSM two days before, and that night there were renewed fears of SSM attacks from the Basrah area. The Patriot crew was also on heightened alert following news of a suspected ground attack on US forces at a nearby encampment.

The RAF inquiry into the loss of Yahoo 76 produced recommendations that chiefly concerned the Tornado GR4's IFF system. The US recommendations were more far-reaching and deserve to be quoted in full:

The modern battle space presents a new dynamic in complex combined/joint operations. Lessons learned in this environment can be costly and life threatening. Independent and autonomous operations significantly reduce higher echelon command and control (C2) at points when lives can be quickly lost ... Current autonomous and independent operations Tactical Standard Operating Procedures (TSOP) significantly inhibit track deconfliction and IFF, and call into question the wisdom of continued autonomous and independent operation of PATRIOT battery elements. The PATRIOT community must address and, where necessary, repair ... interoperability, battery communications, C2 in general, and, in particular, C2 in these degraded communications environments.¹⁴

The divergence between the Air Component's approach to GBAD, emphasising its position within an IADS, and the Land Component's long-established custom of autonomous, semi-autonomous or procedural activity reappeared later in Operation Telic after the Iraqis launched several adapted Seersucker anti-ship missiles against Kuwait from the Basra area. The commander of the Army's 7 Air Defence Brigade and one of his staff had deployed to form a proportion of the Battlefield Coordination Detachment in the UK Air Component Headquarters, but there was no Army Rapier in theatre. Fortunately, however, the RAF Regiment had a proven track record of supporting the Land Component on exercises such as SAIF SAREEA II in Oman in 2001.¹⁵ On 30 March, 16 Squadron was therefore re-tasked to provide SHORAD for 1 (UK) Armoured Division – Operation Sayyad. The RAF SHORAD Commander – the Officer Commanding (OC) 16 Squadron RAF Regiment, Squadron Leader AG Knowles – found himself operating under the division's Duty Air Defence Commander (DADC) and subsequently recorded:

The process of having Tactical Battle Management Functions (TBMFs) delegated from higher AD authority (ultimately the CAOC) down to Div level did not appear to be understood, the perception being that authority rested with the DADC for the tactical battle management of AD assets without recourse to higher authority – whether the appropriate Airspace Control Measures (ACM) had been promulgated or not.¹⁶

Squadron Leader Knowles supplied two illuminating examples. On 5 April, the divisional headquarters had ordered him to assume Readiness State 1, or Battle Stations, and EMCON A – full radiation – and further measures activating their local airspace for GBAD use. No such activation had been authorised or promulgated in the Airspace Control Order, Emission Control authority had not been delegated to the DADC, and no Operation Sayyad ROE for GBAD had been promulgated by any responsible authority at the time. On his advice, the order was rescinded. Nevertheless, as he put it,

The consequence of following such direction could have been for a Coalition aircraft to target the illuminating surveillance radar whose presence (and emission) in the Forward Area was not known or authorised. A SEAD-on-Patriot blue-on-blue incident had already occurred earlier in the campaign.¹⁷

A similar problem arose in relation to 1 (UK) Armoured Division's plans for 16 Squadron to generate an 'attrition line' dictating the geographical area in which incoming missiles might be engaged. These were prepared before the squadron deployed forward and without consultation with the division's Joint Helicopter Force Liaison Officer (JHF LO). When he was eventually invited by the OC 16 Squadron to contribute to the ACM planning process, significant procedural difficulties became apparent due to the locations of helicopter FOBs and landing sites in the proposed engagement area.

The Weapons Free engagement criteria for cruise missiles envisaged that a target should be engaged if it was transmitting an incorrect Mode 1 IFF interrogation response, and if it was flying due south at low level. Yet this might have allowed a Rapier launch against a coalition helicopter flying south with unserviceable or incorrectly set IFF equipment. The danger was increased by the fact that, as the JHF LO pointed out, minute-to-minute positive control could not be exercised over all helicopter movements in the area. On this basis, Knowles advised that the proposals for both ACM and ROE were unworkable, that they

could result in fratricide, and that alternative ACM should be considered. Again, his arguments prevailed.¹⁸

Subsequently, 16 Squadron's organic CIS facilitated contact and coordination with higher air command and control and other air defence elements; the 1 (UK) Armoured Division DADC recorded in his post-operation report that 'the integration of the RAF Regt Sqn into the Div worked extremely well.'¹⁹ Within days, the Seersucker launch sites had been overrun by coalition troops, and the Rapier units were then withdrawn.²⁰

Notes

1. HON/2251/5/GBAD, RAF GBAD Operations since 1982.
2. CAS 3/23 Pt C, DOC Operational Audit 01/02, *Air Defence*, 25 June 02.
3. Ibid.
4. Ibid.
5. Ibid.
6. Ibid.
7. Ibid.
8. Ibid.
9. Ibid.
10. Ibid.
11. HON/2251/5/GBAD, RAF GBAD Operations since 1982.
12. AHB monograph, *The Royal Air Force and UK Air Power in Operation Telic, Iraq, 2003* (MOD, 2023), pp. 107-110.
13. Ibid.

14. Ibid.

15. STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: paper entitled Delivering Integrated (GB)AD to the Joint Commander, 25 May 2004; STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: 2GP-FP MAN SO2-S to ACAS/PSO-S, 26 May 04.

16. STP-04 Medium Term Workstrand 14, GBAD, Vol 4, RAF Only and GBAD Operations: Squadron Leader AG Knowles, Officer Commanding 16 Squadron RAF Regiment, Op SAYYAD Deployment Report, 14 April 2003.

17. Ibid.

18. Ibid.

19. STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: Delivering Integrated (GB)AD to the Joint Commander, 25 May 2004; STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: ACAS to ACNS, 26 May 2004.

20. HON/2251/5/GBAD, RAF GBAD Operations since 1982.

15. GBAD Ownership: Workstrand 14

Meanwhile, in the UK, the Chiefs of Staff had turned their attention to the DOC audit of air defence, with its recommendations for harmonisation and interoperability between RAF and Army GBAD. Following the audit, the Vice Chief of the Defence Staff – by this time Air Chief Marshal Sir Anthony Bagnall – launched an initiative on Air Defence in the Joint Battlespace.¹ Although Bagnall was reportedly keen to resurrect the plan for establishing a Joint GBAD Headquarters, reviews by a 1-Star Joint Air Defence Development Group and a 2-Star Joint Air Defence Oversight meeting in March 2003 rejected the concept, and this decision was reconfirmed after the appearance of the formal Operation Telic lessons reports later in the year. Instead, they eventually agreed on the introduction of Joint GBAD doctrine and common operational standards, on the progression of joint training and on the employment of Army GBAD on operational GBAD commitments such as the Falkland Islands.²

To achieve common operational standards, the 2-Star meeting determined that the established RAF Standards and Evaluation (STANEVAL) system should be adopted, and the Army agreed to a timetable that envisaged the Royal Artillery Rapier units attaining the required standard between late 2005 and 2007. These were now all to be drawn from 16 Regiment, and 22 Regiment was disbanded. The achievement of STANEVAL was set as a prerequisite for any Rapier sub-unit deploying to the Falklands.³ The Army also committed itself to reducing the amount of time spent by GBAD elements on out-of-role tours.⁴

A subsequent capability initiative, known as GBAD Phase 1, was intended to address what one document described as the ‘very limited air situational awareness, and cumbersome procedural airspace control arrangements’ of the Army Rapier batteries. GBAD Phase 1 would ‘use Control Nodes, the GBAD Battle Management Application, bespoke comms and Local Air Picture sensors to fully integrate GBAD with the IADS and provide key elements of NEC.’^{5gg}

Yet while these plans for UK GBAD were evolving, the MOD was conducting a broader policy review. Its conclusions appeared in the Defence White Paper of December 2003 entitled *Delivering Security in a Changing World*. The White Paper sought to address the security challenges confronting the UK after the terrorist attacks on the United States in September 2001 and laid greater emphasis than SDR on operations against terrorists and other non-state actors, operations in

gg. NEC – Network-Enabled Capability.

connection with ‘failing states’, and measures to protect the UK against asymmetric threats.

Planning and capability development were now substantially linked to the perceived demands of small-to-medium-scale and peace-support operations of a deployed or expeditionary character, mounted at short notice by joint forces. Networked capability was a regular theme, as was the so-called ‘comprehensive approach’, which envisaged maximising effect through combined and coordinated cross-government action – particularly by the MOD, the Foreign Office and the Department for International Development. Although the UK had only recently conducted a large-scale conventional operation in Iraq, the White Paper maintained that such operations were far less likely in the post 9/11 world; moreover, if they occurred at all, they would be fought alongside allies with the capacity to plug UK capability gaps:

We must therefore plan to support three concurrent operations, of which one is an enduring peace support operation ... This requires the rebalancing of the Armed Forces to enable them better to meet the demands of the more likely Small and Medium Scale contingencies and needs to include the enhancement of strategic enablers – communications, logistics and intelligence. We will maintain a broad spectrum of maritime, land, air, logistics, C4ISR and Special Forces capability elements to ensure we are able to conduct limited national operations, or be the lead or framework nation for coalition operations, at Small to Medium Scale. But we will not need to generate large-scale capabilities across the same spectrum, given that in the most demanding operations we will be operating alongside the US and other allies, where capabilities such as air defence and naval escorts are less likely to be at a premium.⁶

This ‘rebalancing’ would require flexibility across Defence in terms of personnel, structures and equipment.

We must adapt to stay ahead of potential adversaries and be prepared to make tough decisions to ensure that our forces and equipment deliver the required capabilities. Force structures will need constantly to evolve as we seek to exploit new technologies, techniques and equipment to improve capability and respond to the changing strategic environment.⁷

It was against this background that the MOD established a series of Workstrands to consider Defence structures, capabilities, and the possible scope for achieving savings in several areas. The aim was to cut spending by £1.6 billion and achieve substantial manpower reductions.⁸ Although short-term savings measures had already reduced the UK's GBAD forces substantially below the strength envisaged by SDR, Workstrand 14 was established late in 2003 to realise further economies. Several options were proposed in relation to Rapier, ranging from no saving at all to the total withdrawal of the missile, to the transfer of all Rapier to the Royal Artillery or the RAF Regiment, reducing overall force size, to the formation of a Joint Rapier Regiment, also reducing total force size.⁹

In the search for savings, there was clearly a significant element of 'divide and rule'. UK GBAD had been drastically cut back since the end of the Cold War and possessed an effective strength considerably below its notional strength, as the DOC audits both noted. This same point was raised at another 2-Star oversight meeting convened as part of the Air Defence in the Joint Battlespace initiative on 21 October:

Concern was raised that the current RP^{hh} Options being considered for GBAD were based on out-of-date threat and capability considerations. It was agreed that DG Infoⁱⁱ would write to ACDS(RP) to propose that any substantive decisions on GBAD options should be informed by a study of SHORAD and VSHORAD within an expeditionary warfare scenario.¹⁰

Nevertheless, the MOD now sought still further reductions by diverting attention to the issue of ownership. Instead of combining to defend the remaining GBAD forces, the RAF and the Army became embroiled in a bitter argument over the question of which Service would continue to operate what was left of the UK's Rapier force. Another obvious danger – the possibility of more cuts downstream – failed to exert any influence at all, and 'capability' was confused with 'mass' throughout the entire process.

At the time, the RAF was viewed as the loser and Army as the winner, yet such labels are substantially meaningless. The real loser was UK GBAD as a whole, not only through the immediate loss of fire units but also because of the total elimination of the RAF's GBAD capability. The loss of RAF Rapier represented

hh. RP – Resources and Plans; ACDS(RP) was Assistant Chief of the Defence Staff Resources and Plans.

ii. DG Info – The MOD Director General of Information.

a greater sacrifice to UK GBAD than the loss of the Army capability due to the superior standard of the RAF's Rapier force and because the elimination of RAF Rapier terminated the Service's association with the provision of GBAD altogether. It entailed the near-total loss of an immense reserve of experience and expertise that had accumulated over 62 years. By contrast, even without Rapier, the Army would still have possessed HVM.

Had the RAF Regiment's Rapier force been preserved in 2004, it is unlikely that the UK's contingent SHORAD capability would have been eliminated so soon afterwards, and UK Defence would also have retained a broader GBAD base for regeneration later. It may still be that the RAF Regiment is drawn back into the provision of GBAD in future, but that process will not be facilitated by the fact that it will have to start from scratch.

Initially, the RAF Regiment's position in the ownership battle appeared strong. In its favour were the DOC audits of 1996 and 2002, its record of recent in-role operational deployments, notably for Operation Telic, and its high readiness. Had immediate operational capability been the decisive factor, the RAF Regiment would unquestionably have retained Rapier. However, certain other issues conspired to undermine the Regiment's position.

The first of these was Typhoon. The delays and cost overruns associated with the Typhoon's development were the subject of political controversy in the early years of the century, and the perceived reduction of air defence threats caused some commentators to question whether the aircraft was needed at all. In time, in the context of later conflicts in Libya, Iraq and Syria, and of NATO requirements in Eastern Europe, the case for the Typhoon would be emphatically demonstrated. Yet the contentious nature of the Typhoon project in 2004 did not place the RAF in a strong position to fight for the future of its GBAD force.¹¹

The second was the disbandment of 22 Regiment Royal Artillery in 2003, which occurred alongside substantial reductions to the HVM force. This created a perception that the Army had been hit more heavily by previous GBAD cuts than the RAF Regiment, which had retained a stable force of four front-line squadrons since 1996. On this basis, there was ostensibly a case for arguing that a further RAF cut was due. Yet any such contention would have been very misleading. The RAF Regiment had entered the 1990s with ten Rapier squadrons and had lost six to the post-Cold War axe; it had also lost the two cadre squadrons in 1998, and the two Sky Guard-Oerlikon squadrons. Moreover, the potential demise of 22 Regiment had been on the cards since SDR announced that all UK Rapier elements would standardise on the FSC system. There was never any serious likelihood that 22 Regiment would be re-equipped with FSC.

The third factor, which was probably decisive, was the Service complexion of the Chiefs of Staff in 2004. GBAD was a sphere in which the RAF and the Army had a major stake. Unsurprisingly, therefore, the Workstrand task was assigned to the leadership of the Royal Navy's Director of Resources and Plans (DNRP) – Commodore Tim Laurence. Superficially, this provided an appearance of objectivity. However, this was only true before the Workstrand's recommendations reached the Chiefs of Staff. At this point, in the event of an impasse, the Chief of the Defence Staff (CDS) was bound to exert a decisive influence, and the CDS post in 2004 was occupied by General Sir Michael Walker.

On 13 January 2004, Laurence visited Honington as part of a programme that took him to the key organisations involved in the delivery of UK GBAD.¹² There, he declared that his aim was to find major savings. It was clear to RAF officers in attendance that his work was not backed by prior consideration of developing air threats, such as cruise missile and tactical aerodynamic missiles, nor had he considered the potential vulnerability of APODs, SPODs, and DOBs to attack during the initial deployment phase of an operation. Equally, at this stage, he was not aware of the capability gap Rapier had filled in Gulf operations since the turn of the century – the gap between medium-range SAMs and VSHORAD. Yet this was 'a critical niche capability for any US-led coalition in future'.¹³

Very soon, the issue of ownership emerged as a key factor in Workstrand 14's deliberations. Just ten days after Laurence's visit, the SO1 Force Protection Plans at HQ STC presented a series of 'RAF GBAD Key Points' to the Assistant Chief of the Air Staff (ACAS), Air Vice-Marshal David Walker, which promoted the case for the retention of Rapier by the RAF Regiment. He argued that GBAD was part of the broader air defence system and the core business of the Joint Force Air Component (JFAC), and that air defence was a priority task for early entry forces; the high readiness of RAF Rapier as opposed to Army Rapier should be considered in this context. Moreover, the four RAF Regiment squadrons possessed a wealth of operational experience extending back through Telic, Resinate, Granby and the RRS commitment, and Telic had, in particular, demonstrated the flexibility and utility of RAF GBAD, which had operated in support of both the Air and Land Components.¹⁴

By mid-February, Laurence and his team had developed a series of 'packages' covering the various options under discussion to achieve savings against GBAD.¹⁵ Potential economies seemed possible in such areas as training and support, through the establishment of a single GBAD Headquarters, and through a 25 per cent reduction in the size of the Rapier force. Another possible option involved a 50 per cent reduction of Rapier fire units and single-Service ownership of Rapier.¹⁶ Again, the responsible HQ STC staff were struck by the extent to which the various

options had apparently been developed in a vacuum. If operational factors had been considered at all, it was in the context of Telic, or rather certain aspects of Telic such as large-scale ground manoeuvre, the absence of air threats, and the presence of American airborne and ground-based air defence assets in strength. And yet, as one RAF officer pointed out,

Future campaigns may not be the same as our recent previous experiences in Iraq, particularly where National, NATO or European operations are concerned. We may at some stage be challenged for control of the air when overwhelming US superiority will not be available ... Reductions should be viewed against the doctrinal concept of layered defence and the capabilities that contribute to this.¹⁷

No less worrying was Laurence's declared methodology. As the Air Officer Plans advised ACAS on the 26th:

His chosen method was to extract progressive reductions up to the maximum acceptable level of pain to deliver maximum savings. However, the levels of reduction appeared arbitrary in the tabled options as they did not identify the degree of risk that attached to each one.¹⁸

By the beginning of March, the RAF was already beginning to realise that the two DOC air defence audits might not be enough to safeguard their GBAD force and its support and training infrastructure, although they had both concluded that 'UK GBAD best practice lies with the RAF, where integrated AD is core business.'¹⁹

On the 8th, Laurence circulated a 'think-piece' paper for the MOD's Policy and Planning Steering Group (PPSG) on the progress of Workstrand 14. After reconfirming the scale of UK GBAD (48 fire units equally divided between the RAF and the Army and 156 Army HVM fire units), he pointed out that no missiles had been fired in anger since 1982, although there had been several deployments.

This largely reflects a period of relatively low air threat to UK and allied forces. Considerable reductions in GBAD holdings have been made during and since SDR, amounting to an overall capability reduction of about 40%.²⁰

An assessment of threats commissioned from DIS had suggested a diminishing challenge from conventional aircraft but an increasing threat from short-to-medium range cruise missiles and attack helicopters.^{jj} Unmanned Air Systems – UAS – were also thought likely to pose an increasing problem but only in an ISR capacity. The potential for UAS weaponisation was not foreseen at this stage. These pronouncements ran counter to the tasking guidance received by Workstrand 14, which had all been based on the fast jet threat and took little or no account of other developing hostile capabilities.

Laurence drew attention to the importance of air defence fighters in future operations and to GBAD provided by Allies, but he now accepted that Rapier filled a capability gap between medium-range SAMs and VSHORAD weapons like HVM; he had therefore rejected one option proposed in his terms of reference for withdrawing the missile from service entirely. However, he did believe that there was scope for ‘balanced reductions’ of both Rapier and HVM, particularly if planning scenarios were restricted to the medium and small-scale operations envisaged in the Defence White Paper.

There were bound to be risks. GBAD was not a capability that could easily be regenerated, and a DSTL study commissioned to inform the Workstrand had concluded that, of 46 scenarios considered, 18 required the deployment of UK GBAD assets. On average, at least two DOBs would require SHORAD, and some scenarios envisaged that four might need protection, with eight fire units being necessary to provide an adequate level of coverage for a DOB. As the think-piece put it, ‘The key judgement is, how much risk are we prepared to take against the more demanding scenarios.’

Laurence did not accept RAF and Army arguments to the effect that their respective GBAD arms were fundamentally different and so specialised that they were best generated and commanded separately. On the contrary, he argued that their underlying task – ‘air defence in a complex battlespace’ – was the same and that interoperability was essential; ‘We cannot afford to have sub-specialisations that might only be required in certain limited circumstances.’ Increased interoperability could be achieved through joint training and command and control, but the RAF would not contemplate the creation of a Joint GBAD HQ unless it was established within HQ STC, while the Army was no less insistent

jj. DIS subsequently denied predicting this increase and stated: ‘We believe numbers of AH will probably decrease but, at worst, remain roughly static out to 2030.’ DIS had produced a report for Workstrand 14, but this was then ‘distilled and combined with another study. The resultant tabled figures were neither produced by DIS nor seen by them.’ See STP-04 Medium Term Workstrand 14, GBAD, Vol 7: Tiger Team, ACAS to ACNS, 16 June 2004.

that the headquarters, if created at all, should form under HQ Land auspices at Larkhill.

The think-piece then discussed four options developed for Workstrand 14, addressing Rapier and HVM force scales together and proposing several different percentage cuts for both. The options process had been a familiar feature of Whitehall business for decades. Ostensibly, it demonstrated that a range of policy initiatives had been carefully and dispassionately weighed before the selection of an optimal solution. However, in practice, this procedure was often employed to promote an overwhelming argument in favour of one particular course of action.

Option 1 proposed Short-Term Plan (STP) savings of £17 million; the Option 2 STP savings were estimated at £19.5 million, achieved by imposing 25 per cent and 23 per cent cuts on the Rapier and HVM forces respectively. The Option 3 savings were £27.6 million and envisaged a larger HVM reduction. And then there was Option 4. Option 4 envisaged abandoning any aspiration to provide GBAD for large-scale operations and maintaining a GBAD force resourced for operations at medium or small scale. On this basis, UK Rapier holdings could be reduced by 50 per cent to 24 fire units under the control of the RAF Regiment. HVM holdings would also be cut by 62 per cent to 60 fire units (disbanding one HVM regiment) to produce savings over the STP of £137 million – in other words, considerably more than all the other options put together.²¹

The most obvious point that can be made about the Workstrand 14 think-piece is that it was heavily weighted towards cutting Rapier. Going forward, nothing other than the 50 per cent Rapier reduction was likely to rank for serious consideration given the financial savings that it promised to deliver, despite the increased risks identified by the think-piece and its supporting annexes. The degree of weighting towards Option 4 was also reflected in the way that the Rapier and HVM reductions were mixed and matched. For example, if the level of HVM cuts envisaged under Option 4 had been incorporated into Option 3, the savings differential between the two options would have been reduced, but this was not proposed. The four options were not obviously exhaustive but were presented as such.

Secondly, while greater interoperability between the two Rapier forces might have been desirable, their differences were rooted in history and existed for very good reasons. From the RAF's perspective, their GBAD force had been created to provide airfield defence and had evolved to fulfil the same purpose. The continuing operational requirement for Rapier to protect DOBs and FOBs had been confirmed in the DSTL study conducted for Workstrand 14; indeed, on the basis of recent experience and the Falklands commitment, the majority of

scenarios involving Rapier had envisaged that it would be used in an airfield defence role.

By 2004, two DOC audits in the space of six years had confirmed the operational capability of the RAF Rapier force in its assigned role, but the suggestion that the force represented a 'sub-specialisation that might only be required in certain limited circumstances' was entirely false. As we have seen, as recently as 2003, RAF Rapier units operating under unified (Air) command and control had demonstrated their operational readiness, their capability in early tasks such as theatre entry, DOB protection and force assembly, and their subsequent capacity to deploy forward to provide air defence for ground forces. It was the Land Component – most recently the British and US Armies – that had faced far greater difficulties with the provision of 'air defence in a complex battlespace' in Iraq. Among other things, a US Patriot had downed a Tornado GR4 en route to its base at Ali Al Salem, while 1(UK) Armoured Division had issued orders and plans for GBAD that would have increased the risk of fratricide. Yet the Workstrand think-piece reiterated the refrain that had been evident since SDR to the effect that the difference between RAF and Army SHORAD somehow reflected a weakness that afflicted the entire UK GBAD community.

On 16 March, Laurence presented his initial report and costings to the PPSG. While proposing the allocation of Rapier to the RAF under Option 4, he recommended the creation of a Joint GBAD Headquarters under HQ Land at Larkhill. This was the first appearance of an approach that would feature throughout the remainder of the GBAD review process. At this stage, Workstrand 14 accepted that the Rapier capability should be assigned to the RAF, yet the accompanying proposal to position the Joint GBAD Headquarters under HQ Land was obviously suboptimal from an operational perspective, given the central command and control status of the JFACHQ in UK air defence, other C2 issues raised in the DOC audits and the RAF's responsibility for generating Joint STANEVAL. The sole appeal of such an outcome lay in its potential capacity to produce a compromise: it offered something to both Services.

Laurence was subsequently directed 'to continue to identify the costs associated with these options'. They were to be placed before the Defence Management Board (DMB) in May.²² However, although he had proposed RAF ownership of Rapier, subsequent deliberations focused on whether ownership should be assigned to the RAF or the Army. Equally, despite his recommendation, the location of the Joint GBAD Headquarters remained under discussion.

On operational grounds, the RAF promoted a case for owning the headquarters and Rapier – an arrangement that would still have left the Army with HVM. Where the headquarters was concerned, the RAF owned the other elements of the UK air

defence environment, and Rapier was a key layer of the IADS. Thus, it could not possibly be positioned within an Army command chain. On Rapier itself, the RAF delivered the same capability as the Army with significantly fewer personnel – 432 as opposed to 16 Regiment's war establishment of 760 and peace establishment of 603. The RAF Regiment was more capable of conducting operations in complex airspace environments and was 'air minded' but also possessed a demonstrable capability to integrate with the other Services (in both the South Atlantic and Iraq) and with allies (US forces in Iraq).

Experience suggested that Rapier would be required early in an operation for the defence of fixed high-value assets. The RAF Rapier force was available at high readiness and had a proven deployability record. Its capability was also regularly assessed through the STANEVAL process, which was now to provide the basis for a Joint STANEVAL standard that the Army would not start to reach until late 2005. Finally, the force had twice passed through DOC audits with flying colours – unlike the Army GBAD force.²³ Nevertheless, the Army likewise contended that it should own both the headquarters and the Rapier capability, as well as HVM.

Notes

1. STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: Air Defence in the Joint Battlespace 2-Star Oversight Meeting, Record of Decisions, 21 October 2003.
2. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: D CBM/J6 to VCDS, 26 September 2003; STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: DG Info to VCDS, 30 October 2003.
3. STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: D CBM/J6 to MA/VCDS, 10 December 2003.
4. STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: DG Info to VCDS, 30 October 2003.
5. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: point brief on GBAD, 8 January 2004, by SO2 FD GBAD.

6. Command Paper 6041, *Delivering Security in a Changing World* (2003), p. 19, 6.3.
7. Ibid.
8. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Air Commodore SH Anderton, ACOS A3 FP, to PSO/AOC, 14 January 2004.
9. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: SO2 FD GBAD to Gp Capt FP Plans, 16 December 2003; STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: CDS to S of S, 7 July 2004; Air RP to STC-Plans/Air Off, 11 December 2003.
10. STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: Air Defence in the Joint Battlespace 2-Star Oversight Meeting, Record of Decisions, 21 October 2003.
11. See National Audit Office, *Ministry of Defence Major Projects Report, 2003*, Report by the Comptroller and Auditor General, HC 195 Session 2003-2004, 23 January 2004. Typhoon 'was approved for Demonstration and Manufacture in November 1987, to be delivered in 1998 at a cost of £17,364 million. Typhoon is a multi-nation collaborative project comprising two consortia as prime contractors: Eurofighter GmbH Airframe, and Eurojet Turbo GmbH Engine. In the year ended 31 March 2003, total forecast procurement costs increased by £1,037 million, and the in-service date was delayed by 12 months. Adding these to earlier variations, Typhoon is now expected to cost £19,670 million (£2,306 million more than approved) and was delivered in June 2003 (54 months later than approved).'
12. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Commodore TJH Laurence, DNRP, to GBAD Stakeholders, 12 January 2004.
13. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Air Commodore SH Anderton, ACOS A3 FP, to PSO/AOC, 14 January 2004.

14. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Wing Commander RD Lynch, SO1 FP Plans, to PSO ACAS, 23 January 2004.
15. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Commodore TJH Laurence, DNRP, to GBAD Stakeholders, 17 February 2004.
16. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: briefing notes for GBAD workstream meeting 24 February 2004, addressed to ACOS A3 FP on 16 February 2004.
17. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Wing Commander PR Hunter, for Group Captain Ops, to HQ 2 Gp (SO1 FP Plans and Training), 23 February 2004.
18. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Air Commodore Ponsonby, AO Plans, to PSO/ACAS, 26 February 2004.
19. STP-04 Medium Term Workstrand 14, GBAD, Vol 1, Initial Briefs for PPSG: Wing Commander KS Balshaw, Officer Commanding GBAD, to Group Captain Strickland at 2 Group, 8 March 2004.
20. STP-04 Medium Term Workstrand 14, GBAD Vol 1, Initial Briefs for PPSG: Commodore TJH Laurence, DNRP, to PPSG Members, 8 March 2004; Workstrand 14 – GBAD – Summary for PPSG, 16 March 2004; paper entitled Workstrand 14 – GBAD – Report for PPSG 16 March 2004.
21. STP-04 Medium Term Workstrand 14, GBAD Vol 1, Initial Briefs for PPSG: Commodore TJH Laurence, DNRP, to PPSG Members, 8 March 2004; Workstrand 14 – GBAD – Summary for PPSG, 16 March 2004; paper entitled Workstrand 14 – GBAD – Report for PPSG 16 March 2004.
22. STP-04 Medium Term Workstrand 14, GBAD Vol 1, Initial Briefs for PPSG: Commodore TJH Laurence, DNRP, to HQ STC, 19 March 2004; STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: DAS/Strat/GBAD, 21 May 2004, GBAD – Further Work – Brief for Key RAF Players.

23. STP-04 Medium Term Workstrand 14, GBAD Vol 1, Initial Briefs for PPSG: undated paper entitled GBAD – Game Plan; STP-04 Medium Term Workstrand 14, GBAD, Vol 2, Joint GBAD Structure and Concepts: paper by Wing Commander K Balshaw, Officer Commanding RAF GBAD Force, 22 April 2004.

16. GBAD Ownership: The Tiger Team

On 4 May, the DMB considered Workstrand 14's proposals and endorsed the following recommendations:

- a) That GBAD support be rationalised.
- b) That both Rapier and HVM be cut by 50 per cent, the residual Rapier force being owned either by the RAF or the Army.
- c) That GBAD Phase 1 be cost capped at £750 million – down from the original £1 billion costing.¹

However, the DMB's deliberations apparently revealed entrenched opposition from both the RAF and the Army to any compromise or concession on the issue of ownership. Consequently, VCDS established a so-called Tiger Team – typically defined as a specialised, cross-functional team brought together to solve or investigate a specific problem or critical issue.

Again, the Tiger Team was established under Royal Navy leadership – the Assistant Chief of the Naval Staff (ACNS), Rear Admiral Sir Adrian Johns. Other members were ACAS, the Director General of Joint Doctrine and Concepts, Air Vice-Marshal Iain McNicoll, the Commandant of the Air Warfare Centre, Air Commodore Christopher Nickols, the MOD's Director of Equipment Capability (Theatre Attack), Air Commodore Brian Newby, the Assistant Chief of the General Staff (ACGS), Lieutenant-General (later General Sir) David Richards, the Director of Land Warfare (DLW), Brigadier Mungo Melvin, and the MOD's Deputy Director of Resources and Programmes, Colonel (later Lieutenant General Sir) Nicholas Pope. The Team's composition gave the RAF and the Army ample opportunity to air their views, but it did not vote on the issues it addressed.² In the absence of a consensus between the two Services, ACNS's authority was absolute.

The Tiger Team concept originated in the US military but was also a well-established tool of government and business, and Tiger Teams have often proved effective. However, as one-off, ad hoc committees, their processes may sometimes be less open and accountable than those of formal and established managerial structures such as the DMB. All the key documents prepared under Workstrand 14 were copied to RAF stakeholders, but while ACAS subsequently circulated all his Tiger Team papers to other team members, ACGS did not.³



Cross-component capability: in Exercise Saif Sareea II (Oman 2001), RAF Regiment SHORAD supported Land Component insertion and resupply.



Another RAF Regiment Rapier fire unit supporting the Land Component, this time during Operation Telic in 2003.



Air Vice-Marshal David Walker, Assistant
Chief of the Air Staff in 2004.



Air Chief Marshal Sir Jock Stirrup, Chief of
the Air Staff in 2004.

In his initial guidance to ACNS, VCDS stated that Rapier was a strategic asset and should come under the Joint Commander, by which he meant the commander responsible for air defence. 'In doing so, the C2 must also be considered as strategic and full within the higher-level integrated AD system through CAOC into JFAC. This is extremely important.'⁴ This statement, although well intentioned, may not have helped the RAF Regiment's case for ownership, for ACNS apparently viewed himself as a neutral broker whose task was to secure a deal between the two warring parties. As we have seen, the increasingly obvious basis for such a deal was the allocation of the Joint GBAD Headquarters to one Service and Rapier to the other. As VCDS's guidance clearly implied that the headquarters belonged within the Air command and control chain, VCNS may well have been inclined to reverse Workstrand 14's recommendations and propose Army ownership of Rapier from an early stage in the Tiger Team's proceedings, even if this outcome did not represent the best capability and cost option.⁵

RAF members of the Tiger Team subsequently echoed VCDS's arguments, potentially reinforcing this effect. For example, a brief for RAF Team members on 21 May argued that 'all air activity within the battlespace must be fully integrated and controlled by the JFACC.' This was essential if the UK was to achieve a 24-hour, all-weather air defence capability. There was also the problem of fratricide, so recently highlighted in Operation Telic. As the brief pointed out, 'The joint battlespace will include large numbers of friendly ac and Air Battle Management procedures for numerous different aircraft types working both within and outside the ATO.' The brief did not address the key issues of command and control and capability separately. Rather, it maintained that any active air defence system consisted of three basic and closely integrated components: a detection system, a command, control, communications and information system, and a weapon system.⁶ Nevertheless, its strongest arguments were focused on the C2 sphere.

ACAS, Air Vice-Marshal Walker, argued that cross-component co-ordination and synchronisation should be as seamless as possible to ensure effective force protection:

An effective IADS is one that provides defence in depth through a layered approach ... Real success here, however, lies in the effective integration of both air and ground AD. This is achieved primarily through a single point of (centralised) control, someone who has sufficient awareness of all activity in the air and who, in the specific case of AD, is able to flex scarce resources across the battlespace to provide optimum protection

where it is most needed at the time. Experience shows us that the person best placed to make such a decision is the JFACC.⁷

Walker then proposed a concept for the deployment of air defence assets to provide protection throughout the various phases of an operation – theatre entry, establishment and build-up, including lines of communication, DOBs, static depots and assembly areas, control of the air and shaping of the battle space, and support to ground manoeuvre. However, he suggested that ‘support to this manoeuvre can be significantly improved, with the addition of other AD capabilities, and providing we have robust battlespace management, underpinned by the right tools, notably situational awareness and networks.’⁸

DGJDC, Air Vice-Marshal McNicoll, reinforced the concept of JFACC control of GBAD on 26 May in a paper for ACNS that illustrated how it would work in practice. Again, he argued that air defence should be addressed as a whole and that optimisation could best be achieved through consideration of all air defence capability as a single, integrated system.

As part of this process, CCs^{kk} would submit to the JFACC their prioritised list of assets requiring protection. Component lists would then be combined and prioritised under a JPDAL^{ll} process that reflects the precise requirements of the JTFC.^{9mm}

All these arguments were valid, and difficult (if not impossible) to refute. Indeed, the strength of the RAF argument was such that the DLW, Brigadier Melvin, eventually rang an alarm bell. ‘Over the last couple of days,’ he wrote, ‘members of the ACNS Tiger Team have circulated a number of documents which, in my opinion, have considerably strengthened the case for the RAF to retain ownership of Rapier. These documents will have to be challenged.’ He was particularly concerned about ACAS’s paper:

This is a very well-crafted, researched and argued paper that presents a very persuasive argument for the RAF to retain the Rapier capability ... The RAF have (convincingly) argued that they can operate in the land scheme of manoeuvre. There is a

kk. CCs – Component Commanders.

ll. JPDAL – Joint Prioritised Defended Asset List.

mm. JTFC – Joint Task Force Commander.

need to demonstrate that Army Rapier could operate seamlessly in the IADS as part of a DOB structure.¹⁰

He also saw a need for evidence that Army Rapier could operate in Alliance or coalition environments and recommended exploiting inter-Service factors to bring ACNS on to the Army's side.

The command and control of GBAD assets needs to be challenged. Once it is accepted that GBAD units operationally are OPCOM JFAC, it is much easier for the RAF to argue for retention of RAF Rapier units under STC. It is also worth highlighting the implications of the paper for the Maritime Component AD platforms – this may raise a few concerns from ACNS.¹¹

This was wishful thinking, as Squadron Leader Horn of the HQ STC GBAD staff subsequently pointed out:

We have no evidence of Army GBAD operating as part of an IADS or integrating into a DOB. RAⁿⁿ are unfamiliar with RAF FP procedures and organisation, unfamiliar with safe lane procedures ... , lack experience in integrating with ATC, [are] not 'air aware' for safe movement around the DOB, need training in RAF CIS, [and are] unused to operating in busy, friendly-predominant airspace (increased risk of fratricide). There are very specific procedures that have to be understood and practised ... The RA do not practise any of these procedures, all of which are imperative for the protection of friendly a/c.¹²

Furthermore, there was no recent evidence to demonstrate that Army GBAD could operate in coalition environments, and it appeared that Melvin misunderstood the RAF's concept of cross-component GBAD command and control based on the JPDAL. Horn did not think it would 'panic' ACNS, and he was quite correct.¹³ In fact, the Army's Rapier force could only offer to develop cross-component and coalition capabilities under the Joint STANEVAL process between 2005 and 2007. By contrast, the RAF's Rapier squadrons could offer

nn. RA – Royal Artillery.

these capabilities immediately, as they were subject to routine STANEVAL as well as externally audited NATO TACEVAL.¹⁴

Yet it was not necessary to bring ACNS on to the Army's side, for he was already seeking a solution to the impasse that effectively divided the GBAD spoils. The RAF had indeed persuasively argued that Rapier command and control should come under the JFACC, but this merely strengthened ACNS's perception that the Army should preside over current capability. At this point, critically, ACGS shifted position and conceded that the Operational Command of GBAD forces could lie with a joint headquarters at HQ STC.¹⁵ By contrast, the RAF continued to argue that air defence was indivisible.¹⁶

However, this was not the only factor that undermined the RAF Regiment's position in the debate. Two decades and several major operations later, including 14 years of counterinsurgency, we may struggle to recall the post-Operation Telic climate in the Ministry of Defence, but it was common to hear at the time that the opening phase of the operation had established a new model for the future. This was sometimes referred to as 'simultaneous attack'. This concept envisaged parallel ground and air operations, as in Telic, rather than the preparatory or independent air operations that had featured so prominently between 1991 and 2001. Potentially, therefore, it implied an early requirement for the air defence of manoeuvring ground forces rather than airfields and other static facilities in the rear.

This was clearly a large-scale scenario, whereas the government's 2003 Defence White Paper aimed at 'rebalancing of the Armed Forces to enable them better to meet the demands of the more likely small and medium-scale contingencies ... We will not need to generate large-scale capabilities across the same spectrum.'¹⁷ As ACAS pointed out in his final paper to ACNS on 16 June, large-scale was 'the very area where policy^{oo} tells us to take increased risk with AD.' Analysis undertaken in support of Workstrand 14 that covered large, medium and small-scale contingencies had indicated that, on average, 72 per cent of SHORAD requirements supported the Air Component, whereas only 28 per cent supported the Land Component. At medium scale, requirements for Air were more than double those for Land, while for small scale and for the Falkland Islands, SHORAD requirements were 100 per cent Air.¹⁸

Nevertheless, basing their case on a large-scale commitment, the Army argued that the RAF Regiment would be incapable of effective integration into the Land Component. In response, ACAS pointed out that, doctrinally, Land Component

oo. Cited in the original document by ACAS as Policy Sub-Framework Document – D Pol Planning/1/4 dated 19 December 2003.

tasks for SHORAD included protection of vital points and high-value assets of non-fast-moving forces, such as HQs, logistics parks and bridgeheads.

These assets would generally be found *behind* the highly mobile manoeuvre force, and their relocation would only take place periodically, if at all. RAPIER, however, is not used to support fast-moving forces – this is the role of VSHORAD, in the guise of HVM. It is important that we make this distinction as it establishes that the high degree of land-mindedness required for effective integration with fast-moving forces, where friction is usually at its highest, is not a prerequisite for SHORAD operations *behind* these forces. It also indicates that RAPIER and HVM do not operate alongside each other on the battlefield; consequently, there is no need to depend on Army operators to enable successful integration into the Land scheme of manoeuvre. There is in fact clear empirical evidence of successful integration. The RAF Regt provided RAPIER support to 1(UK) Div during Op TELIC, and the CO 12 Regt RA^{pp} was particularly complementary about this aspect.¹⁹

With the overwhelming weight of guidance and evidence contradicting the Army's position on this point, it is unlikely that it caused ACAS much concern. Yet it was this very argument, despite its obvious weaknesses, that was ultimately mobilised first by ACNS and then CDS to hand the UK SHORAD ownership to the Royal Artillery.

While the Tiger Team's full deliberations are not on record, they were apparently characterised by inter-Service deadlock. What were afterwards described as the conclusions and recommendations of the Team concerning Rapier ownership were in fact opposed by its four RAF members and merely reflected ACNS's acceptance of the Army's case. By the third week of June, ACNS's conclusions were being circulated in draft to the rest of the Tiger Team, and on 22 June he submitted them to VCDS. He began by considering the future context for GBAD:

pp. The Divisional Air Defence Commander for 1(UK) Division.

Of the likely threats to be encountered (FJ/AH/CM/UAV),^{qq} none is considered to be of major significance now, particularly in the context of the UK acting as a coalition partner with the US and other Allies where early air superiority may be assumed. In the future, threats from aircraft, CM, AH and UAV are deemed likely to increase. But once again, for the foreseeable future, in any serious operation the UK is likely to be in coalition with the US and will benefit from their will to dominate the air battlespace.²⁰

On this basis, he argued that there was room to take additional risk with GBAD in the short-to-medium term, ‘while continuing to work on ways of improving future capability’. Where scenarios were concerned, ACNS contended that ‘at larger scale, the emerging doctrine of simultaneous attack may require ground forces to manoeuvre rapidly before air superiority has been achieved.’ In these circumstances, HVM might be more useful than Rapier.

The most emotive issue for the Tiger Team had been ownership:

The question of ownership of SHORAD has been the most emotive issue in this package of further work. On the one hand, the RAF believe that they stand as exemplars of high standards with the ability, from a doctrinal viewpoint, to integrate seamlessly into the overall IADS architecture. On the other, the Army argues from a more pragmatic position that GBAD exists to support the tactical land effort and can do so only by being an integral element of the fast-moving land manoeuvre component.²¹

ACNS accepted that the RAF had a demonstrably higher readiness, but he maintained that ‘the Army could be enabled to provide a similar standard in the near future.’ In pursuit of this goal, they had apparently agreed to withdraw 16 Regiment Royal Artillery from the OTP completely. Another critical factor was the reduction of mass:

The reduction in the number of firing units will constrain the flexibility to deploy GBAD across the JOA. The campaign plan

qq. FJ/AH/CM/UAV – Fast Jets/Attack Helicopters/Cruise Missiles/Uncrewed Air Vehicles.

will have to take account of this, but it seems reasonable to assume that more options exist to afford protection to DOBS and other potential rear area targets, and that our limited GBAD effort should be focused in the forward areas. This indicates that the majority of GBAD assets are likely to be deployed in support of the LCC. In the context of making most efficient use of a smaller force structure, there is a strong case for generating Rapier SHORAD along with VSHORAD from within the Army.²²

Having strongly hinted at his support for Army ownership of Rapier, ACNS declared that the ‘key to success’ was the formation of a Joint GBAD Headquarters. While Workstrand 14 had recommended locating the headquarters at Larkhill under HQ Land, he proposed that it should be embedded in HQ STC, an arrangement that combined ‘an integrated approach to AD with forces that are generated and trained for land manoeuvre’. A coherent and carefully structured migration strategy would be required to prevent capability loss in any one environmental area. ‘Such a strategy would need to ensure that domain skills and specialisations were smoothly transferred to the residual single Service.’²³

ACNS noted that there had been no consensus on ownership between the RAF and the Army. However, ‘In relation to the solution proposed in this paper, the Army have given ground to accept that OPCOM of GBAD forces could lie with a joint HQ located in STC.’ By contrast, the RAF continued to argue that their Rapier capability was immediately available in the front line and was more cost-effective than the Army’s. ACNS’s key judgement was that ‘the Joint GBAD HQ should be established within the JFAC under the OPCOM of STC, whilst both VSHORAD and SHORAD components of UK GBAD should be generated from the Army.’ He also judged that combined Rapier and HVM training should be established at Larkhill.²⁴

ACNS’s paper claimed ‘to represent the issues objectively and factually’. Nevertheless, its arguments and conclusions may be questioned on several grounds. The scope for taking additional short and medium-term risks ‘while continuing to work on ways of improving future capability’ brings to mind SDR’s empty promises about medium-range SAMs, and ACNS’s pronouncements on ‘later improvement in capability’ underestimated the challenges that regeneration was likely to involve.

The paper’s uncritical acceptance of ‘the emerging doctrine of simultaneous attack’ was clearly neither objective nor factual; indeed, it was entirely speculative, and it focused, as we have seen, on a large-scale scenario when

Workstrand 14 had been directed to study the demands of medium and small-scale operations, for which GBAD was overwhelmingly required for the Air Component. ACNS's statement that 'The majority of GBAD assets are likely to be deployed in support of the LCC' was directly at odds with the operational analysis conducted by DSTL for the Workstrand. The proposition that air superiority could be assumed in a coalition operation and that the UK could safely rely on US air defences overlooked the coalition SHORAD capability gap previously filled by the RAF Regiment and acknowledged by Workstrand 14.

Statements such as 'the RAF believe that they stand as exemplars of high standards' or that 'the RAF continue to argue that they deliver Rapier now at the front-line more cost-effectively than the Army' ignored the fact that the DOC, a joint organisation, had reached precisely these conclusions in two recent operational audits – neither of which ACNS mentioned. These were not simply RAF arguments. Equally, it was hardly objective to offer like-for-like comparisons of capabilities that the RAF could provide immediately but which the Army could only promise for their entire Rapier force by 2007. Before the events described here, it would have been hard to imagine any of the Armed Services successfully staking an ownership claim by offering to develop, in three years' time, a capability that one of the other Services already possessed.

Finally, the fact that the Army had 'given ground' during the Tiger Team's deliberations should not have been relevant to a capability-based process and merely demonstrates that ACNS's final judgement was not, in fact, capability-based. The RAF could not have made concessions in the manner implied by ACNS without losing their entire GBAD force, and their position was thus completely different to the Army's. The difficulties involved in forming a Joint GBAD Headquarters under HQ Land have already been noted, and the true value of the Army's concession must be considered in this context.

On the other hand, the RAF already possessed a unified GBAD system that incorporated command, control and communications, Rapier FSC fire units, support and training, and which could demonstrably generate SHORAD to externally audited standards to support the Air, Land and Maritime components. This was the very goal that SDR and the subsequent reviews were supposedly targeting even though it had already been achieved under a single Service. Placing GBAD command and control under HQ Air and SHORAD capability under HQ Land merely to secure an apparently equitable settlement represented a major step backwards in operational terms.

Meanwhile, ACAS had advised CAS, Air Chief Marshal Sir Jock Stirrup (later Marshal of the Royal Air Force Lord Stirrup), that he had been unable to support ACNS's recommendations to VCDS and the DMB. 'By a significant margin,' he

wrote, ‘the RAF Regt represents SHORAD best practice both now and in the future. The recommendation that the Army owns Rapier, therefore, seems wholly incoherent with the evidence available.’ He summarised his arguments as follows:

1) Policy confirms that the Air Component (AC) is the major ‘customer’ for SHORAD support (72% air vs. 28% land). Air-mindedness is a crucial factor for successful integration into an AD system and to reduce fratricide. The RAF Regt is by far the more air-minded GBAD force. The Army’s capability in the AC is unproven.

2) SHORAD does not directly support fast-moving ground forces. The RAF Regt has sufficient land-mindedness to meet SHORAD tasks in the LC, as proven during Op TELIC. With a small uplift of manpower the RAF Regt could also provide C2 support to the LC – this has been agreed by RP staffs.

3) DOC audits have shown that Army GBAD has a poor track record, even within its own component. Conversely, the RAF Regt is recognised as best practice.

4) There are significant risks associated with Army ownership of SHORAD both in transition to assuming joint responsibilities and in its potential to meet future capability needs. The RAF Regt is ready now to provide enduring SHORAD support to all components.

5) RAF Regt SHORAD would be cheaper than the Army equivalent.²⁵

Yet there was also a broader issue relating to the more general management of UK Defence. As ACAS put it, ‘As an employer, the MOD is expected to minimise risk by adopting best practice – the right person in the right place, at the right time, doing the right job, using the right systems and equipment.’ Clearly, the proposed Army ownership of SHORAD would not fulfil this obligation.²⁶

On 30 June, the Chiefs of Staff convened to consider the Tiger Team’s recommendations, and CDS afterwards described their meeting to the Secretary of State for Defence. ‘In essence,’ he wrote, ‘this came down to a debate on whether

RAPIER should be deleted from the Army rather than accepting the team's recommendation to delete it from the RAF.'

It is a fine call, based on judgements about the deployment of the system in the most likely future operational scenarios and for either Service...

a) CAS was concerned that the proposal to retain Army Rapier assumed that more options existed for coalition GBAD to be available to cover airfields, points of disembarkation and other critical high-value sites in the rear area. There is a clear risk in this assumption. He therefore took the view that in most instances the operational commander would have to assign UK Rapier to defend these targets. The key challenge in the rear area is the avoidance of fratricide. CAS believed that the RAF Regiment's experience of integrating GBAD with wider air operations and Coalition C2 was crucial in this regard, and that this consequently meant it was best suited to the task.

b) The remainder of the group took the view that the majority of the deployments would be in support of deployed UK manoeuvre forces in the forward areas, where coalition GBAD was most unlikely to be available. They felt that, in any case, deployment would be a matter of operational priorities, which could still provide cover for the rear areas.'

We concluded that the team's recommendation that the Army should assume ownership of all the reduced GBAD capability should stand. It was, however, a majority decision.²⁷

CDS's account was less notable for the information it supplied to the Secretary of State than for what it withheld. For example, CDS did not state that the RAF Regiment could immediately fulfil the joint STANNEVAL requirement, whereas the Royal Artillery would be unable to do so for two to three years. Instead, he recorded that 'by 2007 they would both be at an agreed joint standard of capability' – a form of words obviously open to misinterpretation. His references to 'the team' were also misleading, as they created an impression of unanimity when in fact the RAF members of the Tiger Team had disagreed profoundly with ACNS's conclusions on Rapier ownership.

Subsequently, CDS supplied only a fraction of the RAF's case for ownership but the whole of the Army's, notional as it was, that Telic provided a model for future operations. Furthermore, he omitted the fact that the Army's case was based on a large-scale scenario, whereas Workstrand 14 had been directed to prioritise the medium and small-scale operations that provided the foundation for CAS's arguments, generated most requirements for SHORAD, and generated them within the Air Component rather than the Land Component.

CDS went on to imply that the Army was capable of providing cover for rear areas when there was no evidence that it could do so, and that the RAF could not provide cover for forward areas, as it had only recently done in Operation Telic. He also implied that there was a greater likelihood of coalition (American) GBAD cover in rear areas, whereas, only recently, the Americans had relied on the RAF for SHORAD, and that UK SHORAD would still be available for airfield defence if needed. This presupposed that the Rapier force would be retained on the planned scales under Army ownership.

On 21 July, in a statement to Parliament, the Secretary of State for Defence announced that the number of Rapier fire units would be reduced to 24 and that the RAF Regiment would relinquish its role in the provision of GBAD capability. He added that Ground Based Air Defence would be commanded by a new Joint HQ within the RAF command structure.²⁸

Notes

1. STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: CDS to S of S, 7 July 2004; CAS 8/2/4 Pt T, DMB Meeting, 4 May 2004.
2. Air Marshal (Retd) Iain McNicoll to the author, 23 June 2023.
3. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: ACAS to ACNS, undated; STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: Squadron Leader AB Calame, STC Strat Plans 1c to 2 GP DACOS A3 FP, 6 July 2004.
4. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: VCDS to ACNS, 7 May 2004.

5. STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: Squadron Leader AB Calame, STC Strat Plans 1c to 2 GP DACOS A3 FP, 6 July 2004.
6. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: DAS/Strat/GBAD, 21 May 2004, GBAD – Further Work – Brief for Key RAF Players.
7. STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: ACAS to ACNS, Optimisation of Air Defence Capability in Light of Post-Workstrand Reductions in GBAD, 21 May 2004.
8. Ibid.
9. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: DGJDC to ACNS, 26 May 2004.
10. STP-04 Medium Term Workstrand 14, GBAD, Vol 5A, Army Vs RAF Regt, Ex CLEAN HUNTER: DLW to D Army RP, DRA, Colonel Army Plans, Colonel Challes, Lieutenant Colonel Evans and Major Graham, 28 May 2004.
11. Ibid.
12. STP-04 Medium Term Workstrand 14, GBAD, Vol 5A, Army Vs RAF Regt, Ex CLEAN HUNTER: Squadron Leader NB Horn, SO2 GBAD OPS, STC, to HQ 2GP FP GC Plans, 9 June 2004.
13. Ibid.
14. STP-04 Medium Term Workstrand 14, GBAD, Vol 5A, Army Vs RAF Regt, Ex CLEAN HUNTER: Group Captain KN Strickland, Gp Capt FP Plans, to PSO ACAS, 10 June 2004.
15. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: ACNS to VCDS, 22 June 2004.

16. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: DAS/Strat/GBAD, 21 May 2004, GBAD – Further Work – Brief for Key RAF Players.
17. Command Paper 6041, *Delivering Security in a Changing World* (2003), p. 19, 6.3.
18. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: ACAS to ACNS, 16 June 2004.
19. Ibid. In the same file see also ACAS to ACNS, 26 May 2004.
20. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: ACNS to VCDS, 22 June 2004.
21. Ibid.
22. Ibid.
23. Ibid.
24. Ibid.
25. STP-04 Medium Term Workstrand 14, GBAD, Vol 7, Tiger Team: ACAS to CAS, 21 June 2004.
26. Ibid.
27. STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: CDS to S of S, 7 July 2004.
28. STP-04 Medium Term Workstrand 14, GBAD, Vol 8, GBAD MTWS Announcements.

17. DADS: The Disintegrated Air Defence System

It would not be appropriate for a study of airfield air defence to analyse in detail the subsequent story of UK GBAD. However, there were inevitably developments after 2004 of direct relevance to this history, which must be summarised broadly. The Joint GBAD Headquarters was formed with a joint (but predominantly Army) staff in April 2005; the Joint Rapier Training Unit continued to function until 2006, when it was replaced by the Joint GBAD Training Unit; training in the key areas of GBAD command and control and Air Battle Management was assigned to five RAF Air Battle Management specialists located within the Joint GBAD Training Unit.

Although the original concept for the Joint Headquarters had envisaged that it would command all UK GBAD, including VSHORAD, the Army subsequently retained single-Service command arrangements for several years over two VSHORAD units that provided intimate support to their combat brigades. Otherwise, the theoretical allocation of GBAD capability under the new arrangements was addressed in another paper by Air Vice-Marshal McNicoll.

The JTFC will provide direction to the Air Defence Commander (ADC), normally the JFACC, on the priorities to be adopted for tasking in support of the campaign plan. These priorities will have been discussed with component commanders in the Joint Command Board process. The ADC will produce the AD Plan on behalf of the JTFC using the AD Staff within the JFAC HQ. An AD Estimate is conducted to identify AD tasks and to allocate AD assets against those tasks ... The AD Estimate will be informed by the Joint Prioritised Defended Asset List (JPDAL), a single prioritised list of all possible AD tasks across the JOA.^{rr} This is built up through the fusion of CCs' own prioritised list of assets requiring protection, i.e. AD tasks. Through consideration of the JPDAL, the JTFC can judge the best use of assets across the JOA.¹

In April 2005, 16 Regiment was at last released from its OTP liability, and its first battery began STANEVAL training in October, completing the process the following summer and assuming the Falklands commitment in November 2006.

rr. JOA – Joint Operations Area.

With effect from November, the Resident Rapier Squadron (RAF) became the Resident Rapier Battery (Royal Artillery).²

The RAF Rapier squadrons disbanded between 2006 and 2008. By then, the financial calculations that had underpinned the decisions taken in 2004 had long since become meaningless. Indeed, as early as October 2004, it was possible for a member of Air RP's staff to demonstrate that, while Army SHORAD ownership had been meant to save £18.3 million per year for a one-off cost of £7 million, it seemed likely that only £11.6 million per year would be saved for a one-off cost of £12 million. RAF ownership would have saved £21 million per year for a £3 million one-off cost. Nevertheless, as one Air RP officer noted, 'DD Def RP (Colonel Pope) was aware of the reasons for savings evaporation, but did not wish to revisit the savings targets.'³ It will be recalled that the colonel had formerly been a member of the Tiger Team. A factor in these calculations – one of the cost factors considered by Workstrand 14 – was the projected closure of the Royal Artillery barracks at Woolwich. Air RP noted that the estimated cost of closure had already climbed above the figures supplied to the Workstrand by £5 million. In the end, the MOD decided not to close Woolwich; instead, it received a £50 million refit.⁴

Perhaps, therefore, we should not be surprised to learn that the Royal Artillery ultimately emerged from the process not with 24 Rapier fire units, as the Workstrand, the DMB, the Chiefs of Staff and the Secretary of State for Defence had envisaged, but 32 – the four batteries of 16 Regiment, each with eight fire units. This could be interpreted as a positive development for UK GBAD, but its long-term decline was only temporarily halted. The anticipated era of large-scale ground operations involving 'the emerging doctrine of simultaneous attack' failed to materialise. Instead, the Army became embroiled in two exceptionally challenging counter-insurgency operations that did not generate a requirement for SHORAD to cover manoeuvring ground forces in forward areas.

Thus, when the financial crisis of 2009 led inexorably to another Defence Review – the SDSR of 2010 – that prioritised the requirements of current operations and demanded further manpower cuts from the Armed Services, the Rapier force was very vulnerable even though it was not scheduled for retirement for another ten years. It was duly identified as a potential savings area and reduced from 32 to just 14 fire units – the minimum number deemed necessary to cover the Falklands commitment. The HVM VSHORAD system was retained but was significantly less capable than Rapier; among other limitations, it was a day-only system. Nevertheless, there was no suggestion that HVM might be a more suitable candidate for the axe. As the Army owned Rapier, the cut ostensibly impacted on the Land environment. However, in terms of risk, it could be argued that the RAF made the greater sacrifice because, as operational analysis had demonstrated in

2004, the Air Component generated most of the demand for SHORAD support in small and medium-scale operations.

Although the cuts implemented in 2004 had been announced publicly, and although, following SDSR, the reductions were significantly larger in percentage terms, they were not revealed to Parliament. Writing 12 years later, the author of this history has so far been unable to trace any public statement on this subject before November 2016, when Lieutenant General Mark Poffley, the Deputy Chief of the Defence Staff (Military Capability) revealed to the House of Commons Defence Committee that Rapier was only employed in the air defence of the Falkland Islands: 'For our contingent forces we use HVM regiments.' The contingent Rapier capability had mysteriously disappeared.⁵

By 2011, when the UK was confronted by the prospect of a major operation against the Gaddafi regime in Libya, there was no longer any government appetite to deploy a substantial Land Component, and the UK's combat contribution to the NATO-led campaign came almost entirely from the air. Coalition air forces were not confronted by a threat to their own bases but expended a considerable effort on attacking Libya's, and the presence of Libyan SAM systems also influenced coalition air activity, not only by compelling fixed-wing combat aircraft to fly at medium altitude but by forcing high-value air assets such as airborne command and control platforms and larger ISR aircraft to operate well to the north of the Libyan coast, restricting their coverage of central and southern parts of the country. The threat from Libyan GBAD also prevented the coalition from exploiting the deployed UK Apache attack helicopter capability to the extent originally envisaged.⁶

Then, in 2014, just as the last British ground troops were being extricated from Afghanistan, the UK and her allies found themselves facing another challenge in the form of ISIL – later known as Daesh – in Iraq and Syria. Again, the government avoided the commitment of the regular Army in a combat role and placed their faith in the RAF. Air base facilities in theatre were not available in abundance and were not in many cases geographically suitable for the Shader task. RAF Akrotiri provided the solution. In terms of aircraft deployed, the operation peaked at the end of October 2016, when 24 RAF aircraft of six types were based there.^{ss} By then, by a substantial margin, the RAF was the largest non-US air contributor to the coalition, providing combat air power, wide-area surveillance, tactical reconnaissance, full-motion video, signals intelligence, command and control (on

ss. Additionally, eight Reapers, two Shadow R1s and one Airseeker were supporting the operation from other airfields, bringing the total to 35 aircraft of nine types.

the ground and in the air), air transport, air-to-air refuelling and a range of other supporting capabilities, particularly in the intelligence field.

Since decolonisation, Akrotiri had largely served as an air staging post and logistical hub for operations in the Gulf and further east. However, in Shader, it reverted to its 1950s and 60s role as a mounting base for combat missions and ISR. By the end of 2018, the RAF's Akrotiri-based Tornado GR4s and the Typhoons had flown a total of 4,183 Operation Shader missions (or around twice this number of sorties) and released 3,147 munitions since August 2014. The GR4s released more bombs during the first six months of Shader than during five years of operations in Afghanistan. The intensity of fighting reached such a high level in 2016 that every GR4 and Typhoon mission would have taken to the air at Akrotiri with a high expectation of combat engagement. In addition to the 29,800 flying hours accumulated by the GR4 squadrons on Shader by January 2019, the Typhoons had flown 22,296 by the time Daesh was cleared from Syria.⁷

From the very outset, these operations were mounted from an airfield located close to Syrian airspace and the Syrian Air Force; from September 2015, they were flown in close proximity to Syria-based Russian Air Force units deployed in support of the Assad regime. A potential threat to coalition forces from Iran – another ally of Assad – was also impossible to discount. In 1940, as we have seen, the prospect of using Malta as a mounting base for combat air operations raised expectations of retaliation and led directly to GBAD on the island being strengthened. In 1956, during the Suez crisis, the possibility of retaliation against Cyprus led to the deployment of RAF and Army AAA units to Akrotiri and Nicosia. The establishment of the Near East Strike Force in 1957 generated a long-term AA commitment on the island for the RAF Regiment, and the RAF strengthened its GBAD presence there still further ten years later by deploying Bloodhound II SAMs. Akrotiri then retained two GBAD layers providing medium and short-range defence until 1975 in addition to radar warning and fighter defences.

In 1986, the potential risk of retaliation against Akrotiri following the US Operation El Dorado Canyon was deemed sufficiently high to merit the dispatch of RAF Rapier units to the base. As recently as 2013, the vulnerability of Cyprus to Syrian action in response to potential air strikes by UK allies had been acknowledged when British forces mounted Operation Luminous – a series of enhanced air defence measures involving RAF Typhoons on QRA, Tristar tankers, an E-3D, 1 Air Control Centre and a Type 45 destroyer. And yet, during Operation Shader, despite the UK's continued doctrinal attachment to layered air defence and notwithstanding CDS's confident pronouncements a decade earlier, no GBAD systems were deployed there. Indeed, by that time, no contingent SHORAD

capability existed, and the remaining VSHORAD was unsuitable. American air defences, although present elsewhere in theatre, were not immediately available to fill the vacuum.

Consequently, it was necessary for the RAF to accept considerably more risk against Akrotiri than at any time since the Second World War. While their operations targeted Daesh, the UK formed part of a US-led coalition that overtly opposed Assad, and there was direct US support for Syrian opposition groups, as well as a US military base inside Syria at At Tanf, which was a source of considerable friction. Moreover, Syrian threats to coalition forces or their Allies could have required Akrotiri-based RAF aircraft to release weapons in their defence. In April 2017, the Americans responded to Assad's use of chemical weapons against his own people with TLAM strikes on Shayrat airfield; a year later, following another chemical attack, RAF combat aircraft participated in a series of coalition strikes against Syrian targets, flying from an eastern Mediterranean base that had no GBAD protection. In January 2020, the American air strike that killed Major General Qassim Suleimani, commander of the Iranian Quds Force of the Islamic Revolutionary Guards, could well have led to Iranian retaliation against US allies in the region.

At the same time, Operation Shader witnessed the emergence of new air threats. During the coalition assault on Ramadi in 2015, Daesh began using Uncrewed Air Systems (UAS). This confronted the coalition with a novel if not unprecedented situation – the first significant challenge to western air dominance for many years. Daesh UAS tended to be cheap, off-the-shelf commercial fixed-wing drones or quadcopters. A typical system might comprise the basic commercial UAS, Go-Pro and/or pinhole cameras, an RF transmitter and a GPS module. The basic air platforms and all the additional equipment were easily obtainable online. Deployed in growing numbers, they significantly increased Daesh's general military effectiveness, not least by improving their tactical situational awareness and ability to collect intelligence.⁸

Soon, Daesh were also using UAS to guide Vehicle-Born IED drivers to their targets, and finally they began to field weaponised UAS.⁹ On 24 February 2017, Iraqi government troops advancing into west Mosul were attacked by a formation of about a dozen weaponised UAS and sustained 30 casualties, including four killed. In response, the Commander of the Combined Joint Task Force directed coalition Advise, Assist, Accompany and Enable teams to establish FOB-type defensive positions and employ passive air defence tactics – camouflage, concealment, dispersal and visual spotters.¹⁰ Similar passive air defence measures were soon being recommended in UK doctrinal publications.¹¹



Yet another airfield attack: American BDA imagery of Ghardabiya Airfield, Libya, in 2011 (US DOD).



RAF Typhoons at Akrotiri during Operation Shader.

UAS were but one of several growing airborne threats (encompassing air platforms and missiles) that had been predicted by intelligence and analysis in 2004. Then, however, ACNS had argued that it was possible for Defence to take additional risk with GBAD on a short-to-medium-term basis while developing better capabilities for the future. Where SHORAD was concerned, the MOD had subsequently ordered a replacement for Rapier, which became known as Sky Sabre and was scheduled for introduction to service in 2020, but it did not promise to deliver a new contingent SHORAD capability: it was procured, scaled and resourced to take over Rapier's Falklands task alone.¹²

The potential dangers confronting the Armed Services owing to the paucity of GBAD mass began to attract more attention during the second decade of the century. Yet curiously, the air base air defence issues raised by Operation Shader were of less importance in this regard than plans for the future structure of the Army. In 2015, the second SDSR redirected military attention towards GBAD by proposing to create a new warfighting division. This formation was to be capable of confronting modern state adversaries equipped with advanced combat aircraft and missile systems, and expert opinion quickly concluded that that it would be doomed in the absence of more capable and extensive GBAD provisions. In a report published in 2017, the House of Commons Defence Committee declared:

We are greatly concerned about the level of detail and timescale of the plans to provide ground-based air defence for the new warfighting division. Addressing this vulnerability must be given the highest priority.¹³

This was an entirely valid statement, which was echoed by MOD documents at the time. Yet for reasons that remain hard to understand, the potential requirement for GBAD to defend airfields – historically one of the most common air target categories – failed to attract so much interest. The defence of specific bases such as RAF Akrotiri was by no means entirely overlooked in this period, but it was not an influential consideration.

The 2004 arrangement whereby the Army owned the UK's remaining SHORAD and VSHORAD forces while the RAF assumed responsibility for command and control was shaped by the perceived need to broker a deal between the two Services and was not primarily geared to capability. The operational rationale for placing a Joint GBAD Headquarters within HQ STC – subsequently HQ Air – lay in the RAF's long-term association with integrated air defence and Air Battle Management, and in their capacity to introduce the Army to the STANEVAL system, but there was no obvious case for continued RAF leadership

after the Rapier force reductions of 2011. Indeed, it is surprising that the Joint GBAD Headquarters survived for several years afterwards.

With GBAD attracting more attention after 2015, the value of the Joint Headquarters was soon called into question. In July 2017, it was relocated to 7 Air Defence Brigade's base at Baker Barracks, Thorney Island. Meanwhile, CAS and the Chief of the General Staff were examining a number of areas where it seemed that synergies and efficiencies could be achieved across the Army and Air Top-Level Budgets (TLBs). This produced the so-called Air-Land Proposition, which covered a range of capabilities including GBAD. Accepting the increased threat to ground forces in a future conflict (but apparently not to air forces in a current conflict), they agreed that all GBAD functions should be transferred to the Army TLB, although Air would continue to lead on Battlespace Management, ballistic missile defence and long-range air defence radar. The transfer duly occurred in the first months of 2019, the Army assuming full command of UK GBAD on 1 April; 7 Air Defence Brigade was renamed 7 Air Defence Group. The entirety of UK GBAD was now returned to Army ownership, leaving the RAF with no more active ground-based anti-aircraft capability than it had possessed in the early 1930s.¹⁴ The nation that invented the Integrated Air Defence System now possessed a Disintegrated Air Defence System.

Subsequent planning for the development of GBAD capability has occurred under Army auspices. Predictably enough, it has focused on the Land environment, raising obvious questions (based on historical experience) about how GBAD developed to meet Land requirements will integrate into more complex air scenarios. It is difficult to imagine any GBAD functioning effectively in the modern age without high operator familiarity and close collaboration with the processes of US or NATO CAOCs, both in the broader air command and control context and more specialised but fundamentally important areas such as target approval and engagement – a field in which the RAF has excelled over the last 25 years.

Equally, it is hard to determine how GBAD will be provided for airfield defence in future. This issue is now even more important because the closure of such stations as Coltishall, Cottesmore, Kinloss, Leuchars and Lyneham has left the RAF's combat, ISR and fixed-wing air transport forces entirely concentrated on Lossiemouth, Marham, Coningsby, Waddington and Brize Norton. While UK bases naturally benefit from other air defence measures, both national and NATO, the fact remains that heavy attacks on just five stations have the potential to eliminate the most vital elements of the RAF Order of Battle. The security of overseas DOBs and FOBs appears even more doubtful. Passive air defence offers one possible solution, and recent years have certainly witnessed a renewed interest

in V-Force-type off-base dispersal – rebranded as Agile Combat Employment (ACE). The Air Component may also be able to acquire and operate SAM capabilities developed under the Land GBAD Programme, but this will be dependent on funding.

In terms of allocating existing capability, it is unclear whether the concept of the Joint Prioritised Defended Asset List still applies.¹⁵ However, for the time being, the UK's GBAD resources are likely to remain so limited that they will largely be apportioned in accordance with strategic priorities determined at the highest levels. This was true of the 2022 VSHORAD deployment to Saudi Arabia and of the Sky Sabre deployment to Poland, which presumably diverted assets previously intended for the Falklands. We may note in passing that Sky Sabre – Rapiere's replacement – was not sent to Poland to protect manoeuvring ground formations but to defend Rzeszow air base.¹⁶

Meanwhile, the rapidly expanding threat from UAS is drawing the RAF Regiment back into the air defence business. No. 2 Force Protection Wing, based at RAF Leeming and including 34 Squadron and 63 Squadron RAF Regiment, has assumed the lead Defence role for fixed-site Counter-UAS. This involves the use of the ORCUS system, capable of detecting, tracking, identifying and, if necessary, defeating hostile UAS via electronic means.¹⁷ ORCUS is indeed a very capable platform; nevertheless, in high-threat environments or in the defence of particularly high-value installations, there must be strong grounds for deploying it alongside conventional SAM systems with counter-UAS capabilities to create genuinely layered air defence provisions with the capacity to produce a 'soft' or 'hard' kill. More open to question is whether such a system could be generated when so little remains of the human, technological and logistical infrastructure that once underpinned UK GBAD.

Notes

1. STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: DGJDC to ACDS(Ops), Operational C2 of Post MTWS GBAD and Capability Allocation Process, 11 October 2004: see also AJP-3.3(A), *Allied Joint Doctrine for Air and Space Operations* (November 2009), Section VII - Ground-Based Air Defence and Theatre Missile Defence Planning, para 0433.

2. STP-04 Medium Term Workstrand 14, GBAD, Vol 9, Loss of GBAD and Further Work: draft STP-04 think-piece; STP-04 Medium Term Workstrand 14,

GBAD, Vol 10, GBAD Migration Planning: Group Captain KR Dipper for AOC 2 Gp, to DJtCapINTEG2, 27 January 2005; 20060803, CDS Directive 07-06, Annex A.

3. STP-04 Medium Term Workstrand 14, GBAD, Vol 10, GBAD Migration Planning: Wing Commander Lee, Air RP IOOS, to D Air RP, 22 October 2004.

4. Ibid.; ‘Woolwich Barracks a home fit for heroes after £50 million refit,’ *Evening Standard*, 7 September 2010, accessed 3 January 2003 at: <https://www.standard.co.uk/hp/front/woolwich-barracks-a-home-fit-for-heroes-after-ps50m-refit-6510861.html>

5. House of Commons Defence Committee, HC 108, *SDSR 2015 and the Army*, 1 November 2016: ‘Rapier currently provides that capability in the Falkland Islands, and then for our contingent forces we use HVM regiments. In the future, we intend to bring in the Future Local Area Air Defence System—FLAADS—to replace Rapier with an in-service date of 2019. That will indeed go down to replace the Rapier capabilities in the Falklands, to attend to that particular task.’ FLAADS was later named Sky Sabre.

6. AHB, *RAF Command and Control, 1982-2014*, pp. 199, 206; AHB research paper, *UK Air Power in Operation Unified Protector: Libya, 2011*, pp 16-17.

7. Draft AHB narrative, *The Royal Air Force in Operation Shader: Combat and ISR Support in Operations against the ISIL/Daesh Caliphate, 2014-2019*, p. 83.

8. Kerry Chávez and Dr Ori Swed, ‘Off the Shelf: The Violent Nonstate Actor Drone Threat,’ *Air and Space Power Journal*, Fall 2020, p. 33, accessed 21 May 2023 at: https://www.airuniversity.af.edu/Portals/10/ASPJ/journals/Volume-34_Issue-3/ASPJ-Fall-2020.3.pdf

9. Ibid.

10. AHB, *The Royal Air Force in Operation Shader*, p. 47.

11. Development, Concepts and Doctrine Centre, Joint Doctrine Publication 0-30.2, *Unmanned Aircraft Systems* (2017), para 3.20.

12. House of Commons Defence Committee, HC 108, *SDSR 2015 and the Army*, oral evidence, 1 November 2016.
13. House of Commons Defence Committee, HC 108, *SDSR 2015 and the Army*, para 33.
14. 'Launch of new Joint Air Defence Group,' *British Army website*, 5 April 2019, accessed 31 March 2023 at: <https://www.army.mod.uk/news-and-events/news/2019/04/launch-of-new-joint-air-defence-group>
15. The author asked 7 Air Defence Group HQ, but no answer was forthcoming.
16. 'Prince William makes secret visit to Polish and British troops near Ukraine border,' *Sky News*, 22 March 2023, accessed 31 March 2023 at: <https://news.sky.com/story/prince-william-makes-secret-visit-to-polish-and-british-troops-near-ukraine-border-12840062>
17. 'Counter-drone tech and state-of-the art radar for the RAF,' *Ministry of Defence and Defence Equipment and Support news story*, 3 September 2020, accessed 17 April 2023 at: <https://www.gov.uk/government/news/counter-drone-tech-and-state-of-the-art-radar-for-the-raf>

Conclusion

Airfield defence emerged as a major factor in air warfare during the First World War but gained in significance in the inter-war years as the capability – particularly the bomb-load – of aircraft increased. By the outbreak of the Second World War in 1939, large and modern air forces like the Luftwaffe were able to inflict extremely heavy damage to airfield facilities and aircraft on the ground. Awareness of the scope to defeat air adversaries before they became airborne by striking their bases was reflected in the counter-airfield operations that opened the German campaigns against Poland, France and the Low Countries, and the Soviet Union, and the Japanese attacks on Malaya and Singapore. Of all the conventional military campaigns mounted across the globe since 1939, a substantial majority were initiated by air attacks on airfields, and hardly any did not involve airfield attack at some stage.

The threat to airfields was countered in several ways and not merely by GBAD. The establishment of radar-based integrated air defence systems together with large and modern fighter forces was fundamental to a wider area air defence effort that also protected point targets like airfields, and passive measures substantially reduced the effectiveness of airfield strikes. Experience from 1939 to early 1942 illustrated the danger to airfields in environments in which control of the air was contested or where effective integrated air defence provisions had not been established. Yet GBAD was an essential air defence element for both area and point defence, light and short-range AA weapons representing a final protective line with which to confront hostile aircraft that evaded the other layers of the IADS.

The UK began the Second World War with hopelessly inadequate AAA resources, and underinvestment in the 1920s and 1930s was also reflected in the high proportion of First World War weapons that still equipped the Royal Artillery in the rearmament and early wartime years. It is hardly surprising that the RAF struggled to secure AAA protection unless Army formations were specifically allocated to airfield defence, and resources were often severely stretched, even then. Under operational pressure, Army commitments to defend airfields frequently proved difficult to honour.

Finally, amid overwhelming evidence that airfield defence required a radically new approach, the government established an RAF airfield defence corps – the RAF Regiment. The Regiment assumed responsibility for airfield LAA defence and operated effectively in this role in all theatres until the end of the war. Their Bofors guns proved their worth in multiple campaigns, as well as individual

actions such as the first LAA interception of a jet combat aircraft or the defence of 2 TAF bases in Operation Bodenplatte on 1 January 1945.

After the war, the demands of home and European defence had still to be balanced against those of the UK's wider global interests. The Warsaw Pact threat to airfields in the NATO area and the potential vulnerability of Mediterranean and Middle East bases generated a requirement for the RAF Regiment to retain considerable strength for more than a decade. This same period witnessed the development of the medium-range SAM system, Bloodhound, which was operated by Fighter Command to defend V-Bomber airfields and American bases in the UK. Active defences were combined with passive measures in the form of a particularly elaborate off-base dispersal regime that was constantly rehearsed for a decade.

This was not, as events turned out, an era in which RAF bases came under attack, but airfield defence remained supremely relevant to contemporary conflict. During the Korean War of the early 1950s, both sides regularly targeted airfields, and the RAF attacked Egyptian airfields during the Suez operation of 1956. Nevertheless, only a year later, the Sands Defence White Paper brought substantial cuts, removing all RAF Regiment LAA squadrons from West Germany. Bloodhound remained in service until the introduction of Bloodhound II in 1964, but Bloodhound II, although offering a significantly improved capability, was procured on a far smaller scale and no successor was developed.

By the mid-1960s, only the UK's Mediterranean and Far Eastern airfields were deemed worthy of GBAD protection. During the Indonesian Confrontation and in support of CENTO, the RAF established classic layered and integrated air defence systems incorporating radar, fighters and LAA. Bloodhound II provided a further medium-range air defence layer in the Far East from 1964 and Cyprus from 1967. Regular exercises and practice deployments away from the Cyprus base created scope for the Near East Strike Force to disperse if it was threatened. The deployments in Malaysia and Singapore reflected the emergence of a direct challenge from Indonesia during the decolonisation process. However, the RAF strengthened Cyprus's air defences in recognition of the fact that the positioning of strike and then nuclear strike capabilities on an exposed eastern Mediterranean air base increased the risk of hostile air action against it.

Investment in conventional air defence increased again in the NATO area in the later 1960s after the alliance adopted the doctrine of Flexible Response. The RAF Regiment's Bofors guns returned to airfields in West Germany, and Bloodhound II was deployed there. Passive air defence measures such as on and off-base dispersal, hardening and tone-down were also implemented under SACEUR's Programme for the Physical Protection of airfields. The Rapier

SHORAD missile was meanwhile developed to replace the Bofors gun and entered service with the RAF Regiment in West Germany in 1974.

By the mid-1970s, the UK had relinquished most of her colonial possessions in the Far East, and CENTO had disintegrated. Yet new and enduring airfield defence tasks emerged for the RAF Regiment in Belize and, from 1982, the Falklands, and the Regiment was also assigned the major new commitment of providing SHORAD for the USAF's UK bases. Bloodhound II similarly assumed a UK airfield defence role in the mid-1970s that endured until the end of the Cold War. The combination of responsibilities – in the UK, West Germany, the Falklands and Belize – ensured that RAF GBAD was more heavily committed in the 1980s than at any time since the early 1950s and, relative to the GBAD resources available, any time since the end of the Second World War. This degree of commitment helped to ensure the maintenance of extremely high levels of professional competence and operational capability.

The end of the Cold War was widely grasped as an opportunity for disarmament but gave rise to a new era of conflict inaugurated by first Gulf War. Further operations followed in Bosnia, Kosovo, Afghanistan and then Iraq for a second time as the western military drawdown continued. The RAF Regiment and the Royal Artillery began to re-equip their SHORAD forces with the highly capable Rapier FSC, but the MOD's significantly reduced FSC purchase illustrated the extent to which GBAD was viewed as a sphere in which major economies could be realised. This outlook was encouraged by western – USAF – dominance of the air. UK participation in US-led coalitions appeared to reduce the likelihood that airfields would come under attack and promise the availability of American GBAD if they did. Ostensibly, western air forces could strike adversary air bases (as they did in Iraq, the FRY, Libya and eventually Syria) without coming under attack themselves.

The immediate post-Cold War years witnessed the elimination of Bloodhound II; it was not replaced. RAF Regiment SHORAD was cut down to four front-line squadrons equipped with Rapier FSC. The DOC audit of 1996 confirmed that the Regiment was accommodating the drawdown far more comfortably than the Royal Artillery, yet SDR subsequently proclaimed that the absence of jointery across RAF and Army SHORAD was a serious weakness. Joint dogma began to prevail not least because jointery appeared to offer significant cost savings relative to single-Service alternatives. RAF SHORAD was demonstrably capable of operating in a joint environment: among other things, the RAF Regiment worked closely with Maritime and Land elements in the Falklands. Yet this was not a model of jointery that found favour in the UK Defence community in the late

1990s. More acceptable was the Joint GBAD Headquarters concept proposed by SDR but quietly abandoned two years later.

The DOC audit of 2002 reinforced the judgements of the 1996 audit and specifically upheld RAF Regiment SHORAD as ‘best practice’. The Regiment retained its established airfield defence role in the Gulf from 2001 to 2003 but also deployed forward very successfully in support of the Land Component during the second Gulf War. Yet the continuing search for economies ultimately condemned the Regiment’s SHORAD capability, which by then was the only RAF GBAD capability. This outcome was indeed a sorry reflection on UK Defence management in the early years of the 21st century. The fundamental facts are:

- 1) Policy development by Workstrand 14 was based on four options, but the enormous savings disparity between the first three options and the 4th, which cut Rapiere by 50 per cent, was always certain to be decisive. The processes employed by Workstrand 14 were manifestly not objective and guaranteed that Option 4 would be selected.
- 2) Operational capability was subordinated to the perceived requirement to produce an outcome that gave something to both the RAF and the Army. This was a process in which the RAF was placed at a considerable disadvantage because, unlike the Army, it had nothing to concede. However, the Army’s concession – the formation of a Joint GBAD Headquarters under HQ STC – can only be described as hollow, as it was never likely that it would be formed under HQ Land. Workstrand 14’s original recommendations to this effect are impossible to take seriously.
- 3) The 1996 and 2002 DOC audits, which characterised RAF GBAD as ‘best practice’, were ignored.
- 4) The RAF Regiment’s proven capacity to provide GBAD across the Air, Land and Maritime Components was ignored.
- 5) The lack of Army STANEVAL was ignored; a force that was already subject to STANEVAL and NATO TACEVAL in 2004 was discarded in favour of a force that could not reach these standards until 2007.
- 6) The likely increase in the number and range of air threats confronting the UK was not ignored, but the concept that short-term cuts might be offset by long-term investment in capability did not materialise, partly because there was no follow-

up strategy to pursue this objective and partly because of the elimination of the contingent Rapier capability after SDSR in 2010.

7) Government guidance prioritising small and medium-scale operations over large-scale operations was ignored.

8) The key rationale for assigning SHORAD to the Army – the emerging doctrine of simultaneous attack – was entirely notional and was not realised before the elimination of the contingent Rapier capability after SDSR.

9) Cost calculations that only slightly favoured RAF Regiment ownership of Rapier in 2004 proved inaccurate; the correct figures would have demonstrated that Regiment ownership was significantly cheaper than Royal Artillery ownership.

10) Assurances in 2004 that Army SHORAD would remain available to provide cover for ‘rear areas’ (primarily airfields) were fatally undermined by the surreptitious elimination of the contingent Rapier capability after SDSR. The 2004 supposition of coalition (US) GBAD protection for UK airfields was not realised during Operation Shader. In the absence of Army and US protection, it proved necessary to accept greater risk against RAF Akrotiri’s security than the UK had taken at any time since the Second World War.

Between 1942 and 2004, only one of the three British Armed Services maintained enduring operational GBAD commitments in the UK, West Germany, the Middle East, Cyprus, Malaysia, Belize and the Falklands. Only one deployed short and medium-range GBAD as part of a fully integrated and layered air defence system that also included radar warning and fighter control, visual observation, fighter defences and passive air defences. Only one operated the world’s first short-range ground-to-air missile. Only one produced officers with the ability to design an aircraft recognition system for the UK and 13 NATO countries. Only one was deemed sufficiently competent by the American government to provide operational SHORAD for USAF air bases at a time of extreme international tension. Only one demonstrated a capability to operate across all three components – Air, Land and Maritime. Only one demonstrated the resourcefulness to meet SACEUR’s SHORAD requirements quickly and at minimal cost via the refurbishment of captured enemy weapons and radar equipment. That Service was the Royal Air Force. Throughout, the RAF accumulated an enormous, invaluable and, in the UK at least, unrivalled bank of

GBAD knowledge and expertise, which the events of 2004 largely consigned to the history books.

The withdrawal of the contingent Rapier capability after 2010 meant that Rapier's Sky Sabre replacement was only resourced for the Falkland Islands, and it is now unclear where active GBAD for the defence of RAF airfields other than Mount Pleasant will come from. Yet base closures – from the hundreds of airfields of 1945 down to the mere handful still operational today – have left the RAF a more concentrated target than at any time in its history. There are very few airfields left to attack. V-Force-type off-base dispersal may provide a passive solution, to an extent, but passive measures have only previously been deemed effective in conjunction with active GBAD.

The air threat has changed in several ways in recent years, but the appearance of UAS and particularly *armed* UAS has generated acute challenges and drawn the RAF Regiment into the provision of countermeasures via ORCUS, reviving the air defence role for which the Regiment was partly created in 1942. Yet electronic measures alone may not be enough to defeat the threat. The ongoing development and proliferation of UAS will almost certainly demand a more kinetic response, too.

In its introductory paragraphs, this study raised three particular issues in relation to GBAD: these were (1) integrated air defence, (2) air superiority and (3) deterrence. What conclusions can now be drawn under these headings?

Integrated air defence. In the earliest years surveyed in these pages, pronounced differences emerged over the deployment of GBAD, which did not initially follow strict inter-Service lines. The RAF, together with Army elements specifically assigned to airfield defence, accepted such concepts as centralised air command and integrated air defence. GBAD was not employed independently of other air defence elements but as part of a layered system that was ultimately radar-based, whether it was static, as in the UK, or mobile, as in North Africa. Army GBAD elements committed to the support of ground manoeuvre (as well as naval AA gunners) found this perspective difficult to grasp, and their tactical doctrine proved less suited to complex air environments in which there was a substantial friendly air presence. Friction was the inevitable consequence: over Tobruk and in such operations as Husky and Overlord, gunners frequently engaged their own aircraft. At other times, restrictions designed to protect Allied air assets seemed to impose intolerable constraints on the employment of AAA.

After the war, this doctrinal divergence became more pronounced as the Army's airfield defence role was restricted to occasional reinforcement tasks – for example, during the Suez crisis and the Indonesian Confrontation. RAF and Army

GBAD otherwise developed separately to fulfil very different functions. The RAF duly retained its more integrated concept of GBAD and the accompanying assumption of complex and potentially congested airspace utilisation in areas where GBAD might be employed. Numerous operational deployments across the globe ensured the alignment of doctrinal theory and practice. Thus, even in 2003, the RAF Regiment possessed a demonstrably superior grasp of how to integrate into the coalition Order of Battle in Operation Telic than the British Army air defence staff or the US Army's Patriot batteries. Even after the Patriot-Tornado shoot-down, the Army at first sought to deploy Rapier in ways that would have increased the likelihood of a blue-on-blue engagement, whether ground to air or air to ground.

Now and in the future, some relatively independent tactical action will doubtless be necessary to defend manoeuvring ground forces from air threats, but it is inevitable that much GBAD activity will continue to demand the closest possible integration into wider air operations. This will particularly be true of airfield defence measures because of the complexity of the air picture in base areas. However, even in forward locations, effective air defence will not be delivered by GBAD alone. In Operation Shader, coalition aircraft flew numerous Defensive Counter-Air missions to protect friendly ground forces.¹ All GBAD force elements should therefore be prepared via their doctrine, training and equipment to operate as part of a multi-layered air defence effort.

Air superiority. The evidence of history is that successful airfield attack and air superiority normally go hand in hand. A belligerent with a clear advantage in the air is more likely to execute effective airfield strikes and less likely to be attacked. This elementary truth has been demonstrated repeatedly from the beginning of the Second World War to the present day. Yet it is dangerous to conclude that air superiority eliminates the threat. This was the lesson of Operation Bodenplatte at the end of the Second World War, and it should not be forgotten.

We should also recall the many occasions when airfields have been targeted by other means – by special forces, insurgents or regular ground units. Although the US had an overwhelming advantage in the air during the Vietnam War, the USAF's ten main bases in South Vietnam suffered frequent attacks that left a total of 75 aircraft destroyed and 898 damaged.² The use of ground forces to target airfields in the absence of conventional air alternatives, while not directly relevant to a study of GBAD, further emphasises the enduring importance of airfields as targets and the likelihood that they will be targeted by any available means. The advent of cheap and easily obtainable armed UAS is certain to alter adversary

perceptions of how airfields can best be targeted, reducing the likelihood of ground attack relative to air attack.

Deterrence. It is all too easy to accept uncritically the notion that the resources allocated to GBAD are wasted in the absence of air attack or actual engagements by AA weapons. GBAD can also exert a strong deterrent effect and has been deployed for this specific purpose on many occasions. The problem lies in demonstrating or measuring this effect, and the difficulty of so doing has left GBAD vulnerable to cuts during periods of financial retrenchment.

Deterrent effect was particularly evident during the Second World War, when the Axis airfield attack calculus changed visibly over time – notably in the North African theatre. At first, the weakness of air defences and the exposure of airfield targets attracted hostile action, but it invariably declined as the defences grew stronger until it ceased altogether. The game was no longer worth the candle.

A further illustration is supplied by the deployment of GBAD by adversaries and its effect on the RAF and other western air forces in more recent operations. In the first Gulf War, Iraqi GBAD compelled all the deployed RAF ground-attack detachments to operate at medium altitude when they were predominantly trained and equipped for low-level mission scenarios. During the Kosovo conflict, FRY GBAD claimed very few NATO aircraft but forced the alliance to employ medium-level tactics that were very susceptible to weather interference. In 2011, Libyan GBAD deterred optimal coalition exploitation of airborne command and control aircraft and larger ISR assets, as well as attack helicopters. In summary, historically, GBAD has repeatedly served to influence adversary behaviour in ways that make effective air attacks more difficult to prosecute. It's true value should be assessed on this basis.

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Any temptation to draw close parallels between the UK's current GBAD deficiency and the situation that existed in the 1930s – in the first years addressed by this study – should be resisted. Such factors as the independent nuclear deterrent and the NATO alliance have fundamentally altered the strategic environment. Many of the defence challenges that now face the UK must necessarily be addressed through measures far beyond the imagination of the military chiefs and statesmen who were confronted by the rise of Hitler's Reich.

Nevertheless, in some ways, the history of UK GBAD has come full circle over a period of 90 years. In the 1930s, the threat of air attack was increasing ominously, as is the threat in the 21st century, and the scarce resources available

to the senior officers and planners of the rearmament years would seem all too familiar from a modern military perspective. In the capability area, in 1939, British forces were equipped with few anti-aircraft weapons that could defeat the most modern combat aircraft of the period; today, the UK's very limited GBAD resources cannot counter the full array of airborne weapons fielded by potential adversaries.

On the outbreak of the Second World War, the RAF lacked an effective ground-based AA capability and was left with no alternative but to depend for airfield defence on an Army that was simply not resourced to fulfil such a major commitment in addition to the many other requirements for GBAD. In 2004, the RAF's organic GBAD capability was eliminated by government spending cuts on the most questionable of grounds, leaving the Service entirely dependent on the Royal Artillery's Rapier arsenal for airfield defence before it, too, was axed. Now, however we view the situation on the UK mainland, the scope for providing effective GBAD cover to FOBs or DOBs barely appears greater than it was on the day that Neville Chamberlain uttered the infamous words, 'This country is at war with Germany.'

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Glossary of Abbreviations

2 TAF	-	Second Tactical Air Force
AA	-	Anti-Aircraft
AAA	-	Anti-Aircraft Artillery
AASF	-	Advanced Air Striking Force
AC	-	Air Component
ACAS	-	Assistant Chief of the Air Staff
ACDS	-	Assistant Chief of the Defence Staff
ACE	-	Agile Combat Employment
ACE	-	Allied Command Europe
ACFF	-	Air Component of the Field Force
ACGS	-	Assistant Chief of the General Staff
ACM	-	Airspace Control Measures
ACNS	-	Assistant Chief of the Naval Staff
AD	-	Air Defence
ADC	-	Air Defence Commander
ADIZ	-	Air Defence Identification Zone
AH	-	Attack Helicopter
ALG	-	Advanced Landing Ground
AOC	-	Air Officer Commanding
ARM	-	Anti-Radiation Missile
ARRC	-	Allied Rapid Reaction Corps
AWC	-	Air Warfare Centre
BAFF	-	British Air Forces France
BDA	-	Battle Damage Assessment
BEF	-	British Expeditionary Force
C2	-	Command and Control
CAOC	-	Combined Air Operations Centre
CAS	-	Chief of the Air Staff
CC	-	Component Commander
CDS	-	Chief of the Defence Staff
CENTO	-	Central Treaty Organisation
CH	-	Chain Home
CM	-	Cruise Missile
CO	-	Chain Overseas
COL	-	Chain Overseas Low
CP	-	Collective Performance

CRC	-	Control and Reporting Centre
DADC	-	Duty Air Defence Commander
DLW	-	Director of Land Warfare
DMB	-	Defence Management Board
DNRP	-	Director of Naval Resources and Plans
DOB	-	Deployed Operating Base
DOC	-	Directorate of Operational Capability
FDT	-	Fighter Direction Tender
FEAF	-	Far East Air Force
FJ	-	Fast Jet
FOB	-	Forward Operating Base
FRY	-	Federal Republic of Yugoslavia
FSA	-	Field Standard A
FSB	-	Field Standard B
FSC	-	Field Standard C
GBAD	-	Ground-Based Air Defence
GCI	-	Ground Control Intercept
GDA	-	Gun-Defended Area
GL	-	Gun Laying
HAA	-	Heavy Anti-Aircraft
HQ STC	-	Headquarters Strike Command
HVM	-	High-Velocity Missile
IADS	-	Integrated Air Defence System
IAZ	-	Inner Artillery Zone
IFF	-	Identification Friend or Foe
JFAC	-	Joint Forces Air Component
JFACC	-	Joint Forces Air Component Commander
JFACHQ	-	Joint Forces Air Component Headquarters
JHF LO	-	Joint Helicopter Force Liaison Officer
JOA	-	Joint Operations Area
JPDAL	-	Joint Prioritised Defended Asset List
JRRF	-	Joint Rapid Reaction Force
JRTU	-	Joint Rapier Training Unit
JTFC	-	Joint Task Force Commander
LAA	-	Light Anti-Aircraft
LG	-	Landing Ground
LLAD	-	Low-Level Air Defence
LOMEZ	-	Low-Level Missile Engagement Zone
LWS	-	Light Warning Set

MEZ	-	Missile Engagement Zone
MOD	-	Ministry of Defence
MRS	-	Master Radar Station
MRU	-	Mobile Radio Unit
NATAF	-	Northwest African Tactical Air Force
NBC	-	Nuclear, Biological and Chemical
OC	-	Officer Commanding
OTP	-	Operational Tour Plot
PAC	-	Parachute and Cable
PGM	-	Precision-Guided Munition
PPP	-	Programme for Physical Protection (of airfields)
PPSG	-	Policy and Planning Steering Group
RA	-	Royal Artillery
RAAF	-	Royal Australian Air Force
RAP	-	Recognised Air Picture
RDF	-	Radio Detection/Direction Finding (radar)
REAF	-	Royal Egyptian Air Force
RP	-	Resources and Plans
RRS	-	Resident Rapier Squadron
R/T	-	Radio Telephony or Transmission
RTF	-	Readiness to Fire
SAM	-	Surface-to-Air Missile
SAWS	-	Surface-to-Air Weapons System
SDR	-	Strategic Defence Review
SDSR	-	Strategic Defence and Security Review
SHORAD	-	Short-Range Air Defence
SOC	-	Sector Operations Centre
SOI	-	Standard Operating Instructions
SOP	-	Standard Operating Procedures
SSM	-	Surface-to-Surface Missile
STANEVAL	-	Standards and Evaluation
STO	-	Survive to Operate
STP	-	Short-Term Plan
TA	-	Territorial Army
TACEVAL	-	Tactical Evaluation
TCC	-	Tactical Control Centre
TCO	-	Tactical Control Officer
TLB	-	Top-Level Budget
TRU	-	Transportable Radio Units

UAS	-	Uncrewed Air System
UAV	-	Uncrewed Air Vehicle
VCDS	-	Vice Chief of the Defence Staff
VP	-	Vulnerable Point
VSHORAD	-	Very Short-Range Air Defence
WCO	-	Weapons Control Order
WDAF	-	Western Desert Air Force
WOU	-	Wireless Observation Unit
W/T	-	Wireless Telegraphy or Transmission

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