

**The Royal Air Force in
Operation Shader: Air Combat
and ISR Support in Operations
against the Islamic State,
2014-2019**

Air Historical Branch (RAF)



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Photographs

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Introduction

Operation Shader was the name assigned to the United Kingdom's contribution to military operations against the so-called Islamic State of Iraq and the Levant (ISIL). The Royal Air Force was overwhelmingly responsible for UK combat operations against ISIL, which began in the autumn of 2014 after the formation of a US-led coalition based in Iraq. The coalition's primary tasks were to halt ISIL's advance and then recapture the territories it had conquered – a massive undertaking that took four and a half years to complete. High-intensity air combat operations had to be sustained throughout, and it was this combination of duration and intensity that really defined Operation Shader from the air perspective. Earlier conflicts in Iraq and the former Yugoslavia might have witnessed combat on a larger scale but for only a few months. Other operations – Afghanistan or the various No-Fly Zones – were more protracted but far less intensive in terms of combat. The challenge was all the more pronounced in the aftermath of the defence cuts implemented by a number of western nations in response to the economic crisis of 2009.

To date, the published literature on operations against ISIL has largely been written from a United States perspective. The aim here is to provide a clear, fact-based narrative of the RAF's contribution in the spheres of air combat and Intelligence, Surveillance and Reconnaissance (ISR). The resulting history is in one respect misleading, for it suggests a more sequential campaign progression than actually occurred. Another key feature of Shader was the extended geographical reach of the air campaign. It was characterised by multiple simultaneous missions that stretched far beyond the main battle fronts. Yet it would be impossible to capture the totality of the coalition air power story or provide a blow-by-blow account without constant digression. One way of addressing this problem might have been to use a more thematic structure addressing each of the main air power roles and missions in turn. However, such an approach would not have adequately captured the resource pressures that Operation Shader imposed on participating coalition air forces.

Therefore, this study follows a basic chronology suggested by the main campaign developments defined as follows: the start of coalition operations in 2014, the first year of fighting that halted ISIL's advance, the coalition's move on to the offensive and the subsequent struggle to liberate ISIL-held territory in 2016, the decisive assaults on the ISIL strongholds of Mosul and

Raqqa,^a and the final elimination of the last pockets of ISIL resistance from 2018 to 2019. This did not signify their outright defeat but the end of their capacity to hold and govern Iraqi and Syrian territory.¹

The RAF's experience in Operation Shader must be considered in context. UK air power had been committed to operations over Iraq almost continuously from 1990 to 2009. The first Gulf War (1990-91) had been followed by more than a decade of No-Fly Zone operations and then by Operation Telic, which had endured for six years. Meanwhile, the RAF had also maintained operations over the former Yugoslavia throughout the 1990s, and 2004 had witnessed the launch of Operation Herrick in Afghanistan, which lasted until 2014. From the late 90s onwards, while the armed forces were steadily reduced in size, UK defence activity consistently exceeded defence planning assumptions – a fact that the MOD itself openly admitted on several occasions.² Nevertheless, with the Afghan conflict still very much in progress, the RAF was committed to operation Ellamy in Libya from March to October 2011.

Among other things, the UK Strategic Defence and Security Review (SDSR) of 2010 retired the Harrier GR9 – one of the RAF's two crewed ground-attack platforms. Alongside the Tornado GR4, the Typhoon was employed in a ground-attack role in Operation Ellamy but with capabilities as yet immature. The RAF's primary investment in combat and ISR in this period focused on the Reaper Remotely Piloted Air System (RPAS) force, which doubled in size between 2010 and 2014. However, its other ISR fleets – E-3D, Sentinel, RC-135 Airseeker and Shadow R1 – were small. The difficulties involved in supporting demanding overseas operations with detachments of just one or two aircraft were illustrated all too clearly during the period when Herrick and Ellamy were running in tandem.

By 2014, the UK had extricated itself from Iraq and Libya, and the end in Afghanistan was very much in sight. RAF forward planning assumed that 83 Expeditionary Air Group (83 EAG) would continue to operate from Al Udeid, Qatar, alongside AFCENT's^b Combined Air Operations Centre (CAOC), but a period of recuperation and regeneration was otherwise widely expected, involving a break from the apparently interminable cycle of deployed and expeditionary operations. There was much discussion of a 'return to contingency' in defence circles, but the reality could hardly have been more different.

a. Map spelling Raqqah.

b. AFCENT – the Air Force division of US Central Command.

1. The Initiation of Operation Shader

Operation Shader was launched in 2014 in response to the spread of ISIL control across substantial areas of Iraq and Syria. Exploiting the weakness of Iraqi governmental and security institutions, Sunni opposition to Iraq's Shia majority and Syria's progression from civil war to near-total anarchy, ISIL extended its influence along the Tigris and Euphrates valleys and captured Fallujah in Iraq and Raqqa in Syria in January 2014. The Iraqi cities of Mosul and Tikrit had been overrun by the middle of June. On 30 June, ISIL declared the foundation of a caliphate extending across an enormous swathe of northern Iraqi and Syrian territory. By September, Bayji was under ISIL control, and Baghdad itself was threatened from the north and west. The stability of the entire region was in jeopardy, and the safe haven of the caliphate provided ISIL with a base from which, directly and indirectly, they began exporting terrorist atrocities around the world.

The US counter-ISIL operation, Inherent Resolve (OIR), began in June, although the first US air strikes did not occur until 8 August, after ISIL captured Sinjar and drove out much of its Yazidi population. RAF involvement initially took the form of Humanitarian Assistance (HA) air drops to the many thousands of refugees in the Mount Sinjar area, which were flown from Akrotiri from the 10th by 47 Squadron C-130s. Soon, the C-130s were also helping with the delivery of military equipment and supplies to Erbil to support Kurdish Peshmerga forces resisting ISIL and to Baghdad for the Iraqi Security Forces (ISF).

Meanwhile, Tornado GR4s equipped with the RAPTOR reconnaissance pod deployed to Cyprus with the Tactical Imagery Wing (TIW) to provide ISR collection and exploitation, and RC-135 Airseeker surveillance aircraft positioned in the Gulf for Operation Herrick flew their first counter-ISIL sorties. Voyager was employed operationally for the first time for AAR. The RAF elements at Akrotiri were assigned to 140 EAW. By 18 August, 140 EAW included six GR4s with at least eight crews, three C-130s and one Voyager.³

A major obstacle to counter-ISIL planning in the summer of 2014 lay at the top of the Iraqi government in the form of Prime Minister Nouri al-Maliki. With his position founded on a substantial Shia powerbase, Maliki's policies had contributed much to the alienation of Iraq's Sunni population, fuelling the expansion of ISIL, and he had assumed a pro-Iranian and anti-western posture for much of his time in office.

The Royal Air Force in Operation Shader



RAF C-130Js carried out Humanitarian Assistance drops to Yazidi refugees in the Mount Sinjar area in August 2014.



One of the C-130s being refuelled en route to Iraq by a Royal Air Force Voyager tanker.

The Royal Air Force in Operation Shader



Final checks on the aid packages.



Hercules-borne aid packages shortly before the drop.

Although the threat from ISIL ultimately forced him to seek help from Washington, it was soon clear that a solution to the crisis – both political and military – would be impossible while he remained in power. Against this background, US President Obama took the decision to make American military support dependent on Maliki's replacement. However, during the month-long process required to achieve this end, it was difficult to secure the necessary diplomatic clearances for GR4 missions over Iraq. Only after 8 September, when Haider al-Abadi was sworn in as Prime Minister, were over-flight restrictions relaxed.

The GR4 detachment soon established northern and southern routes from Akrotiri to Iraq thus securing a degree of tactical flexibility and potential re-routing options in the event of poor weather. Routing and diplomatic clearance issues were handled by liaison officers at the CAOC, and by the responsible British Embassy staffs in theatre. The provision of Joint Personnel Recovery, largely under US auspices, was another essential prerequisite for coalition air operations against ISIL, and a network of potential diversion airfields was also quickly developed. The dire consequences of abandoning an aircraft in flight over ISIL-held areas due to unserviceability or damage from surface-to-air fire became all too clear within months, when Jordanian pilot Lieutenant Moaz al-Kasasbeh baled out of an F-16 near Raqqa and was taken prisoner. Soon afterwards, ISIL released a video of him being burned alive in a cage.⁴

Planning in the MOD by this stage broadly assumed the formation of a US-led counter-ISIL coalition to which the UK would contribute. Yet the options were limited. In the later months of 2014, a war-weary British public was looking forward to final disengagement from Afghanistan and the end of more than a decade of continuous operations since the invasion of Iraq in 2003. There was little enthusiasm for further military action. Moreover, the armed services had been compelled to absorb significant economies by SDSR, and the forces returning from Afghanistan urgently needed a period of recuperation.

Finally, as recently as August 2013, Parliament had voted against military action in Syria following the Assad regime's use of chemical weapons on the outskirts of Damascus. For its majority in the House of Commons, Prime Minister David Cameron's coalition government depended on Liberal Democrat MPs who had largely opposed intervention.⁵

For all these reasons – and in the absence of a significant US ground presence – it was never likely that the UK would commit ground troops to a counter-ISIL coalition in large numbers or a combat role. Instead, the MOD

proposed the deployment of an RAF strike and attack package. This promised to impose considerable pressure on the RAF's aging Tornado GR4 fleet, and there had been no expectation in the RAF or across the wider defence community that the GR4 would contribute to an enduring high-intensity operation immediately after the Afghan conflict. Indeed, it was planned that the aircraft would be withdrawn from service in this period, while its combat capabilities passed to the Typhoon and the F-35 Lightning. After a final deployment to Afghanistan, 12 Squadron had been disbanded in 2014 to leave a front-line GR4 fleet of just two squadrons. However, the impossibility of maintaining the Shader commitment with so small a force compelled the RAF to re-establish 12 Squadron and prepare for a long haul based on one squadron deployed at any given time, one in preparation and the third on stand-down. HQ 1 Group maintained the Tornado force at 45 crews and around 390 engineers in total.⁶

By September, the creation of a counter-ISIL coalition was under active discussion between a number of western and Middle East states, and at Al Udeid the CFACC had been tasked with the integration of coalition air assets. The presence of 83 EAG and the RAF's close association with the USAF in the Gulf proved especially advantageous at this point, providing senior British officers with the clearest possible visibility of air planning developments and a direct insight into more detailed tactical matters. By the 11th, the scale of Australian and French contributions had been clarified, and such issues as basing and overflight clearance were being addressed. Their resolution over the following days allowed the French Air Force to attack ISIL targets in Mosul on the 19th, while other coalition nations mounted their first strikes on the 23rd.⁷ By then, US aircraft were also targeting ISIL in Syria.

On the 25th, the British government approved the use of military force against ISIL in Iraq – but not Syria – and parliamentary approval was received on the 26th.⁸ CDS was duly authorised to execute Operation Shader, and an Execute Order was then issued for air strikes in Iraq, covering self-defence (including the defence of coalition partner forces on the ground – so-called Persons of Designated Special Status, or PDSS), planned attacks, dynamic strikes on emerging targets and combat engagement.

The new operation upset the RAF's command plans for 83 EAG, which were based on a low-intensity post-Herrick presence in the Gulf. The UK Air Component Commander (UKACC) and Air Officer Commanding 83 EAG, Air Commodore Alan Gillespie, was due to yield his appointment to Air Commodore Martin Sampson in December, when the post duration was to

be extended from one to nearly two years. This represented a long tour for an overseas commander during a period of heightened operational activity; it is easily forgotten that UKACCs only served for six months during the early stages of Operation Herrick. When Air Commodore Sampson handed over the post to Air Commodore Johnny Stringer in October 2016, it reverted to a one-year appointment. Stringer was followed by Air Commodore Roddy Dennis in October 2017, and the UKACC during the final months of the caliphate's existence was Air Commodore Justin Reuter.

RAF GR4s initially carried weapons over Iraq on 27 September 2014 and first engaged targets on the 30th, striking a heavy machine gun position and a militarised SUV ('technical') with Paveway 4 bombs.⁹ The pattern for the future was thus largely set, for the vast majority of GR4 strikes targeted small, mobile (or at least temporary) and ad hoc tactical targets. The 500lb Paveway 4 and smaller Dual Mode Seeker Brimstone (DMSB) munitions were most regularly used; DMSB was replaced by Brimstone 2 in 2016. By the end of September, the GR4s had flown 252 operational hours on counter-ISIL missions, but concerns over the sustainability of their flying rate were already emerging. On 2 October, the Prime Minister announced the dispatch of two more aircraft.¹⁰

During the early months of Operation Shader, the volume of coalition air strikes on ISIL targets was restricted by a lack of ISR resources in theatre. At that time, the RAF was operating a detachment of Reaper RPAS in support of ISAF and other ground forces in Afghanistan. Missions were remotely piloted by 39 Squadron from Creech Air Force Base, Nevada, and 13 Squadron from RAF Waddington. The RAF's Reapers were originally to be recovered from Kandahar to the UK at the end of the ISAF mission. However, in October, the recovery plan was abandoned in favour of a phased move from Kandahar to the Gulf so that they could fly in support of Shader. Together with other RAF ISR assets, Reaper was authorised to collect intelligence against ISIL in Syrian airspace; like the GR4s, they were only authorised to release weapons over Iraq.¹¹

RAF Reaper support for Shader commenced in the fourth week of October, and armed missions began early the following month. They were chiefly tasked in support of US Special Operations Forces (SOF) or the coalition Land Component Headquarters, and their targets for both intelligence collection and air strikes ranged from rank-and-file ISIL fighters or their equipment to so-called 'High-Value Individuals' – middle-ranking or more senior leadership. They also provided target designation and positive identification of ISIL forces for other coalition aircraft, and over-watch of

friendly force positions. At first, they were armed with Hellfire missiles alone, but mixed bomb loads including the 500lb laser-guided GBU-12 were soon approved so that Reapers could strike larger ISIL targets at locations where there was no risk of collateral damage.¹²

Command and control arrangements for the US-led coalition employed a familiar model. The operational construct of Inherent Resolve was guided by the principle of achieving campaign end states ‘by, with and through’ partnered Iraqi and Syrian forces. This removed much of the risk, cost and accountability of deploying large numbers of boots on the ground in combat roles. The counter-ISIL military campaign was based on a US SOF methodology that featured ‘accompany’ as a core tenet. In Iraq and Syria, this involved coalition personnel moving forward with the Forward Line of Own Troops (FLOT), assisting with the planning of tactical actions and accompanying indigenous ground forces into contact with the enemy.¹³ The coalition elements involved were substantially drawn from the SOF or other Special Forces. Coalition ground units were otherwise employed to train Iraqi, Kurdish and Syrian forces opposed to ISIL. By an enormous margin, air power provided the coalition’s primary combat contribution.

Nevertheless, the operation was placed under a Combined and Joint Task Force Commander (Commander CJTF), and this post was assigned to a US Army officer, initially Lieutenant General James L. Terry. He exercised command from his Baghdad headquarters and Joint Operations Centre (JOC), in his view, ‘a headquarters of more than a 40-nation coalition that is designed to integrate our collective military capabilities to defeat ISIL’.¹⁴

Yet the CJTFHQ evolved from a Land headquarters even though the majority of under-command combat elements were in the Air Component, and despite the existence of a distinct Combined Forces Land Component HQ (CFLCHQ) and Special Operations Joint Task Force HQ (SOJTFHQ).¹⁵ Starting at the top, land representation in the CJTFHQ was surprisingly large given the absence of coalition ground forces. It was mainly staffed on a rotating basis by US Army corps command groups. Furthermore, although the Deputy Commander Operations and Intelligence at the CJTFHQ was a USAF officer, the Commander CJTF’s authority over future weight-of-effort allocation was absolute, and his headquarters produced levels of guidance so prescriptive that they substantially dictated air apportionment.

Several factors contributed to this situation. One key point was that AFCENT, the USAF formation with theatre responsibility, had jurisdiction over an area far beyond Iraq and Syria – an area that extended to Afghanistan in the east and Yemen in the south. The AFCENT CAOC at Al Udeid existed

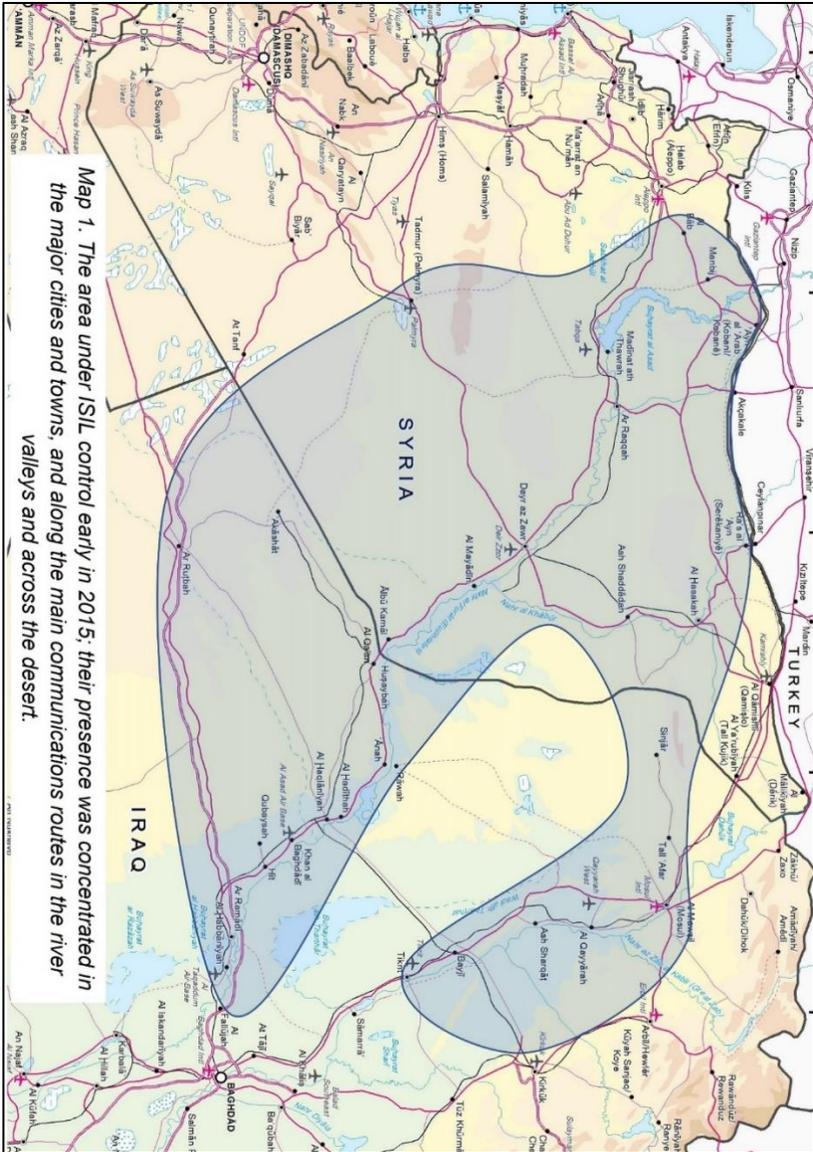
to command and control air assets right across this huge region; the USAF did not have a separate deployable headquarters to run individual operations. Yet at the same time it appears that one of the more important air command and control lessons of the war in Afghanistan had quickly been forgotten. In Afghanistan, several years passed before the USAF succeeded in positioning staff in the key planning cells at HQ ISAF and HQ ISAF Joint Command.¹⁶ In Operation Shader, according to a USAF-sponsored study prepared by the RAND Corporation, many positions earmarked for airmen on the task force staff were left unfilled because the USAF initially did not prioritize filling the billets. It was not until the autumn of 2017 that the USAF Chief of Staff, General David Goldfein, took steps to rectify this issue, with the result that 109 posts were filled at the CJTFHQ.¹⁷

Air power was delivered in support of a US campaign plan theoretically sequenced in terms of Iraq first and Syria second, with Degrade, Dismantle and Defeat phases for each. Yet military operations rarely conform to precise timetables and flowcharts, and it is thus not surprising to learn that the air effort was regularly apportioned and frequently shifted between both countries and all three phases simultaneously. The essential logic behind the ‘Iraq first’ strategy was that, from the outset, the coalition could operate in collaboration with an established government and a coherent ground force – albeit one that required considerable training, modernisation and expansion. By contrast, the Syrian task was immeasurably complicated by the ongoing civil war and the absence of governmental institutions or military forces that the coalition could support.¹⁸

The plan for Iraq envisaged securing the major population centres in the Anbar region, as far north as Haditha, while ‘shaping’^c operations isolated Mosul and prepared the battlespace for an assault on the city. At the same time, Kurdish forces would bring pressure to bear on ISIL in north-east Syria to prevent them from redirecting combat power towards Iraq. Once Mosul was liberated, ISIL would be defeated in northern Iraq, and Iraqi forces would establish control of the northern Iraq/Syria border to prevent further ISIL incursions. The culminating action would be the capture of the key border town of Al Qa’im.

c. Shaping operations are typically conducted in or around an area where future operations are being planned and are designed to gain or increase military advantage after the operation is launched.

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The Tornado GR4's RAPTOR reconnaissance pod being prepared for an Operation Shader mission in May 2015.



Tornado GR4s mounting their first armed mission in support of Operation Shader on 27 September 2014.

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A Tornado GR4 on the ground at Akrotiri on 4 March 2015.



GR4s tanking from a Voyager over Iraq on the same day.

From the outset, it was clear that campaign success would hinge on the synchronisation and coordination of effects across the land, airspace and information domains of Syria and Iraq. But while planning defined broadly how so-called ‘land effects’ were to be achieved, there was rather less clarity where ‘air effects’ were concerned, nor was it clear how land and air would be coordinated at the operational level to ensure that air power was integrated into the ground scheme of manoeuvre and not merely added on to it.

During these early months, coalition aircraft chiefly conducted ‘dynamic’ tasking. In other words, they were dispatched to attack emerging targets or fulfil support requests from troops on the ground, and ‘deliberate’ or planned strikes were rare. Throughout the operation, there were also hybrid systems, whereby approved targets were struck within the Air Tasking Order (ATO) cycle by aircraft formally assigned to dynamic missions. This approach was normally referred to as ‘deliberate on-call’, although the term ‘deliberate-dynamic’ was also employed during the battle for Mosul in 2016 and 2017. This was similar to the deliberate-dynamic targeting concept that emerged during Operation Unified Protector over Libya in 2011.¹⁹

Some early missions were tasked with X-INT,^d or what would once have been known as armed reconnaissance. In other words, they were sent to specified areas to find targets of opportunity, albeit with extensive intelligence support. Others operated in the X-CAS^e role. Coalition JTACS were not attached to forward Iraqi or Kurdish units until later in the campaign. Instead, so-called strike cells positioned in Baghdad and Irbil received requests for air support from forward troops that were studied and checked against intelligence sources – primarily Full-Motion Video (FMV) – and assessed against rigorous targeting criteria. Only then, if approved, could the request be submitted to the Air Component.²⁰

One of the key problems with this system was the high demand it generated for FMV to support target clearance and allow friendly ground forces to be tracked from the strike cells to ensure that they were not in potential target areas when they were bombed. As an elevated priority in the allocation of collection assets was also assigned to the immediate requirements of SOF units, the ISR resources available for longer-term target development were often extremely limited.²¹

Although numerous countries contributed to the counter-ISIL coalition, dynamic support to the ISF was only provided by the main contributing air

d. X-INT – Airborne Alert Interdiction.

e. X-CAS – Airborne Alert Close Air Support.

forces due to the testing nature of this targeting process and the overriding requirement to avoid civilian casualties. For the RAF, drawing on experience gained in Afghanistan, Libya and earlier operations over Iraq, dynamic targeting was relatively straightforward. It was also closely monitored via a range of intelligence feeds by targeting staffs at Al Udeid to ensure the appropriate level of restraint relative to the Law of Armed Conflict (LOAC) and Rules of Engagement (ROE). National oversight of deliberate targets was closer still. At first, many had to be referred back to the UK authorities for approval, although it was possible to relax this requirement somewhat as the campaign progressed.²² In their report on UK military operations in Iraq and Syria, the House of Commons Defence Committee recorded visiting the CAOC and discussing targeting criteria with the responsible staffs. As the Committee put it, ‘We were impressed by the care taken to minimise collateral damage and civilian casualties, which was at the forefront of all targeting decisions.’²³

The intensity of early air operations soon generated several significant challenges. By 22 November, while ISIL had sustained heavy casualties, the coalition had already employed more than 3,300 Precision-Guided Munitions (PGMs). When II(AC) Squadron returned from theatre to RAF Marham at the beginning of December, they recorded the expenditure of 39 Paveway 4s and 24 Brimstones over a period of just two months. This high consumption rate inevitably raised concerns about weapons stocks. More broadly, the exceptionally high operational tempo imposed considerable pressure on key UK command and control staff at Al Udeid and on GR4 engineering personnel at Akrotiri. To move on to a more sustainable footing, the CAOC agreed that RAF aircraft should not be assigned to combat tasking on one day in every seven, and a weekly GR4 maintenance day was instituted from 6 December.²⁴

Thereafter, the documents typically record a flying rate of two GR4 missions per day (four sorties) for six days per week – a total of 12 missions or 24 sorties. The detachment continued to operate eight aircraft and was established for 110 personnel. This provided greater resilience and allowed the GR4s to fulfil virtually all their tasked missions despite the inevitably rapid accumulation of flying hours. The impact of the high number of flying hours on the GR4 fleet was mitigated by distributing the hours across a wider fleet base of eight rather than six deployed airframes. Detachments of 12 additional aircraft engineering maintainers routinely deployed to Akrotiri for up to 183 days per year.²⁵

In the second week of December, 140 EAW was transformed into 903 EAW, reflecting Shader's evolution from a contingency operation to a long-term commitment.²⁶ Yet the commitment would soon be enlarged in response to strong AFCENT pressure for further RC-135 Airseeker deployments, airborne command and control in the form of RAF E-3Ds, and the Synthetic Aperture Radar (SAR) and Ground Moving Target Indicator (GMTI) capabilities of Sentinel. Co-location of Sentinel, RAPTOR-equipped Tornado GR4s and the TIW at Akrotiri would also create scope to fuse intelligence products there, augmenting the output of the Intelligence, Surveillance and Reconnaissance Division (ISRD) at Al Udeid. In January 2015, the Prime Minister duly announced that the UK's airborne ISR contribution to Shader was being increased.²⁷ HQ Air Command developed a series of plans to deliver a sustainable and enduring contribution to Shader from each deployed platform, based on the continuous presence of Tornado, Reaper and Voyager, and recurring E-3D, Sentinel and Airseeker detachments interspersed with periods of regeneration in the UK. The UK also helped to alleviate the strain on ISR resources by providing additional intelligence Processing, Exploitation and Dissemination (PED) capacity.

2. Halting ISIL

On the ground, the end of 2014 witnessed an all-out Peshmerga effort to liberate Sinjar and drive ISIL out of the Sinjar mountains. The bulk of coalition air tasking involved support for the offensive, and the RAF's Reapers played a particularly prominent part. On 28 September, one conducted overwatch for a coalition air strike on three ISIL buildings known to have been fortified as heavy machine-gun positions, and then mounted two strikes of its own using Hellfire missiles against ISIL ground forces.²⁸ On 8 January, a Reaper again provided targeting assistance to coalition fast jets in strikes against ISIL positions before executing another attack with Hellfire.²⁹

The Kurds next launched Operation Mekur Sur in Ninawa Province to extend their presence further south towards Mosul and secure the Kissik Junction, so disrupting ISIL lines of communication between Mosul, Tal Afar^f and Sinjar. The supporting air operations reached new levels of intensity, the Tornado GR4 detachment alone dropping 21 Paveway 4s and 10 Brimstones during January and collecting imagery that identified ISIL targets struck later by other coalition aircraft.³⁰ The RAF attacked targets in support of the Peshmerga on at least seven occasions during the month, targeting ISIL fighters, defensive positions, vehicles, checkpoints and observation posts.³¹

At the end of January, two RAF E-3Ds and 100 personnel from 8 Squadron joined 903 EAW.³² By then, the airspace over Iraq and Syria had been divided into three Battle Management Areas (BMAs); the E-3Ds were assigned to the western BMA until the beginning of September. Given the number of aircraft typically airborne in theatre (including Syrian, Iraqi and Iranian platforms) and the ever-present risk of mid-air collision, their role was of considerable importance. Aircraft such as the Tornado GR4 were equipped with Link 16, which reduced their dependence on dedicated airborne command and control to some extent, but many other air assets operating over Iraq and Syria were not Link-16 capable. In addition to airborne command and control, the Americans had established an airspace control and reporting centre known as Kingpin, which operated under the auspices of their 727th Expeditionary Air Control Squadron from Al Dhafra in the UAE.³³

f. Map spelling Tall Afar.

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In October 2014, RAF Reaper RPAS began a phased move from Afghanistan to the Gulf to operate in support of Shader.



RAF Reapers provided invaluable ISR and combat capabilities to the coalition.

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Coalition ISR resources were augmented further by the arrival of Sentinel at Akrotiri in March 2015.



For airborne command and control, 8 Squadron E-3Ds first deployed to Akrotiri in January 2015.

Inevitably, the winter months witnessed significant periods of weather disruption, yet in mid-February, when many coalition aircraft were grounded by poor weather, key RAF assets continued to fly. On one day when the weather reduced the availability of combat air power, Voyager refuelling of French and US Navy formations in southern Iraq ensured their continued availability for CJTF tasking, and the E-3Ds also maintained airborne command and control. Akrotiri's position west of the operational theatre proved particularly valuable when poor weather affected airfields in the Gulf and other parts of the Middle East, allowing the GR4s to continue flying when many combat aircraft were grounded. They also repeatedly extended their on-task periods to cover weather-related shortfalls in combat air coverage.

In March, the 5 Squadron Sentinel detachment deployed to Akrotiri, and operational flying began at the beginning of April. Although the original plan for Sentinel envisaged a period of six months in theatre and a flying rate of five sorties per week, the advantages of a lower flying rate and a more enduring deployment soon became clear.³⁴ In November, it was necessary to withdraw one of the two Sentinels to the UK to serve as a training aircraft, but the other remained in theatre.

During the first six months of Operation Shader, coalition aircraft executed more than 2,400 strikes in Iraq and Syria, 90 per cent of which were dynamic attacks under X-CAS or X-INT arrangements; 60 per cent of all dynamic strikes were executed in Iraq.³⁵ ISIL's heavy losses in this period led to a pronounced change in their tactics. They reduced the use of overt checkpoints and the number of vehicles in transit that could easily be associated with them and began using a limited amount of dummy military equipment. As the scope for finding targets of opportunity declined, so too did coalition X-INT activity. By March, it was clear that the task confronting the Air Component would require more sophisticated intelligence analysis and target development, and probably more combat aircraft too.³⁶

Yet there were numerous uncertainties, not least because the application of air power depended substantially on the development of counter-ISIL operations on the ground. This point was underlined in the first week of March, when the ISF launched an offensive to recover Tikrit without coordinating their plans with the coalition. As the Iran-backed Popular Mobilisation Forces (PMF) played a prominent role and were not viewed by the coalition as PDSS, the sudden demand for additional air resources was problematic, to say the least, and extended deliberations between the CJTFHQ and the CAOC did not immediately produce a solution. More than

a fortnight was required to realign coalition operations and secure an agreement with the Iraqis partially to withdraw the PMF.³⁷

Then, at the end of March, the ground scheme of manoeuvre was unexpectedly changed and accelerated again to permit more PMF involvement in the final assault on the city centre. Coalition air planning had to be adapted rapidly in response, but more effective collaboration with the Iraqis now allowed the operational environment to be accurately mapped and understood so that air action could be safely and effectively co-ordinated with surface fires and Iraqi ground and air operations west of the Tigris. To the east, the presence of the PMF still prevented coalition intervention.³⁸

Around Tikrit, ISIL had prepared a multitude of trench systems, defensive barriers and firing positions designed to funnel Iraqi forces into areas where numerous Improvised Explosive Devices (IEDs) had been planted, but their defences were successfully targeted from the air across a wide front. As part of the broader coalition air effort, the RAF's GR4 detachment flew 106 sorties and released 24 Paveway 4s and 11 Brimstones in March 2015.³⁹ On 26 March alone, they successfully targeted three ISIL strongpoints in the city; on the 29th, exploiting the precision of Brimstone, they destroyed an armoured personnel carrier concealed under a bridge.⁴⁰ The RAF's presence at Al Udeid, including their embedded personnel in the CAOC, allowed the assault to be closely monitored and helped the UKACC to gain confidence in the developing situation.⁴¹ This in turn enabled him and his subordinates to respond rapidly to Iraqi requests for air support. Tikrit was duly freed from ISIL control during the first week of April.

By 5 April, ground operations in Tikrit were chiefly a matter of consolidation and 'mopping up'. The PMF were again deployed alongside the ISF in this phase, which was largely land-specific, so combat air support from the coalition was withdrawn. The CFACC reapportioned fast air across Iraq and also reduced the level of FMV collection over Tikrit. Attention now turned towards the next northerly objective – Bayji – and the recovery of Fallujah and Hit to the west of Baghdad.

Analysis of coalition air strikes from October 2014 to April 2015 concluded that they had been balanced almost evenly across ISIL-held locations and had overwhelmingly struck fielded forces or targets in their immediate vicinity. This accorded with the Inherent Resolve operation plan, which referred to a so-called 'close battle' that encompassed decisive land operations, where the greatest effects would be achieved through information operations, air power and land power. Nevertheless, the plan also stressed the importance of a 'deep battle', using air power and information actions to

shape the environment. This was expected to exert a significant influence effect on ISIL. The plan also explicitly acknowledged the capacity of the deep battle to facilitate the close battle.⁴²

And yet, as early as the spring of 2015, it appeared to the CFACC that the air effort was being dispersed and was leaving some important and profitable deeper targets unscathed, notably those associated with oil production and trade – a significant source of ISIL revenue. His desire to attack the oil trade was reflected in tasking assigned to the RAF's Sentinels when they arrived at Akrotiri: their first missions were flown in the oil-rich Ninawa region, which surrounds Mosul, and Sentinel subsequently played a key role in gathering intelligence on ISIL's oil enterprise.⁴³

However, he faced challenges that extended far beyond intelligence collection. During more than a decade of counterinsurgency, coalition intelligence and targeting organisations had lost some of their capacity to support deliberate air operations against deeper or complex target sets, and the reconstruction of this capability inevitably took time. More broadly, the performance of the CENTAF CAOC had for many years been measured chiefly in terms of output rather than effect. Since the second Gulf War, output had overwhelmingly been expressed in volume or time measurements of Close Air Support (CAS) or ISR delivery to the Land Component, and successive coalition commanders had been content if they received enough tactical air support. In this context, the issue of *how* air power was employed or of whether it could be used more effectively had perhaps appeared rather less important than the basic task of generating sorties.⁴⁴ Reprioritising the deep battle implied a significant shift in the mindset of both the Land and Air communities and was always bound to be an uphill struggle.

Consequently, although the CFACC believed that a greater deep targeting effort was needed, particularly over Syria, it proved hard to realise his ambitions for the time being. Indeed, if anything, the scope for doing so declined further in May, when (in addition to the various Iraqi actions) the Kurdish Peoples' Protection Units (YPG)^g launched Operation Talon Anvil on Syria's northern border; a strike cell of the same name was established under US SOF auspices to feed targets to the Air Component.⁴⁵ This occurred just after the US aircraft carrier Theodore Roosevelt had been temporarily withdrawn from the Gulf for tasking off Yemen.⁴⁶ Coalition air power was

g. The YPG was established in 2011 to protect Kurdish-inhabited areas in northern Syria. It expanded in subsequent years, particularly in response to the threat posed by Islamic fundamentalists and, ultimately, ISIL.

thus stretched still further, with single formations (including RAF GR4s) often maintaining high-priority Combat Air Patrols (CAPs).

The pressure on coalition air resources was revealed all too clearly during the fighting around Baiji in April and May. Although, theoretically, plenty of aircraft were available to support the ISF, many coalition members were prevented by national restrictions from executing attacks on the oil refinery – Iraq’s largest – where much of the fighting occurred. At first, relatively few assets were cleared to strike what were often small and fleeting targets located in a confined but complex area, even though the refinery was non-operational, and the Iraqi government was prepared to accept proportionate damage to the facility. The same problem subsequently emerged when ISIL captured Ramadi on 17 May, taking possession of key government and administrative buildings. Although many of the restrictions were promptly relaxed to allow ISIL to be engaged, earlier air intervention at both locations would have been advantageous.

While something of a stalemate subsequently endured on the ground in Iraq, the RAF consolidated its role as a major ISR provider. By 24 May, RAF ISR assets were delivering a proportion of the coalition’s air-collected SAR, GMTI, FMV and SIGINT exceeded only by the USAF; the 8 Squadron E-3Ds were also providing 15 per cent of airborne command and control.⁴⁷ When opportunities arose to cross-cue between assets, they were readily exploited. By June, RAF RC-135 Airseekers, Reapers and Sentinels were operating over Syria and Iraq, and the E-3Ds were providing tactical air C2 over Syria while airborne over Iraq. Thus, while RAF aircraft were still unable to attack targets in Syria, their role in Syrian airspace was increasingly important. Approval to fly over Syria allowed RAF ISR assets to approach the entire theatre of counter-ISIL operations as a single battlespace – an advantage then shared by few other coalition air forces where ISR was concerned. In July, addressing the Royal United Services Institute, the Secretary of State for Defence revealed that the RAF was ‘delivering in total 30 per cent of the ISR of the whole international operation’.⁴⁸

In the meantime, the absence of RAF combat aircraft was not especially significant in mid-2015, given the prevailing direction from Commander CENTCOM and the CJTFHQ to eliminate ISIL opposition in the main contested areas of Iraq. The GR4 detachment’s contribution to the achievement of this goal was perfectly illustrated on 7 June, when they destroyed an ISIL position in defence of Peshmerga forces near Sinjar and then repositioned to strike a target at the Baiji oil refinery – a building where ISIL fighters were assembling and preparing to attack an ISF unit. Both air

strikes were executed at night; they were 150 NM apart and were coordinated within the space of 34 minutes through the Baghdad and Irbil strike cells (see Map 2).⁴⁹ Few coalition partners could have matched this level of sophistication. Nevertheless, the extension of such capabilities to Syria would clearly have been valuable.



Map 2. The 7 June Tornado GR4 mission was executed at night and successfully struck targets 150 NM apart at Sinjār and Bayji in just 34 minutes.

The balance between resources and commitments was never far from the minds of coalition air commanders in the summer of 2015. RAF expenditure of Paveway 4 munitions continued to climb, generating renewed concerns over the depletion of stocks and prompting MOD measures to replenish

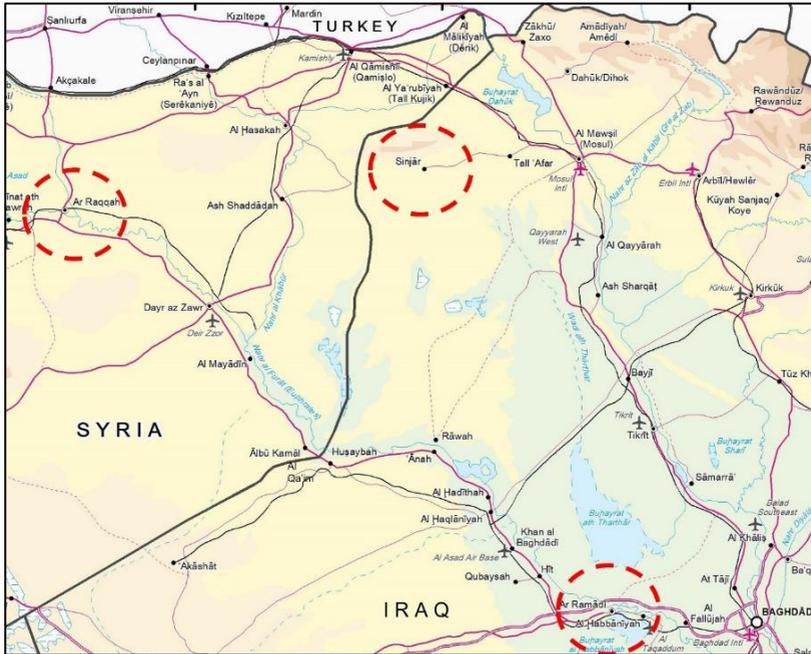
them.⁵⁰ Yet the geographical spread of counter-ISIL operations and the coincidence of multiple tactical actions generated more immediate problems, and it became clear that several members of the coalition were operating at the very limits of sustainability. A single week witnessed the E-3Ds regularly lengthening their time on station to the maximum extent possible due to the delayed arrival of other air command and control assets, GR4s striking deliberate targets originally assigned to coalition partners, and constant re-tasking of GR4 RAPTOR missions to CAS when other aircraft were unable to fulfil the requirements of the ATO.

To make better use of existing resources, certain states increased the capabilities and targeting permissions on offer to the CFACC, and a new system of CAS allocation was introduced in an attempt to limit the number of flying hours expended on CAS missions. The pressure on resources was equally apparent where ISR was concerned. The constant clamour for tactical FMV continued to divert RPAS platforms like Reaper and Predator away from deeper tasking of potential operational value.⁵¹

By the end of June, the first phase of Operation Talon Anvil had drawn to a successful close, illustrating the considerable potential of the YPG backed by coalition air power. By mid-July, operational planning was crystallising around four fronts – the main ground operations in the Ramadi and Sinjar areas, deeper targeting around Raqqa and support for the US-backed New Syria Forces, which were to be inserted into Syria following training in Turkey. Their story lies beyond the scope of this narrative.

The assault on Ramadi became the primary coalition focus in Iraq, although fighting also continued around the Bayji oil complex. As the PMF presence in Tikrit had proved more of a hindrance than a help, the Iraqis were persuaded to mount the operation with conventional army formations and Special Forces; the trade-off for the loss of PMF troops would be a substantial increase in coalition air support. Yet ISIL were well dug in, and the ISF were confronted by roadblocks, defensive berms and IEDs. By this stage, too, ISIL were regularly employing 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. ISIL UAS tended to be cheap, off-the-shelf commercial fixed-wing systems or quadcopters. One downed UAS was described as a Chinese Talon X with a payload of a Go-Pro camera, two pinhole cameras, a long-range RF transmitter and a GPS module. The basic platform and all its equipment could easily have been bought online. It soon became clear that the proliferation of UAS was increasing ISIL's general military effectiveness,

not least by improving their tactical situational awareness and ability to collect intelligence.⁵²



Map 3. In July 2015, coalition air power was committed to operations in the Sinjar and Ramadi areas, and there was some deeper targeting against Raqqa.

The isolation of Ramadi was a more straightforward task than its ultimate capture, which was only achieved following an exceptionally challenging period of urban warfare that consumed coalition resources without much obvious gain. In northern Iraq, the coalition mounted Operation Lagertha on 4 August against ISIL positions near Sinjar, co-ordinating Peshmerga land fires with air strikes on multiple targets. Additional air attacks were subsequently required. A further operation named Biollante in the final week of August was more successful and allowed Peshmerga fighters to advance rapidly and seize approximately 250 square kilometres of terrain. In support, on the 26th, RAF Reapers executed five strikes on ISIL forces manoeuvring on foot and in vehicles in open desert.⁵³

Meanwhile, on 21 August, two British ISIL fighters, Reyaad Khan and Ruhul Amin, were killed in an RAF Reaper strike over Raqqa, Syria – the first targeted strike by the RAF on British citizens. A third Briton, Junaid Hussain, was killed in a separate US air strike. The attack was not executed as part of broader coalition operations but as an act of UK self-defence. Addressing Parliament, the Prime Minister stated:

Both Junaid Hussein and Reyaad Khaan were British nationals based in Syria who were involved in actively recruiting ISIL sympathisers and seeking to orchestrate specific and barbaric attacks against the west, including directing a number of planned terrorist attacks right here in Britain, such as plots to attack high-profile public commemorations, including those taking place this summer. We should be under no illusion. Their intention was the murder of British citizens.⁵⁴

At the beginning of September, the stalemate in central Iraq provided a welcome opportunity for the Air Component to engage deeper ISIL targets on a scale hitherto unknown. Week on week, there was a 30 per cent reduction of coalition hours flown over Ramadi but a 50 per cent increase in the number of targets struck across the operational theatre.⁵⁵ Indeed, despite the static situation on the ground, the coalition air effort increased to a new high, and the RAF released more munitions than in any month since the start of Shader – a total of 60 across the GR4 and Reaper detachments. Targets extended from western Iraq to supply boats and stockpiles along the Euphrates, to Bayji, and to more northern areas around Mosul and Sinjar.⁵⁶ The evidence seemed to suggest that air power could exert the greatest pressure on ISIL when it was employed flexibly for both CAS and a range of interdiction strikes. Moreover, untethering ISR from directly supporting the ISF had proved particularly beneficial, enabling deeper targets to be identified, developed and attacked, and sustaining the attrition of ISIL fighters, equipment and stores despite the lack of progress in Ramadi. The RAF's Reapers released only 17 munitions in July 2015 but 37 in September.⁵⁷

Historically, areas of weak government, instability or civil war have tended to function as vacuums that relentlessly draw intervention from surrounding countries or other interested power brokers. From the autumn of 2014, Iran-backed militias supported the Iraqi armed forces in their defence

of Baghdad and in other operations. But the second half of 2015 witnessed foreign intervention on a far larger scale, appreciably complicating the coalition's task.

In mid-July, after a period of negotiation, Turkey offered extended basing to the Americans – a valuable concession that undoubtedly benefited the counter-ISIL campaign. However, shortly after the deal was concluded, the Turks launched a series of air attacks in northern Syria and Iraq, targeting both ISIL and the Kurdish separatists of the Kurdistan Workers' Party (PKK).⁵⁸ Although Turkey was a member of the coalition, these strikes were mounted unilaterally, and the CAOC received only a generalised warning at the last minute. In broad terms, the coalition could only welcome the attacks on ISIL, although the prospect of further Turkish operations raised issues of co-ordination and deconfliction that had to be addressed over the following weeks and months; but strikes on Kurdish separatists were more problematic given the Kurds' commitment to fighting ISIL on the ground – with coalition support – in northern Iraq and Syria.

Within the CJTFHQ, Turkey's activities were viewed as inconvenient but manageable. The next foreign intervention was a source of greater concern. During the third week of September, large-scale Russian air and aviation deployments began into Bassel Al Assad airfield in Syria.⁵⁹ By the 20th, SU-30 and SU-25 fighters, MI-8 and MI-17 rotary assets, main battle tanks and armoured personnel carriers had all been observed at the airfield, and the strength of Russian capabilities in Syria was increasing swiftly and significantly. On the 27th, Russia, Iran, Iraq and Syria signed an intelligence and security co-operation pact primarily targeting ISIL.⁶⁰ Nevertheless, the Russian deployment was chiefly designed to strengthen the Syrian regime, giving it a decisive upper hand in the civil war that had been raging since 2011. On the 28th, President Putin addressed the United Nations General Assembly, denouncing the US-led air strikes on ISIL as illegal and arguing that foreign intervention should support President Assad of Syria rather than the Syrian opposition.⁶¹

At first, it seemed likely that the Russian presence would impose severe limitations on coalition air activity over Syria, but such fears were to prove exaggerated until the later stages of operations against the caliphate. The CFACC urged other coalition air commanders to stay the course and view Russian activity only as a distraction; the key was to concentrate on the primary mission, the defeat of ISIL. Reflecting this general philosophy, the coalition maintained its support for YPG ground operations, and planning began to resupply them by air to enable further advances against ISIL into

northern Syria.⁶² There was also an increased focus on deliberate targeting against ISIL's oil infrastructure in Syria (Operation Tidal Wave II), and other coalition members extended the scope of their operations in Syrian airspace.⁶³ During the fourth week of September, approximately 30 per cent of the coalition's air effort was applied over Syria.⁶⁴

By 18 October, there was reason to be cautiously optimistic about the establishment of effective flight safety procedures over Syria, despite the Russian presence. On the 20th, the American and Russian authorities signed a Memorandum of Understanding, which formally instituted a range of deconfliction measures. By this time, there was already a so-called 'hotline' between the CAOC and the Russian Air Defence Control Centre, providing an immediate communications route that could be employed in the event of any difficulties and a medium for twice daily routine conversations.⁶⁵ Yet there were extensive changes in the Syrian Integrated Air Defence System (IADS) after the Russian deployment, including the appearance of additional Surface-to-Air Missile (SAM) systems that posed a particular threat to manned ISR assets – a fact that was eventually illustrated all too graphically when the Syrians mistakenly shot down a Russian Il-20 in September 2018.⁶⁶ Although intelligence assessments concluded that neither the Syrians nor the Russians intended to target coalition aircraft, their tactical freedom was sometimes restricted, albeit temporarily. Each additional SAM presented new tactical and operational challenges that required appropriate coalition responses.⁶⁷

3. Ramadi, the SDF and the Expansion of UK Air Operations

After a period of reorganisation, the ISF resumed their efforts to capture Ramadi. They achieved some early progress, but this period witnessed a sharp increase in their demand for air support, which again occurred at an inopportune moment for the CFACC. It coincided not only with the programmed departure of certain coalition aircraft but also with another temporary withdrawal of US carrier-borne airpower.⁶⁸ There was also a further notable development on the ground. This was the foundation of the Syrian Democratic Forces (SDF), an alliance (brokered substantially by the coalition) of anti-ISIL and Syrian rebel groups of which by far the strongest element was the Kurdish YPG. From then on, coalition air and SOF operations extending from northern Iraq into Syria would be conducted in support of the SDF.⁶⁹

On 12 October, they received their first supply drop from USAF C-17s, which delivered some 100 pallets with 45 tons of arms and ammunition.⁷⁰ However, there were limitations to the material support that could at first be provided. Unwilling to antagonise Turkey, the US administration of Barack Obama publicly declared that weapons would only be supplied to non-YPG elements of the SDF. While it seems likely that at least some of these later found their way into YPG hands, and YPG weapons acquisition has since been the subject of much discussion in open sources, the fact remains that the SDF initially possessed few heavy weapons.⁷¹ Consequently, their operations were bound to generate an increased requirement for combat air power and supporting ISR that would stretch the Air Component's resources further still.

Despite the reduced number of coalition strike aircraft in theatre, November 2015 ushered in a period of particularly intense air-to-ground combat. In the first week alone, RAF force elements delivered a record number of strikes in a seven-day period – 27 in total, involving Paveway 4, Hellfire, GBU-12 and Brimstone. Targets ranged across the spectrum from fielded forces, weapons caches, occupied buildings and IEDs, to moving and static ISIL vehicles.⁷² There were further periods of poor weather, but the GR4s still flew 22 of their 24 tasked missions.⁷³ The coalition found more opportunities to strike at ISIL for three basic reasons – geographical concentration of friendly force activity, effective exploitation of 'weather windows' and developing ground force capabilities and competences.

Notably, after the recapture of Bayji, it was possible to focus ground operations concurrently around the two key areas of Sinjar and Ramadi. Both were of great importance to ISIL, and their efforts to stand, fight, reinforce and resupply them generated abundant targeting opportunities. If the target areas had been more numerous or widely dispersed, the coalition's task would have been far more difficult.

On 5 November, a Ministry of Defence brief described how the RAF's GR4s and Reapers had been active on both fronts.

A particular focus has been around Sinjar city, in preparation for a large Kurdish offensive to drive ISIL from their remaining positions in the southern part of the town. ISIL positions in and around Sinjar have been methodically targeted by coalition aircraft ahead of the ground assault by the Kurdish security forces. As part of these preparations for the Kurdish attack, Tornado GR4s from RAF Akrotiri were able, despite bad weather, to use Paveway 4 guided bombs against a pair of ISIL fortified positions near Sinjar; the Kurdish unit whom the GR4s were supporting confirmed that both terrorist positions had been destroyed.⁷⁴

The exceptionally high tempo continued, encouraged by progress on the ground in the north, where Sinjar was finally liberated (Operation Dweller), and in Ramadi. At the same time, via deliberate targeting, coalition aircraft struck a further series of oil-related targets. In the third week of the month, there were more than 900 coalition air strikes, and the proportion of strike formations releasing weapons neared 70 per cent; in September the figure had been just 45 per cent. Ultimately, throughout November as a whole, RAF combat aircraft delivered the UK's largest monthly strike contribution since the start of Shader. The 80 targets they attacked represented twice the average monthly figure for 2015.⁷⁵

Although the broad range of strike options offered by the RAF was extensively exploited over Iraq, the GR4 and Reaper detachments were still side-lined when the coalition's focus swung towards Syria. On one occasion in November, GR4s airborne over north-western Iraq were unable to assist SDF forces engaged by ISIL just seven miles inside the Syrian border. Fortunately, this scenario would never be repeated. On 13 November, Paris was targeted by a series of terror attacks that left 130 people dead and hundreds wounded. ISIL claimed responsibility. On the 20th, United Nations

Security Council Resolution 2249 was unanimously adopted to ‘redouble’ action against ISIL. The resolution, drafted by the French government but co-sponsored by the UK, urged UN members to ‘take all necessary measures’ in the fight against ISIL and called on member states to ‘eradicate the safe haven’ ISIL and other militant groups had established in parts of Iraq and Syria. The Prime Minister subsequently sought to build cross-party support for UK air strikes against ISIL in Syria, fielding questions on the subject from 103 MPs in the House of Commons on 26 November and setting out a detailed written case for the use of force in a 32-page response to a report by the Commons Foreign Affairs Select Committee.

Mr Cameron pointed out that, with coalition air support, Iraqi and Kurdish forces backed by coalition air power had halted ISIL’s advance and recovered 30 per cent of the territory it had captured in Iraq.

Together with the RAF’s Reaper drones, RAF Tornados have flown more than 1,600 missions over Iraq and carried out over 360 air strikes. RAF aircraft have destroyed ISIL targets in Iraq, including: key positions holding up Iraqi Security Forces on the ground (e.g. the last remaining stronghold in Rabiya, which allowed the Kurdish Peshmerga to successfully liberate the town); large stockpiles of ammunition and explosives; several underground bunker and tunnel networks; and supply boats attempting to smuggle large quantities of ammunition down the Euphrates to isolated terrorists in Ramadi.⁷⁶

At the same time, he argued that the RAF was being handicapped in its ability to target ISIL by the fact that it was only authorised to use force over Iraq. This restriction had never made military sense. ISIL did not recognise the border between Syria and Iraq and operated over ungoverned space that straddled both countries. Its practical and ideological headquarters was in Raqqa, in eastern Syria, from where it conducted operational command, planning and recruitment. Following the passage of UNSCR 2249, the US and France were developing an appropriate military response and had asked the UK to join them, and there was also regional support for the extension of RAF air strikes to Syrian territory. Mr Cameron felt that it was ‘wrong for the United Kingdom to subcontract its security to other countries, and to expect the aircrews of other nations to carry the burden and the risks of protecting our country’.⁷⁷

In the wake of the Paris attacks and the new UNSCR, Mr Cameron's arguments won over Parliament, which voted to authorise RAF air strikes against ISIL in Syria on 2 December. The successful motion offered assurances that the government would not deploy UK troops in ground combat operations. In his opening statement to the Commons debate, the Prime Minister also declared that ISIL would in future be known as Daesh. As he put it, 'This evil death cult is neither a true representation of Islam nor is it a state.'⁷⁸ The term 'Daesh' also had negative connotations in the Middle East.

UK targeting permissions were revised in conformity with the parliamentary vote. The government also extended the Tornado GR4 commitment again, pushing back 12 Squadron's retirement into 2018, and approved the dispatch of two additional GR4s and six Typhoons to Akrotiri along with the necessary personnel and equipment. The aim was to raise the Operation Shader strike sortie rate to three GR4 pairs and two Typhoon pairs per day for six days per week. The Typhoons were to deploy on an enduring basis, while the two extra GR4s were to be sustained in theatre for 90 days.⁷⁹

While the Typhoon had demonstrated an impressive air-to-ground capability during Operation Ellamy in 2011 and was a far more modern platform than the Tornado GR4, it was not a purpose-built bomber. Indeed, it was originally designed for air defence, and its adaptation for the ground-attack role was still quite a recent development in 2015. It was not yet cleared to carry the same variety of weapons employed by the Tornado GR4s, and some Typhoon pilots lacked air-to-ground combat experience. Yet the Typhoon force also possessed attributes that proved very valuable in Shader – especially its air-to-air combat capability. RAF Typhoons would regularly be tasked in Defensive Counter-Air (DCA) or combined DCA and air-to-ground roles during the later stages of the operation.⁸⁰ The Typhoons deployed on 3 December and flew their first operational mission within 24 hours, carrying Paveway 4 bombs as well as Advanced Medium Range and Advanced Short Range Air-to-Air Missiles (AMRAAM and ASRAAM).⁸¹

Less than three hours after the vote in Parliament, a pair of GR4s successfully struck targets in the Omar oilfield in Syria, which was one of the largest and most important sources of Daesh revenue, representing over 10 per cent of their potential income from oil. With AAR from Voyager and support from other coalition aircraft, including RAF Reapers, the GR4s released Paveway 4s against six aiming points in the oilfield. Another pair of GR4s provided three hours of CAS coverage in northern Syria. The following day witnessed further attacks on the oilfield, several of which were

executed by Typhoons.⁸² The immediate deployment and next-day delivery of operational kinetic effect in Syria by Typhoons as well as GR4s sent a strong message of UK intent to the coalition. The RAF could now offer up to 15 hours of strike cover per day, equating to 17 per cent of daily coalition strike capacity.⁸³

A snapshot of RAF activity on the evening of 4 December perfectly illustrates the greater scope and flexibility provided by the parliamentary vote and how rapidly it was exploited. The ability to operate freely across the Iraq/Syria border provided immense tactical advantages. Within a period of just 23 minutes, GR4s executed a deliberate strike in Syria and relocated to provide CAS in central Iraq. Typhoons mounted a deliberate attack in Syria before flying on for CAS tasking in northern Iraq. Meanwhile, a Reaper located and destroyed a Vehicle-Borne IED (VBIED) before it could be used against Peshmerga forces, a second Reaper conducted ISR over Raqqa and a third supported a coalition ground operation in central Iraq. Later, RAF Typhoons were sent back into Syrian airspace.⁸⁴

In the following week, around 60 per cent of RAF strike missions were tasked or re-tasked across the Iraq/Syria border after take-off. By then, the two extra GR4s had also deployed to generate a temporary surge involving a 50 per cent increase in GR4 tasking. Extended flying rates were authorised, and many 31 Squadron aircrew ultimately flew more hours during their 90-day deployment period than they would have flown in two years in the UK. Inevitably, this was a challenge that required a phenomenal effort by all concerned. Below, 31 Squadron's Operation Shader statistics are compared with those of 9 Squadron for the preceding 90-days.⁸⁵

9 Squadron

Sorties flown	Hours flown	Weapons employed
296	1659:05	122

31 Squadron

Sorties flown	Hours flown	Weapons employed
436	2649:15	210

It was typical of Operation Shader that, soon after the UK strike permissions were extended to Syria, the coalition's focus should have switched back towards Iraq. By mid-December, the predominant weight of air effort again involved support for the ISF ground assault on Ramadi and, in the north, Peshmerga operations near Sinjar, Tal Afar and Mosul. On 16 December, there were particularly intensive air operations in the north in response to an attempt by Daesh to breach Peshmerga front lines near Bashiqaq, north-east of Mosul. All the main RAF combat, ISR and AAR capabilities were brought to bear, and two Reapers, four Tornado GR4s and four Typhoons released munitions.⁸⁶ Overall, the coalition effort resulted in an estimated 187 Daesh killed in action and the destruction of 8 vehicles, 4 bulldozers and 3 VBIEDs. The cost to the Peshmerga of preventing Daesh territorial gains amounted to around 50 killed and 60 wounded.⁸⁷

By contrast, deliberate and dynamic targeting over Syria declined. To allow a period of assessment, there were fewer strikes on oil-related targets; initial indications suggested a fall in Daesh-controlled oil output of about 33 per cent, equating to a loss of \$14 million per month in revenue.⁸⁸ At the same time, the coalition's Allies on the ground in Syria paused to allow preparation for the next phase of Talon Anvil, which targeted Shaddadah. The RAF used this opportunity to make preparations of their own for the provision of air support to the SDF when Talon Anvil resumed.

The struggle for Ramadi continued into January. Although Daesh forces had largely been overwhelmed by that time, there were still some extremely stubborn pockets of resistance as well as the inevitable IEDs and booby traps, and it proved necessary to clear the city systematically from west to east. A complicating factor was the early return of civilians to the area. The demand for air support was frequent and largely occurred in defence of friendly ground forces being targeted by active Daesh positions. Considerable destructive force was sometimes needed, but RAF aircrew and the responsible Al Udeid staffs continued to examine every request for air support in meticulous detail to minimise the risk of civilian casualties.

In the second week of the month, Daesh sought to exploit the civilian presence by herding some of Ramadi's inhabitants and using them as human shields. After further heavy fighting, during which the RAF struck command posts, defences, vehicles, VBIEDs and staging locations,⁸⁹ the ISF declared on the 27th that Daesh had been expelled from the city centre, but hundreds of fighters remained at large. A further week of clearance operations with coalition CAS was required before Ramadi was finally liberated.⁹⁰

The Royal Air Force in Operation Shader



Typhoons first deployed on Operation Shader in December 2015; here, two 6 Squadron aircraft taxi past the Akrotiri control tower.



A Typhoon taking off from Akrotiri with an impressive array of stores.

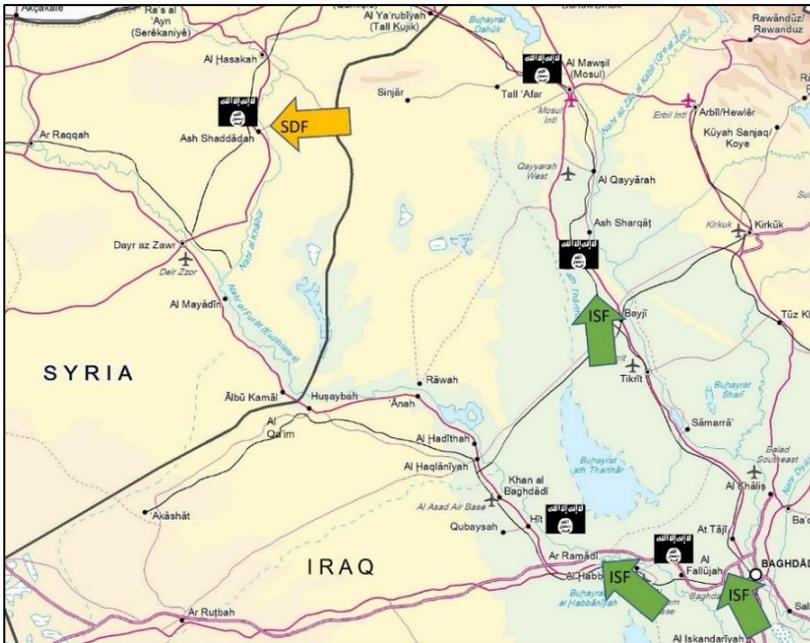
The Royal Air Force in Operation Shader



Typhoons airborne on Operation Shader; visible weapons include Brimstone 2.



Two Typhoons arriving to receive fuel from a USAF KC-10 Extender on 7 August 2017.



Map 4. After evicting Daesh (symbolised by their black and white flag) from Bayji, the ISF turned their attention to Ramadi; in the north, the SDF prepared for their offensive against Shaddadah.

In the context of the UK's extension of air strikes into Syria in December, the renewed orientation towards Iraq was somewhat inconvenient from the RAF's perspective. Yet it is important to remember that the campaign was enemy-focused and that the tactical situation on the ground in Iraq was now offering abundant opportunities to target Daesh. In any case, operations over Syria did not cease entirely. While Daesh continued to hold out in Ramadi during January, the next SDF offensive began and made rapid progress. The RAF supported their advance, assisted with target development in Syria and attacked Daesh checkpoints in the east; moreover, they contributed to the destruction of equipment being used to repair damage inflicted by Operation Tidal Wave II on Daesh oil revenues, and to a separate series of operations that targeted Daesh Ground Lines of Communication (GLOCs) in the areas of Al Qa'im and Abu Kamel, on the Iraq-Syria border.⁹¹ At this stage of

Shader, only US aircraft were authorised to conduct an equally broad range of missions in Syrian airspace.

The liberation of Ramadi did not at first seem to be more than a single step on the long and drawn-out path towards the eradication of Daesh in Iraq. Fighting continued elsewhere in such towns as Haditha and Hit, and while the ISF had initiated operations to isolate Fallujah by the end of the month, the established pattern of urban warfare continued with its innumerable complications. Meanwhile, intelligence suggested that Daesh were preparing counter-offensives – in part to distract the ISF and the Peshmerga from reorientating their efforts towards Mosul.

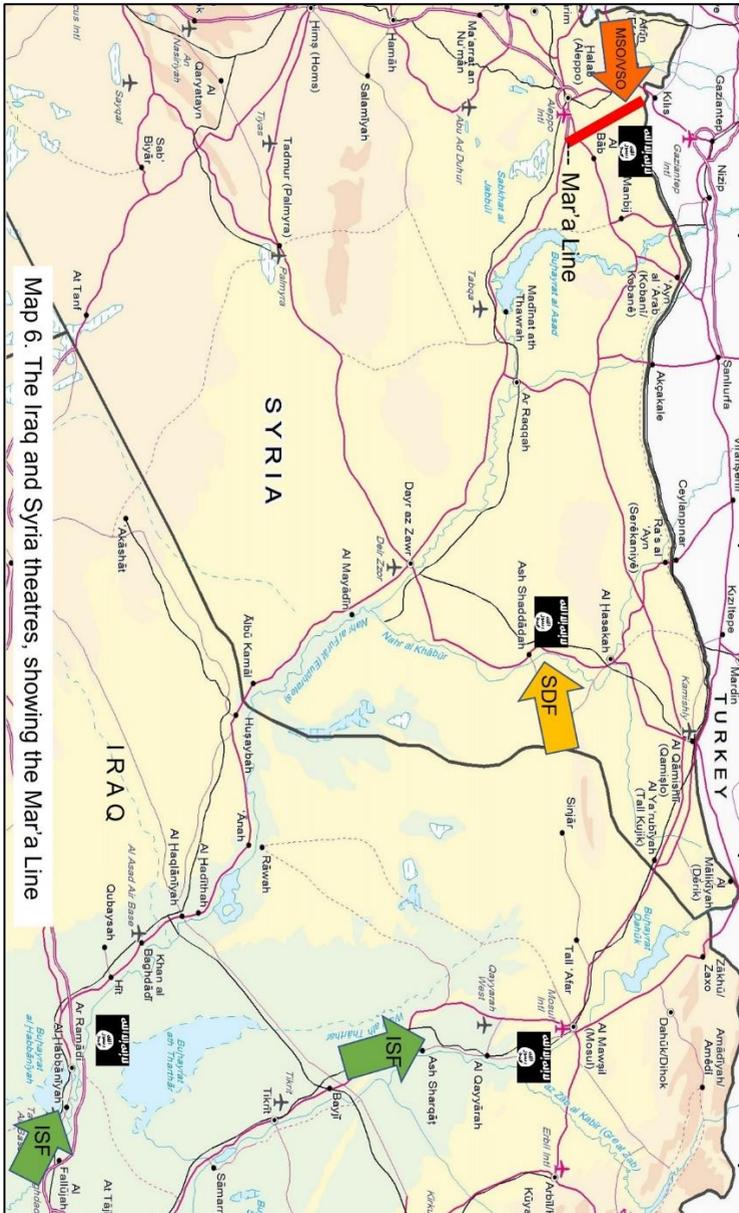
Nevertheless, accumulating evidence soon hinted that Operation Shader had reached a turning point. Daesh's retreat before the SDF was especially telling; they did not seek to hold Shaddadah.⁹² In Iraq, their increased use of IEDs and VBIEDs in the Haditha area was noted. They had, it seemed, largely ceded the tactical initiative along the Euphrates valley upstream of Baghdad and were increasingly responding to events. Relentlessly pressed from the air, the various Daesh concentrations were only selectively committed to harassing attacks and small-scale actions. The broad consensus was that their resilience and combat effectiveness were waning. One RAF assessment suggested that the targeting of their GLOCS had slowed their logistical networks, while the engagement of staging areas and training camps had reduced their redundancy. Destroyed equipment, such as heavy plant and vehicles, had proved irreplaceable, and declining revenue had forced pay cuts and fostered infighting and dissent. Their response to a recent PMF advance towards the Tigris River valley had been uncharacteristically slow, and they were apparently increasing their investment in static defences, such as berms, tunnels and caches.

Yet this changed situation was not easy to exploit. The Combined Forces Land Component Commander (CFLCC) was eager to strike north up the Tigris valley to retake Mosul. His evolving plan, Operation Valley Wolf, envisaged the capture of Qayyarah, including Qayyarah West airfield, which could then be used as a staging post for the Mosul assault. A preliminary step was the establishment of a forward base at Kara Soar, near Makhmur, from where the ISF would cross from the east to the west bank of the Tigris to take Qayyarah (see Map 5). This manoeuvre was initially considered in February 2016, the Kara Soar base being established soon afterwards,⁹³ but it did not actually occur until the first week of July.⁹⁴



Map 5. The Valley Wolf plan involved not only a northward approach along the Tigris valley (1) but an east-to-west river crossing to capture Qayyarah (2) and the Qayyarah-West airfield before the advance on Mosul (3).

The Royal Air Force in Operation Shader



Map 6. The Iraq and Syria theatres, showing the Mar'a Line

4. From Ramadi to Mosul

As we have seen, the challenge facing the Air Component had been eased somewhat in the later months of 2015 by the geographical concentration of the ground campaign. This trend was reversed in the following spring. As well as preparing to advance along the Tigris, the ISF remained heavily committed on the Euphrates, where Daesh still held key towns such as Hit and Fallujah. The coalition task in this area extended right across the western Iraqi desert (Anbar Province) and was covered by at least two sub-operations. Further north on the Euphrates, across the Syrian border, the second incarnation of the New Syria Forces – Ketab Allah Akbar (KAA) – was inserted to target the Daesh line of communication through such towns as Abu Kamal.

Then there was also continuing SDF activity around Shaddadah under Operation Talon Anvil, and Peshmerga targeting of the northern Daesh supply line from Syria to Mosul. Daesh's strategy was now substantially designed to block or at least slow coalition operations. However, in north-western Syria, westward pressure from Daesh towards Syrian opposition (Moderate Syrian Opposition (MSO) and Vetted Syrian Opposition (VSO)) territory north of Aleppo, along the battlefield known as the Mar'a Line, presented the Air Component with yet another commitment at the beginning of April (see Map 6).

Again, the coalition embarked on this particularly intensive period of ground operations without closely considering the implications where air power was concerned. The RAF's assessment, somewhat understated, was that the range and geographical spread of activity might well present a challenge. The intensification of ground fighting once more coincided with a reduction in CAS capacity occasioned by a range of factors, all of which had been planned over a period of several months. They included force restructuring measures and the withdrawal of the French carrier *Charles de Gaulle*.⁹⁵

The consequences were predictable. First, coalition air power became widely dispersed across theatre; second, there was a pronounced increase in the proportion of dynamic tasking – chiefly CAS – in Iraq relative to deliberate and deeper air missions. The trend was no less pronounced where ISR was concerned, collection capacity being overwhelmingly assigned to ground operations in Iraq and spread thinly instead of being massed and layered above high-priority objectives. Although the CFACC warned strongly against relieving pressure on Daesh 'in the deep' and especially in

Syria, and his sentiments received the full support of Commander CENTCOM, the close battle remained central to coalition strategy. Yet deliberate targeting (and the necessary supporting ISR activity) executed on a systematic and continuous basis could well have allowed ground operations to be conducted more economically by shaping the battlespace and weakening Daesh before offensives were launched by the ISF. In the event, the ad hoc diversion of strike and ISR resources to support widely scattered ground actions ruled out sustained targeting of this nature, leaving the operation against Daesh GLOCs in the Al Qa'im-Abu Kamal area as an isolated episode.⁹⁶

Dynamic air operations during March were chiefly mounted in support of the SDF's offensive around Shaddadah, the ISF in the lower Euphrates valley and Peshmerga forces west of Mosul. Although their intensity varied, there were several significant engagements. Fighting to protect their supply route to Mosul, Daesh broke through Peshmerga lines near Tal Afar on 4 March and were only repelled after eight hours of air strikes involving 38 engagements and the release of 46 weapons; RAF Typhoons executed three attacks with Paveway 4.⁹⁷

In the following week, most RAF strikes were again in the areas of Sinjar and Tal Afar, engaging rocket, mortar and heavy gun positions and massing Daesh forces. On three occasions, the assembling fighters were sufficiently numerous to necessitate the use of six bombs or more. While there were further strikes by the Typhoons, RAF Reapers were also regularly tasked in this area. On 11 March, one of them worked with coalition combat aircraft, providing targeting assistance for three successful strikes on groups of Daesh fighters before employing its own Hellfires. On the 12th, another Reaper attacked a Daesh rocket team and then targeted the survivors as they tried to escape in a truck. The Reaper then directed coalition aircraft in an attack on an array of rocket launchers nearby.⁹⁸

Operation Valley Wolf began at the end of March with limited advances by the Iraqi 71st and 72nd Brigades. Although the demand for air support was still highest along the Euphrates, air-to-ground engagements in the Tigris valley jumped from 16 to 97 in the space of one week.⁹⁹ Fortunately, having taken Shaddadah, the SDF paused to consolidate their position and so required less cover from the Air Component. Yet it soon became clear that the concurrent operations were stretching the ISF to the limit and that some prioritisation was necessary. Progress along the Tigris seemed certain to be slow until Hit, the next major conurbation on the Euphrates north of Ramadi, was recaptured from Daesh.

Such judgements were soon reinforced by strengthening Daesh opposition to Valley Wolf. For the RAF, the consequence was a sharp increase in support to operations around Qayyarah, reflecting a broader trend of expanding coalition air activity in the area. Some 11 Paveway 4s were used in dynamic strikes against Daesh forces and their defensive positions in the week ending 2 April.¹⁰⁰ On that day, four Tornado GR4s participated in a deliberate attack on one of two substantial weapons storage facilities, hitting 16 aiming points.¹⁰¹ Nevertheless, despite the growing scale of the supporting air effort, the 71st and 72nd Brigade advance lost its momentum. Operations in the air and on the ground were not helped by another period of poor weather.

In the following week, there was little change on the Tigris, where missions against Daesh firing positions and assembling forces remained the RAF's primary commitment. Eventually, Operation Valley Wolf ground to a standstill.¹⁰² Daesh then repeatedly attempted to mass in large numbers – from 100 to 400 fighters – but dynamic air strikes by the coalition prevented any significant counterattacks. On the 13th, GR4s released Paveway 4s against two clusters of barges being used by Daesh to move personnel and supplies across the Tigris.¹⁰³

Meanwhile, there was an upsurge in air activity over other battlefronts, with operations on the Euphrates encompassing both Hit and Fallujah, strikes in support of the Peshmerga along the northern Daesh GLOC, and attacks on Daesh targets in and around Mosul. There was also some further targeting – GR4 strikes with Brimstone – against Daesh boats on the Euphrates on 14 April. On the 21st, the GR4s participated in a major coalition attack on a complex of tunnels and bunkers dug into terraced hillsides above the Euphrates in western Iraq, achieving direct hits with 2,000lb Enhanced Paveway 3s on two tunnel entrances.¹⁰⁴ In Syria, demand from the SDF fluctuated, but fighting continued along the Mar'a line and required USAF intervention on a substantial scale.¹⁰⁵

Of the various commitments, the struggle to recapture Hit generated the highest demand for air support. RAF aircrew found the operation very different from the earlier battle for Ramadi, where a protracted build-up period allowed many civilians to leave and provided an opportunity for coalition air forces to study residual civilian patterns of life. Similar insights were not available in Hit, but it remained as important as ever to minimise collateral damage and civilian casualties. The situation was further complicated by the flight of civilians after the battle started and the apparent hostility of Hit's Sunni residents to the ISF.

Coalition assessments pointed to significant levels of Daesh attrition in Iraq in the Spring of 2016; their leadership appeared to be squandering manpower and lacked a coherent defensive strategy. Yet it remained difficult to capitalise on their weaknesses, and much depended on the ability of the ISF to maintain momentum on the ground. Once the impetus was lost, Daesh demonstrated an impressive ability to recover and restore operational effectiveness. Moreover, when the ISF paused, Daesh could deploy with the specific aim of reducing their vulnerability to air attack.

Hit was not finally cleared until the last week of April, allowing the ISF to advance further up the Euphrates towards Dulab and Baghdadi, but the position on the Tigris remained static. Consequently, despite an improvement in the weather, there was a significant fall in the number of air strikes. Air pressure on Daesh might have been maintained through deliberate targeting if the essential preliminary ISR had been completed, but the majority of ISR assets had been assigned to the support of ground operations. As a short-term solution, the Air Component generated more X-INT missions beyond the main battlefronts. At first, only American combat aircraft were assigned to this role, but RAF assets, particularly Sentinel, provided valuable ISR support. In the longer term, there was a gradual increase in the volume of deliberate targeting.

KAA operations began in southern Syria in early May, but their initial requirement for air power was limited. Meanwhile, the virtual pause in ISF and SDF manoeuvre continued, and Daesh maintained pressure on the Mar'a line and along their northern GLOC. They also mounted small-scale harassing attacks around Qayyarah. Fortunately, when confronted by sustained air strikes, they were invariably halted and thrown back. On 3 May, they targeted Peshmerga front lines in the north only to be repelled by multiple formations of coalition strike aircraft, which employed no fewer than 59 weapons in 47 different engagements; many of these aircraft were re-tasked from elsewhere in Iraq and Syria. On the following day, Daesh direct and indirect bombardment of Kisik Junction resulted in nine more strikes by five formations over a four-hour period. The RAF was fully involved, supplying strike and ISR capabilities.¹⁰⁶ Sentinels, Reapers and RAPTOR-equipped Tornado GR4s also contributed to extensive ISR activity that preceded and facilitated the ISF's successful assault on the town of Ar Rutbah, in the western Iraqi desert, in the third week of the month. Deeper targeting in Syria included a strike on Daesh command and control on 20 May:

Intelligence analysis pinpointed 2 Daesh headquarters in north-west Syria, located 10 and 25 miles respectively north of Aleppo near the fighting along the Mar'a Line. A pair of Tornado GR4s were tasked with their destruction. One of the command posts was in a very solidly constructed building, this was targeted with 2 Enhanced Paveway 2 1000lb bombs. A pair of 500lb Paveway 4s were used against the 2nd headquarters. Both targets were destroyed by direct hits.¹⁰⁷

At the end of May, the Iraqi government announced that Valley Wolf would remain on hold until Fallujah had been captured, raising the prospect of further delays to the projected assault on Mosul. The proportion of combat aircraft targeting Daesh in Fallujah increased straight away, but it was hard to bring air power to bear decisively. The situation on the ground was often confused. Both the ISF and PMF were committed to the assault and made extensive use of indirect fire; Daesh again used civilians as human shields. Every request for air support received by the strike cells had to be scrutinised in microscopic detail.

At the beginning of June, after a successful feint towards Raqqa, the SDF crossed the Euphrates east to west and launched their long-awaited offensive towards the Daesh-held town of Manbij. Their air support requirements were predominantly serviced by the USAF, while the remainder of the Air Component, including the RAF, was divided between Fallujah, northern Iraq/Mosul and the Tigris. The struggle for Fallujah grew ever more intense, with Iraqi Special Forces – the US-trained Counter-Terrorism Service (CTS) – spearheading the ISF advance. In their way, around the city centre, stood an elaborate system of defensive trenches, tunnels and IED belts. The block-by-block CTS clearance operations relied heavily on the use of armoured vehicles and bulldozers, which therefore drew heavy fire from Daesh. In turn, coalition air power targeted the high-calibre fire teams responsible.

The RAF's mixed weapon load of Paveway 4, Brimstone and Hellfire proved especially valuable in this environment and was repeatedly employed against machine gun, rocket, Rocket-Propelled Grenade (RPG) launcher and artillery teams, as well as VBIEDs, strongpoints and buildings used for command and control. In the Upper Tigris area, the RAF participated in Operation Phoenix Blitz, which involved shaping strikes in preparation for the resumption of Valley Wolf. These chiefly targeted fielded forces, but two GR4s destroyed a VBIED facility south of Qayyarah on the 12th.¹⁰⁸

By the 19th, Fallujah had been isolated, but Daesh were still holding out stubbornly. Nevertheless, with hindsight, it could be argued that the coalition passed another important milestone in the following weeks. At the end of June, under pressure from the SDF at Manbij, Daesh began to transfer some of their forces away from the Mar'a line and mounted a desperate last-minute attempt to pull fighters out of the lower Euphrates valley. Two road convoys departed from an area east of Ramadi, one vectoring west while the other drove north. As the fighters in both convoys would undoubtedly have been encountered again on the front line if they had been allowed to escape, they were repeatedly engaged by coalition aircraft and sustained extremely heavy casualties. The MOD reported that Typhoons released Paveway 4s against two vehicles and a large group of fighters, while two Reapers targeted a further four vehicles and accompanying fighters, using Hellfire and GBU-12.¹⁰⁹

In the following week, Daesh resistance in Fallujah ceased, and attention turned towards the capture of Qayyarah West. Early in July, Sentinel and Reaper provided extensive ISR coverage in support of Operation Valley Wolf, and three quarters of all RAF strikes occurred in the upper Tigris area, targeting rocket rails, mortar teams, Daesh firing positions and a weapons cache.¹¹⁰ Again, Daesh suffered heavy losses, and their command and control provisions in the Qayyarah area were severely degraded. The CTS captured the airfield on the 9th and then cleared the area to the east as far as the Tigris valley. In the meantime, the SDF strengthened their grip on Manbij until, on 12 August, it was possible to negotiate a ceasefire. Daesh were allowed to evacuate their few remaining fighters.¹¹¹

While this series of important breakthroughs depended heavily on air support in the form of dynamic targeting, this was only achieved, once again, by restricting the number of deliberate air strikes. The few planned strikes involving RAF assets in the summer of 2016 included a Tornado GR4 Storm Shadow attack on 26 June against a hardened weapons facility north-west of Rutbah. According to the MOD's published Iraq and Syria air strike record,

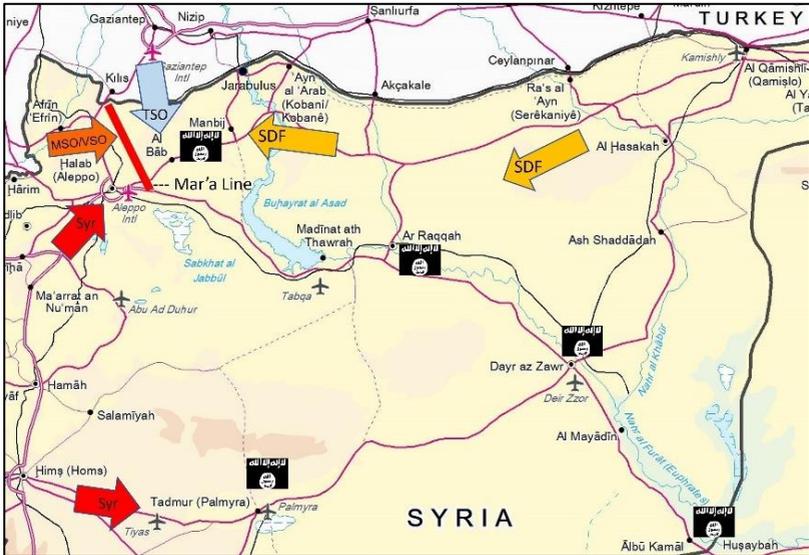
Intelligence had determined that Daesh were using a large concrete bunker in western Iraq as a weapons facility. Due to the massive construction, built during the Saddam era, it was decided to use 4 Storm Shadow missiles against it, as the weapon has particularly good capabilities against such a challenging target. The missiles were launched by 2

Tornados, all 4 Storm Shadows scored direct hits and penetrated deep within the bunker.¹¹²

A Daesh recruiting and training centre in Mosul was also targeted along with VBIED and fuel storage facilities, and bridges across the Euphrates at Raqqa. The Mosul recruiting centre was housed in a palace that also dated back to Saddam Hussein's dictatorship. Positioned in a large secure compound next to the Tigris, the target included not just the main palace building, which Daesh used as an accommodation and meeting venue, but also a number of more discreet outbuildings employed for command and control, training, internal security and repression. A coalition strike force of 12 aircraft attacked the site on 31 July, the RAF providing GR4s equipped with 2,000lb Enhanced Paveway 3s, which were used to target the main headquarters building and a security centre.¹¹³

On 7 August, coalition aircraft engaged a large Daesh oil tanker convoy north-west of Abu Kamal as part of Operation Tidal Wave II. More than 80 oil transporters and support trucks were destroyed, RAF GR4s accounting for eight vehicles with four Paveway 4s and four Brimstones.¹¹⁴ The attack reportedly put a large dent in Daesh's ability to continue with black market oil sales and brought the total number of tankers destroyed in Tidal Wave II strikes to more than 600.¹¹⁵ Subsequent analysis suggested that their income from illicit oil activity had been halved by coalition air targeting since 2015.¹¹⁶

After the liberation of Fallujah, air operations over Iraq again became more geographically concentrated. Daesh's earlier strategy of last-ditch defence at any and every location changed visibly, as relentless coalition pressure forced them to prioritise. ISF clearance operations in the Middle Euphrates River Valley (MERV) did not encounter much Daesh resistance, and little air support was required. Equally, the assault on Qayyarah met less opposition than expected, and the town was taken quite easily. The main coalition air effort was expended on tactical support for preparatory ground operations around Mosul or the protection of ISF forces assembling at Qayyarah airfield. As the build-up at Qayyarah West continued, there was a steady rise in the volume of incoming indirect fire from Daesh positions and an associated increase in force protection tasks for coalition air combat and ISR aircraft. Using Hellfire, RAF Reapers engaged Daesh mortars and their crews on 2, 7, 9, 13, 19, 20 and 24 August.¹¹⁷ The coalition also deployed counter-UAS systems in response to a clear rise in the volume, capability and variety of Daesh UAS platforms.¹¹⁸



Map 7. In August 2016, the Turkish Supported Opposition advanced into Daesh-held territory east of the Mar'a Line, driving a wedge between the SDF and the Kurdish-dominated canton of Afrin.

The situation in Syria remained more complex. Even after the successful conclusion of operations around Manbij, there were continuing clashes along the Mar'a line, and it became necessary to employ at least some coalition air power to help defend the SDF's extended lines of communication across the north. Then, at the end of August, Turkey began unilateral action along her southern border, involving a ground offensive (with air support) west of Jarabulus by Turkish Supported Opposition (TSO) into Daesh-held territory (see Map 7). In part, their intention was to establish a safe zone inside Syria for refugees, but they were also determined to isolate the Kurdish-dominated canton of Afrin (in the far north-west of Syria) from the SDF's westward advance, the SDF being YPG-dominated, the YPG being closely affiliated with the PKK. In turn, the Turkish threat to Syrian sovereign territory brought reactions from the Syrian regime and Russia.¹¹⁹ In the air dimension, these included the extension of their IADs, increased SAM coverage and more frequent patrolling by Russian aircraft in the north. The coalition had to monitor this highly volatile situation very closely.

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The RAF experienced fluctuating fortunes as the coalition's focus turned towards the liberation of Daesh's Iraqi and Syrian bastions – Mosul and Raqqa. On one hand, all the deployed assets continued to make an invaluable contribution to coalition operations; on the other, Shader's duration and intensity imposed an extremely heavy burden on aircrew, engineers, aircraft and munitions stocks. It was periodically necessary to accept temporary reductions of tasking in the interests of longer-term sustainability.



Typhoon armourers with a Paveway 4 at Akrotiri; high-intensity operations exerted considerable pressure on coalition weapon stocks.

5. Mosul and Raqqa: Stage 1

The coalition chose the operation name Eagle Strike to cover the liberation of Mosul, which was to be completed in two stages, east and west of the Tigris. The first week of October 2016 witnessed a pronounced shift in air targeting towards shaping in support of Eagle Strike, and virtually all the combat air power committed to Iraq was sent north. As we have noted, most RAF combat missions at this time were flown in the Mosul area or over the upper Tigris valley. Nevertheless, until October, the priority assigned to Valley Wolf and to supporting Iraqi forces in the lower Euphrates region limited the air resources available to target Mosul itself, and Daesh positions and facilities in the city were only struck intermittently. Most RAF targets in the region were outside – often miles outside – Mosul; a high proportion were of a tactical nature and were attacked to support ground manoeuvre by Iraqi or Kurdish forces.

For example, in January 2016, when coalition aircraft operated more frequently than normal in the Mosul area, only two RAF strikes were in the city, and one of these involved a tactical target. In February, of seven strikes in the Mosul area, only one was inside the city. Typical targets beyond Mosul and its suburbs were mortar, rocket and machine gun teams, identified groups of terrorists, defended positions or buildings, and vehicles.¹²⁰

As late as August, the RAF's targets in the Mosul area all lay outside the city. Tornado GR4s destroyed a Daesh mortar position while patrolling north and west of Mosul on 3 August; Typhoons hit a light artillery piece east of Mosul on the 8th. On the 9th, they struck buildings and a vehicle 20 miles south-east of Mosul; on the 21st, GR4s destroyed a Daesh tank north of the city; on the 22nd, Typhoons bombed a cave 'some miles to the north-west of Mosul' and on the 29th they attacked a bunker and tunnel network 10 miles to the north. On the 30th, they returned to the same area, and on the 31st their target was a Daesh-held building 15 miles east of Mosul.¹²¹ Likewise, in September, the seven RAF strikes in this region shown in the MOD record all occurred outside Mosul and targeted identified Daesh personnel, Daesh-held buildings, strongpoints, and weapons.¹²²

The US Army Mosul Study Group's suggestion that there had been 'years of air operations against ISIS in Mosul' therefore creates a misleading impression of continuous but ineffective air bombardment.¹²³ In truth, the direct support requirements generated into the later months of the year by ground operations elsewhere left little time available for shaping or for the protracted ISR 'soak' of Mosul that might have been desirable in ideal

circumstances before Eagle Strike began. Consequently, much remained unknown about Daesh's defensive preparations and support networks in the city.

It was clear that exceptional challenges lay ahead in terms of targeting and weapons expenditure, and in the co-ordination of air and ground operations. While the Iraqis appeared well prepared, no battle plan survives first contact with the enemy. Daesh would have a vote and their actions were bound to create frictions and uncertainties on the battlefield, in the command chain, and at the political level. In a city with a population of 1.5 million people, there would inevitably be a high risk of civilian casualties.

By the middle of October, the geographical shift towards northern Iraq was complete; Eagle Strike was launched on the 16th. By that date, the RAF's GR4s, Typhoons and Reapers had flown a total of 3,264 missions since the beginning of Shader, expending 2,249 munitions.¹²⁴ It was an appropriate moment for Air Commodore Sampson to pass on the role of UKACC to Air Commodore Stringer, and Stringer's time in theatre would subsequently be dominated by the Mosul and Raqqa operations.

As Eagle Strike gathered pace, the Air Component again fulfilled record strike rates, and there were important tactical gains on the ground. A limited Daesh counterattack at Kirkuk mounted largely for propaganda purposes was defeated without a significant diversion of air effort. Targeting reverted to a largely dynamic format, and the strike cells laboured to integrate air and ground fires. Yet some deliberate attacks continued. They included the demolition of one of Mosul's five Tigris bridges to disrupt Daesh logistics and command and control, and RAF GR4s again employed Storm Shadow on 31 October while leading a strike formation against an IED production plant near Haditha. Sited at a former Iraqi Army depot, this facility included several bunkers that were assessed to be vulnerable to the missile's penetrative capabilities.¹²⁵

By the last week of October, the ISF and Peshmerga ring was tightening around eastern Mosul, and ISR assets were densely packed above the ISF routes of advance to help improve their understanding of the ground picture. Apart from Reaper, the RAF contributed the RC-135 Airseeker to this task, while Sentinel was used more to support the isolation of the city – a role for which its SAR and GMTI systems were particularly well suited. Indeed, the UK was the only coalition nation other than the US delivering a GMTI capability. Sentinel conducted 17 per cent of coalition GMTI collect missions at this time and provided more than a quarter of Level 1 GMTI analysis, including some analysis for the Americans, which was immensely

valued and appreciated. The UKACC later reflected on how Sentinel had added value to wider intelligence collection activity and demonstrated UK influence. ‘One aircraft with a few people supporting it had an utterly disproportionate impact on what it provided for the coalition.’¹²⁶

A typical Sentinel mission (in this case mounted on 3 November) involved an investigation of the flow of traffic over a wide area of the Ninawa desert deep in Daesh-held territory. During the mission, the aircraft monitored friendly and enemy ground positions along the Tigris valley, identified static vehicles using SAR and passed collected intelligence to ground commanders in near real-time to enhance their situational awareness.

Reflecting the dynamic nature of the battlespace, Sentinel was then re-tasked mid-sortie and directed to monitor egress routes from Mosul. Transiting between the two areas, it collected SAR imagery of a large bunker complex, proving Daesh occupation; the complex would later be targeted by an air strike. Having reached the Mosul area, Sentinel detected three convoys and extended its analysis of ground force dispositions all the way to Sinjar. Intelligence collected during this mission and others flown early in November was subsequently fused into a single brief for senior coalition commanders to demonstrate the effect of PMF manoeuvre on Daesh logistics around Tal Afar.¹²⁷

By the end of October, more than 1,000 air weapons had been employed in the Mosul area – a figure that exceeded the peak recorded during the recapture of Ramadi and equated to double the weight of effort expended during the clearance of Fallujah. Some 85 per cent of coalition air munitions were being delivered in direct support of operations to recapture Mosul,¹²⁸ although it seemed likely that the intensity of the fighting would rise further as Daesh came under more pressure on the main ground axes of advance. The acutely demanding nature of the conflict was illustrated by one RAF report that referred to Daesh mortars next to schools, child soldiers, a variety of VBIED types, and significant civilian population movement. The front line shifted constantly, and its location was often difficult to establish from the air. Against this background, the release of air-to-ground ordnance remained subject to the most rigorous oversight from the command chain.

At the same time, the essential requirement for restraint had to be weighed against the need to maintain operational tempo and support for the ISF. A substantial proportion of coalition – particularly Air Component – higher command effort was devoted to the preservation of this vital balance, and the unstinting efforts of the UKACC and his staff to resolve the many complex and sensitive issues that arose in the process were rewarded by a

high level of dynamic tasking for the RAF. Air Commodore Stringer later described the sophistication of the targeting enterprise:

I'm not sure we have ever built anything as sophisticated as what we have had to use in Iraq and Syria. If I could put you into the air operation centre around the UK desk, you would find a team of largely young men and women—imagery analysts, intelligence, targeting support, legal advice and policy advice—all overseen by a relatively senior individual. They are taking a whole number of feeds that are coming in to assess, first order, is it a valid military target? Is it part of Daesh or the target set that we are going after? Does it satisfy the rules of engagement? Does it satisfy UK policy? Is there clear military advantage? All those levels are effectively a check and balance on what we are doing.¹²⁹

While the weekly RAF consumption of Paveway 4s had averaged 19 between 14 April and 30 November, this figure doubled during the early stages of Eagle Strike,¹³⁰ and careful monitoring of weapons expenditure and stock levels therefore remained essential. Nevertheless, there were many occasions on which permission to strike was withheld. Stringer cited the case of a UK red card holder who received around 1,000 strike requests over a six-month period and approved around 400. 'We actually struck about 280. So over 50 per cent fail a test.' Given the highly dynamic nature of the Mosul operation, this was often simply because the situation on the ground changed.¹³¹

Some commentators have argued since that the ISF were too dependent on precision air strikes and that this slowed operational tempo; this over-dependence also allegedly resulted in the excessive use of air support in a manner that increased the scale of collateral damage.¹³² Such contentions ignore the fact that the vast majority of munitions directed into Mosul were discharged by ground forces and were unguided; indeed, many ground fires were indirect. Equally, the view that the ISF would have advanced more rapidly with less precision air support, so reducing collateral effects, massively overestimates their offensive capability. A similar stop-start pattern characterised the actions of another proxy ground force, the Free Libya Forces, during Operation Unified Protector in 2011, and its reappearance in Shader is therefore hardly surprising.¹³³

While it is true that target clearance processes periodically delayed air strikes, combat air support was substantially responsible for sustaining such momentum as the ISF achieved. Without it, the liberation of Mosul would have been even more protracted and would have involved more street-to-street, house-to-house clearance, while unguided mortar, rocket and artillery fire continued to pour down on a grand scale and Daesh fought back with RPGs, IEDs, mortars, mines and much else. This could only have resulted in significantly more collateral damage. Fundamentally, any measure to reduce risk that also has the effect of lowering operational tempo or momentum may actually be self-defeating: risk aversion in one sphere may well imply risk acceptance in another.

As the intensity of air action over Mosul increased, so too did the pressure on the Air Component's resources. France provided some slight relief by delaying another planned break in the Charles de Gaulle's operations until December, and the UK was one of several coalition partners to 'surge' temporarily to provide additional CAS; it was also possible to couple the GR4's ISR and strike capabilities and to combine both dynamic and deliberate tasking. Yet these were only partial solutions, and single-role missions were generally more rewarding than multi-role missions – especially in the context of GR4 tactical reconnaissance. Moreover, it seemed certain that the situation would deteriorate further as winter weather curtailed flying just as the SDF began preliminary actions designed to isolate Raqqa – Operation Eclipse. Ultimately, the CFACC was compelled to seek reinforcements in the form of F-16s from the US Global Response Force (GRF) to cover the period 10 December 2016 to 6 February 2017.^h

The plan to capture Mosul involved a multi-axis advance designed to prevent Daesh from concentrating against one particular thrust. The ground formations chiefly consisted of the CTS, attacking from the east, and broader Iraqi Army elements advancing from the north and south. Other forces, including the PMF, had the task of cutting Daesh supply routes into the city. Despite early progress, Daesh resistance was particularly stubborn, and their tactics proved highly adaptable. On the eastern axis, the CTS saw the hardest fighting, and their casualties numbered around 1,000 by the end of

h. The Global Response Force had two distinct uses. One was to enhance the US's ability to deploy forces rapidly in response to a range of worldwide contingencies with a bespoke joint force; the other was to provide a set or 'menu' of units that combatant commands could request to augment their capabilities in light of unexpected challenges, when requirements exceeded their capabilities.

November. Daesh snipers proved adept at targeting their tactical commanders, and the sustained and effective use of VBIEDs began to undermine the ISF's cohesion and morale. During a period of six weeks, Daesh targeted the ISF in Mosul with no fewer than 632 VBIEDs.¹³⁴

Mosul's bridges across the Tigris raised particularly difficult dilemmas for the coalition. While eastern Mosul had been sealed off by Iraqi and Kurdish ground forces, Daesh could still move supplies into western Mosul and across the Tigris into the east, and they could also strengthen their forces in the east by the reapportionment of fighters, weapons and supplies already positioned in the west. It was clear that the destruction of the Tigris bridges would substantially prevent such measures. However, the bridges were also used by civilians – particularly refugees fleeing the fighting – and they formed a vital part of Mosul's infrastructure, which would be critically important to the city's post-conflict reconstruction and recovery. At first, therefore, both the coalition and the Iraqi government were reluctant to destroy them all. Nevertheless, two more had been targeted from the air by the end of November to inhibit Daesh resupply and reinforcement.¹³⁵

Poor weather in early December disrupted coalition air operations and provided Daesh with an opportunity to regroup and strengthen their defences. Subsequently, Operation Eagle Strike suffered a significant setback when the Iraqi Army's 36th Battalion (9th Armoured Division, on the southern axis) was subjected to a determined counterattack in the area of the Al Salam hospital, which again involved strikes by VBIEDs directed by commanders using UAS. Air power, including strikes by RAF aircraft, supported the 36th Battalion's extraction, but their casualties exceeded 60 killed or wounded, and they left behind around 20 vehicles.¹³⁶

Offsetting this debacle was a weakening of Daesh resistance on the CTS axis of advance (as fighters were moved south to block the 9th Division). Away from Mosul, the coalition also executed a particularly successful air attack on some 168 Daesh fuel tankers in an assembly area in central Syria, further denting their oil revenue streams and revealing the true vulnerability of areas they had previously considered safe.¹³⁷ The GRF F-16s meanwhile arrived in theatre to make up for the withdrawal of the Charles de Gaulle and the US carrier Dwight D. Eisenhower.¹³⁸

The CJTFHQ worked closely with the CFACC and his staff in this period to ensure that air support was better integrated with future ground operations. Among other things, the Commander CJTF issued a new tactical directive that led to the attachment of US JTACs to forward ISF units as part of American Advise, Assist, Accompany and Enable (A3E) teams.¹³⁹ The lull

in fighting also provided a brief window for further intelligence collection and analysis, as well as several attacks on Daesh command and logistical targets beyond Mosul. Typhoons and GR4s struck weapons storage areas, explosives manufacturing facilities and Daesh accommodation blocks at locations such as Bayji and Tal Afar.¹⁴⁰

Yet aspirations to resume Eagle Strike quickly were frustrated by continuing poor weather, which forced the cancellation of strike, AAR and RPAS missions. The result, in combination with CTS attrition and the repercussions of the Al Salam hospital battle, was a prolonged pause.¹⁴¹ A revised CJTF timetable for future operations ultimately appeared, which envisaged that east Mosul would not be cleared until mid-January and that another month would pass before the Iraqis were ready to evict Daesh from the western sector of the city – a task certain to be difficult and protracted in itself. Planning for the SDF assault on Raqqa continued in the interim, based on an initial approach from the north followed by an envelopment to the south; a landing strip at Kobane already used to supply the SDF was made ready for the C-17 landings that would sustain their campaign.¹⁴² But there was little scope for preparatory air strikes in the Raqqa area while Eagle Strike was on hold because coalition ISR and subsequent target development had been overwhelmingly concentrated on Mosul.

Finally, on 29 December, the ISF relaunched their offensive. It was accompanied, among other things, by a more deliberate counter-VBIED strategy. In the early stages of Eagle Strike, the coalition had chiefly targeted the individual VBIEDs. Typhoons destroyed a command post controlling VBIED attacks on 20 October, while GR4s targeted a production workshop in south-eastern Mosul on 25 November, but RAF strikes were otherwise confined to deployed weapons.¹⁴³

Yet counter-VBIED measures to support the resumption of Iraqi ground operations were more carefully planned. Many of the VBIEDs employed in October and November had been manufactured before the Iraqi offensive and pre-positioned in hide sites in eastern Mosul.¹⁴⁴ However, most of these weapons had been expended by late November, and the movement of Iraqi forces into the city had denied Daesh some of their manufacturing facilities, leaving them more dependent on re-supply from outside the immediate battle zone. With eastern Mosul ringed by coalition forces, re-supply came from the west, and the VBIEDs had to cross the Tigris. Coalition countermeasures therefore included the destruction of one further river bridge and strikes on key roads and junctions to prevent or channel Daesh vehicle movements. There were also further attacks on manufacturing facilities, although few

could be found in the limited time available. It is notable that the only such targets allocated to the RAF lay far beyond Mosul near Tal Afar and Kirkuk; they were attacked and destroyed on 4 and 8 January 2017 respectively.¹⁴⁵

The intelligence staffs at the CJTFHQ and the CAOC also sought to develop a better understanding of Daesh VBIED activity from production through to attack prosecution by gathering intelligence on associated senior leadership and the commercially available UAS they employed to guide drivers to their targets. UK personnel from across the ISR collection, analysis and targeting spectrum played a particularly active role in operations against the UAS organisation. In the UKACC's words,

What we actually did was effectively go into that network and find out what it constituted, both at the frontline and where it was being supported, and then offer a proposal back into the coalition of how we would go about going after it, which we then very successfully did in the early part of 2017, directly supporting Iraqi security forces on the ground and fully integrated with the coalition Land Component and the coalition taskforce HQ.¹⁴⁶

On 9 January, USAF F-15Es struck 11 targets in Tal Afar, degrading much of Daesh's UAS operating, development, command and storage capability. On the 12th, a MOD news release described how a building in the southern area of central Mosul had been identified as a base for UAS launch and operation. 'A pair of Royal Air Force Typhoons targeted the site, demolishing the building with 2 Paveway 4 guided bombs.'¹⁴⁷ Nevertheless, the ISR effort required to target the VBIED and UAS networks ensured that such strikes were only intermittently executed.

By the second week of January, the battle for east Mosul was swinging decisively in the coalition's favour. Sustained pressure on the main fronts overwhelmed Daesh's defences, and the ISF – heavily reinforced – succeeded in gaining and holding ground. The Al Salam hospital was recaptured, and some Iraqi troops even reached the Tigris.¹⁴⁸ The destruction of the one remaining Tigris bridge virtually cut off the Daesh fighters holding out on the eastern bank, and attempts to relieve them by boat and barge were anticipated by the coalition: between the start of Eagle Strike and 21 January 2017, the coalition destroyed at least 112 watercraft on the Tigris in Mosul and destroyed or damaged several more outside the city.¹⁴⁹ In the absence of resupply from the west, the number of VBIED attacks declined sharply.

All RAF combat aircraft were closely involved in the battle, but the demand for the Reapers' Hellfire missiles was particularly high. Of the 27 Hellfires released by RAF Reapers in the first three weeks of January, 25 were employed in the Mosul area.¹⁵⁰ On 5 January, a Reaper flying overwatch for Iraqi troops advancing in the south-eastern area of the city conducted three successful Hellfire strikes against Daesh fighters in their path and provided surveillance support to three further engagements by other coalition aircraft. Similar attacks were executed over the next two days. On the 8th, a Reaper operator spotted a group of fighters attempting to cross the Tigris by boat; a single Hellfire sunk their craft. Over the following week, the targets included a concealed mortar team, a truck containing a rocket, a VBIED and several groups of Daesh fighters. On the 17th, after the identification of a car bomb hidden under a car port in a newly liberated area of northern Mosul, an RAF Reaper maintained overwatch as the ISF moved civilians in the area to safety; it then destroyed the bomb using Hellfire.¹⁵¹

East Mosul was liberated on 24 January amid reports of declining Daesh combat capability and morale and in-fighting between locally raised and foreign personnel, but the ISF paid a high price for their victory. Commander CENTCOM subsequently advised a congressional committee that 490 ISF troops had been killed and another 3,000 wounded.¹⁵² Between 17 October 2016 and 24 January 2017, in support of Eagle Strike, the coalition conducted 558 air strikes using 10,115 munitions against Daesh targets. They destroyed 151 VBIEDs, 361 Daesh-occupied buildings or facilities, 140 tunnels, 408 vehicles, 392 bunkers, 24 anti-air artillery systems and 315 artillery/mortar systems.¹⁵³

6. Mosul and Raqqa: Stage 2

Attention now turned to west Mosul and, in Syria, Raqqa. ISR in all its forms had a crucial preliminary role to play, both to identify targets for shaping air strikes and to understand Daesh's defensive plans. The RAF was actively involved in preparatory reconnaissance activity over west Mosul by the last week of January.¹⁵⁴ By early February, it was clear that the assaults on the two cities would overlap and were likely to generate many similar challenges, particularly for the Air Component. In west Mosul, the urban environment was more tightly packed than in the east, and many of the narrow streets of the old quarter were shielded from the air by awnings, which threatened to reduce the utility of FMV. Raqqa was protected by a formidable network of fortifications, and, again, it seemed certain that dense housing and a multitude of narrow streets would hamper airborne surveillance.

The large civilian presence in both cities was particularly problematic. There were thought to be around 700,000 civilians in west Mosul. Daesh were fully aware that civilian casualties could be exploited for propaganda purposes, and experience demonstrated that they would seek protection for their troops and equipment by deploying them near civilians and civilian infrastructure or by driving civilians into combat areas.

The brief lull that separated the east and west Mosul operations was extended by bad weather in the middle of February, providing Daesh with some scope to counterattack. Among other things, east Mosul came under heavy indirect fire from the west, and Daesh also struck against the PMF near Tal Afar to reopen a ground route into Syria. Weaponised UAS were employed against Iraqi forces assembling for the assault – the Federal Police (FEDPOL) and Emergency Response Division (ERD)ⁱ – and there were skirmishes to the west of Kirkuk, where an RAF GR4 attacked a Daesh defensive position in support of the ISF and a coalition unit on the 2nd.¹⁵⁵

The delay was frustrating but provided more time for shaping operations under deliberate or deliberate on-call targeting procedures. On 11 February, two Typhoons successfully attacked a Daesh tunnel and bunker dug into a hillside seven miles south-west of Mosul, and further coalition strikes over the following days targeted Daesh command and control, VBIED production facilities, defensive positions and foreign fighters (who were assessed to be

i. The Emergency Response Division was the other arm of the Iraqi Special Forces.

the most effective enemy forces). On the 14th, another Typhoon mission demolished a Daesh headquarters in the city.¹⁵⁶

Iraqi operations to liberate west Mosul were launched before aircraft carrier support had been restored, and both USAF and RAF combat aircraft consequently mounted another temporary surge. The initial phase of the operation involved breaching outer obstacles such as berms, ditches and T-walls to allow the ISF to advance to the edge of the built-up areas. Iraqi units were provided with coalition A3E teams, including JTACs, down to divisional level for the FEDPOL and ERD, and to brigade level for the CTS and the 9th Armoured Division.

The offensive began on 19 February and quickly overran Albu Sayf, Ghazlani Military Base and Mosul airport.¹⁵⁷ At first, there was little resistance partly because Daesh chose not to contest these outlying areas, and partly because of a carefully staged Iraqi-coalition deception operation that threatened an attack across the Tigris. The advance left Daesh controlling only one road out of the city to Tal Afar, and that would soon be lost. Supporting RAF missions struck such targets as mortar teams, artillery and defensive positions.¹⁵⁸

On 22 February, the Iraqis paused to consolidate. However, when the offensive resumed on the 24th, they were attacked by a formation of up to 12 weaponised UAS and sustained 30 casualties, including four killed. In response, the Commander CJTF directed the A3E teams to establish Forward Operating Base-type defensive positions and employ passive air defence tactics – camouflage, dispersal and visual spotters. This was probably the first time such measures had been used operationally by western forces for more than two decades. Jamming equipment was subsequently deployed, which greatly reduced the threat.¹⁵⁹ Active air countermeasures again focused on locating Daesh's UAS generation and support network and striking identified UAS-related targets.

Meanwhile, in northern Syria, the SDF resumed their advance to the east of Raqqa,¹⁶⁰ exploiting a successful feint that held Daesh fighters to the south, intelligence-led targeting of their battlefield commanders and broader shaping strikes to isolate the city. These included attacks on canal bridges and road culverts to slow Daesh movement and introduce additional friction and complexity into their logistics (the Euphrates bridges in the Raqqa area had already been destroyed). RAF involvement included a Typhoon strike on a Daesh headquarters on 6 March and attacks by GR4s on similar targets on the 12th and the 18th.¹⁶¹

We are talking about speeds where people are closing at 1,000 mph, and we are covering a mile between aircraft in three seconds. The decision space for a dynamic environment requires people to make really timely, crunchy calls and get them consistently right. We should probably reflect on the fact that people *were* getting it consistently right day after day, in a very challenging environment.¹⁶⁴

Ultimately, the SDF maintained their focus firmly on Raqqa, but the situation in northern Syria remained complex and potentially volatile. Plans to strike west of the city to seize Tabqah, its airfield and its strategically important dam (at the opening of the Euphrates into Lake Assad^j) were placed on hold following reports that Daesh had heavily reinforced their defences in the area. Daesh meanwhile withdrew from Al Bab,¹⁶⁵ but their retreat had broader implications, for it released Syrian government forces for a possible advance to the east in the direction of Tabqah or even Raqqa. At the same time, in a separate development, Syrian and Russian forces evicted Daesh from Palmyra after a prolonged struggle.¹⁶⁶ The full significance of this achievement was not immediately clear, but it was far-reaching. Palmyra's fall promised to open the main supply road east towards the MERV, which was also the primary focus of coalition planning for the next phase of Shader, to be initiated after the liberation of west Mosul and Raqqa.

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The original concept for the assault on west Mosul again envisaged advances along three main axes, with coalition air power effectively providing a fourth. As in the east, the key to success lay in the integration of air support with multi-axis manoeuvre on the ground. Yet for more than two months there were just two ground axes, which were sustained by the FEDPOL, the ERD and the CTS. This allowed Daesh to concentrate their forces and further complicated the Iraqi task. By 5 March, the Iraqis had successfully aligned their front lines in the urban southern area of the city but had suffered some 600 casualties, including 100 killed.¹⁶⁷ RAF Tornados and Typhoons continued to provide valuable support, striking numerous Daesh firing positions.¹⁶⁸

j. Labelled in mapping as Buhayrat al Asad.

Daesh went on adapting their tactics, using indirect fire to fix Iraqi forces so they could be targeted with VBIEDs and employing a multiplicity of sniper, direct fire and RPG positions, often from elevated sites. Although now almost encircled, they were sustained by a hard core of fanatics, who were willing to fight and die without any regard for the cost in terms of civilian casualties. In the second week of March, the RAF released 35 Paveway 4s, taking 903 EAW's total number of precision weapon releases beyond 2,000 and the RAF's total, including Reaper, to 2,700 since the start of Operation Shader.¹⁶⁹

It was only a matter of time before the weather intervened once more, and it eventually did so in the third week of March to prevent much planned air ISR activity. The Iraqi advance continued but against fierce opposition. In the following week, the weather again held numerous aircraft on the ground, and the RAF, flying from Cyprus, provided the only fixed-wing coalition strike assets over Mosul on two out of three consecutive days. The demand for support was high, and the GR4s and Typhoons released some 27 Paveway 4s. The published MOD record for 19 March records:

A busy day for both the Tornado and Typhoon aircrews over Mosul. Yet again working very closely with the Iraqi troops, they repeatedly struck Daesh positions engaged in extremely close combat with the security forces. In total, eleven Daesh targets, including sniper, heavy machine gun and rocket-propelled grenade teams, were eliminated by Paveway 4s.¹⁷⁰

On the 24th,

A Typhoon flight, armed with Paveway 4s, targeted the entrance to a tunnel some 6 miles west of Tall Afar. Other coalition aircraft had successfully destroyed a neighbouring building used by the terrorists, but Daesh had also been spotted making use of the tunnel, most probably for ammunition or supply storage. A direct hit from a Paveway 4 collapsed the tunnel entrance. The Typhoons then headed east to support operations in Mosul, where they attacked 4 Daesh-held buildings which the extremists were using to fire at Iraqi units. A second Typhoon pair were also active over the city. They provided similar assistance to Iraqi forces

engaged in close combat, striking 3 terrorist positions with Paveway 4s. A flight of Tornados also patrolled over Mosul and the surrounding area, where they conducted a simultaneous strike on 2 Daesh strongpoints inside the city. They then headed north-west to deal with a reported mortar team. The terrorists were spotted with a vehicle in rocky ground near the Tigris and hit with a Paveway.¹⁷¹

VBIEDs were far less numerous in western Mosul than in the east. In the east, the average number of VBIED attacks recorded in a 45-day period amounted to 14 per day. Daesh succeeded in mounting around 10 attacks per day in the early stages of the operation in the west, but this was not sustainable; over a period of 36 days, the average rate was just 3 per day.¹⁷²

The difference primarily reflects the high number of pre-positioned weapons in the east, but it may also be that subsequent resupply efforts for the eastern portion of Mosul reduced the number of weapons that could be pre-positioned in the west. Coalition targeting of manufacturing facilities would have reduced the production of VBIEDs, although its precise impact is impossible to quantify, and air strikes on such facilities remained few and far between. An RAF Reaper destroyed two VBIEDs at a workshop on 24 February, while GR4s hit a factory on 1 March, and a mixed GR4-Typhoon formation struck another on 8 April. Considerably more coalition air effort was expended on cratering the main access roads into Mosul. This proved effective in slowing the transit and use of VBIEDs but was costly in terms of sorties, re-attack sometimes being necessary after Daesh filled up the craters. RAF aircraft bombed roads into Mosul at least six times in March, hitting at least nine targets.¹⁷³

At the same time, Iraqi ground manoeuvre also impacted on the production and resupply of VBIEDs, defensive measures improved, and the reduced number of VBIED attacks increased the scope for individual weapons to be defeated by Iraqi ground forces or coalition air power. Of the 109 VBIED attacks staged by Daesh in western Mosul by 26 March, 83 were halted by Iraqi or coalition countermeasures. This was a fourfold increase over the rate of interception recorded in east Mosul.¹⁷⁴

The ferocity of the fighting led to a mass civilian exodus, but considerable numbers remained in Mosul, taking such shelter as they could find; the risk of a significant civilian casualty incident was always high. On 17 March, more than 100 sadly died in an American strike on a sniper position. Requested by Iraqi ground forces and approved by one of the strike

cells, the attack caused a major secondary explosion that destroyed the entire building from which the snipers had been shooting. Subsequent investigations revealed that the targeted building had been under observation by Iraqi forces for more than two days, and they had not observed civilians entering or using it. Daesh, on the other hand, knew it was a civilian shelter and intentionally brought in explosives, placing them at locations that would cause a catastrophic collapse if it was hit from the air. Then they set up the sniper position to encourage the ISF to request an air strike.¹⁷⁵

The incident presented Daesh with a propaganda opportunity and contributed to an Iraqi decision to pause the Mosul offensive temporarily. The high civilian loss of life also generated a degree of friction between different coalition members. In the heat of the moment, it was easily forgotten that all weapons employed by a coalition force are ultimately *coalition* weapons. If their use results in tactical and, ultimately, operational success, that is a coalition achievement. Equally, if measured risks are taken in pursuit of campaign progression and something goes wrong, the responsibility is collective. The preponderant role of US air power in the coalition substantially increased the likelihood that any civilian casualty incident would involve American aircraft. In the aftermath of this tragic episode, no other coalition member offered to deploy more aircraft into theatre or assume risks that the Americans, as coalition leaders, had been compelled to accept since 2014.

The coalition cause was not helped by a western media that struggled to grasp the reality of the Mosul battle. While the volume of PGMs delivered from the air with pinpoint accuracy and in accordance with strict ROE was dwarfed by the scale of (substantially) unguided and haphazard Iraqi artillery, rocket and mortar fire, the shells and rockets arrived through the air and stoked an uninformed and misleading narrative of disproportionate and indiscriminate air strikes. The reality was that the coalition faced an exceptionally difficult urban fight against opponents with no exit strategy or interest in personal survival – opponents who also employed heavy and damaging ground weapons indiscriminately. In this situation, while the clearance of Daesh defences could be (and often was) attempted using low-yield ground or air weapons, larger payloads were regularly necessary.

Resource-related issues further complicated the challenge facing coalition forces. Apart from the American Small Diameter Bomb and the RAF's Brimstone, one of their most accurate low-yield air-to-ground weapons was the Reaper-borne Hellfire, and its utility over eastern Mosul has already been noted. However, by February 2017 (in a notable shift away

from the close-battle prioritisation hitherto applied), the CJTFHQ was diverting a growing proportion of Reaper effort to other locations in support of future planning. These included the main Syrian objective, Raqqa, identified pockets of Daesh resistance such as Tal Afar and Hawijah, and such regions as Anbar and the MERV, extending from border towns like Al Qa'im (Iraq) and Abu Kamal (Syria) northwards towards Dayr-az-Zawr. Throughout the spring of 2017, these areas were subject to continuous coverage by theatre ISR assets as the coalition sought to understand what remained of Daesh and prepare for clearance operations. RAF Reapers (as well as the single deployed Sentinel) were regularly tasked over the MERV in support of this collection effort, limiting the availability of Hellfire during the struggle for western Mosul. Reapers executed strikes in Mosul on 15 days during the first three weeks of January, but only a single attack is recorded in the MOD's published narrative in March.¹⁷⁶ In April, only one RAF Reaper released Hellfires over Mosul, targeting two Daesh mortar teams on the 7th.¹⁷⁷

When civilian casualties did occur, the media and a variety of interested charities and pressure groups confidently anticipated post-incident investigation on the ground, as was commonly undertaken in Afghanistan. However, the application of such a system in Operation Shader was often impossible because of Daesh's continuing presence in the areas concerned. And whereas, in Afghanistan, an air strike might represent the only expenditure of ordnance in an area where civilian casualties occurred, in Shader, air munitions were frequently released against Daesh positions that were also being subjected to heavy (and far less accurate) fire from ground weapons, and from which weapons were also being discharged. Moreover, there was clearer regional and national delineation of airspace over Afghanistan than there was over Iraq and Syria, and it was therefore easier to establish which of the participating coalition air forces had been involved in civilian casualty incidents.

All air strikes were subject to prior collateral damage risk assessments designed to minimise the chance of civilian casualties and damage to civilian infrastructure, and the MOD also conducted an assessment after every RAF engagement of the damage caused; this included consideration of whether civilian casualties might have occurred. Nevertheless, in the absence of ground investigation, such measures were largely dependent on air imagery from ISR assets or weapons system video. There was no viable alternative.

In an operational environment in which there could be little ground investigation, in which multiple air forces were involved, and in which a

huge volume of ground-launched munitions was employed in support of (and retaliation against) ISF and SDF manoeuvre, the difficulty of reliably connecting specific air strikes to specific civilian casualty incidents should be obvious. As an illustration, two years after Shader began, PJHQ received an assessment of potential civilian casualties from a third party, linking evidence they had gathered and the MOD's online narrative of RAF operational activity. Subsequent PJHQ analysis confirmed that in 46 of the 53 cases listed there had been no UK involvement, while in the other seven cases there was not enough information in the evidence provided to make an accurate assessment of where the incidents took place. However, none of the MOD's post-strike assessments had yielded evidence of civilian casualties on the dates in question. Many of the reported air strikes occurred in Mosul before the start of Eagle Strike or in other towns and cities under Daesh occupation.¹⁷⁸ By the time they were liberated, usually after prolonged and heavy fighting, there would have been minimal scope for obtaining useful evidence via ground investigation.

The ground offensive resumed at the end of March, albeit with even closer scrutiny of air strike requests and the rejection of increasing numbers, despite inevitable protests from senior Iraqi ground commanders. The CTS were confronted by well-coordinated Daesh defences, while the FEDPOL, hemmed in by the Tigris on their right – lost and then regained ground. Heavy casualties fuelled calls for the Iraqi Army to open a genuine third axis from the north. By mid-April the reporting was more optimistic, the CTS having made particularly significant progress. Air-delivered munitions continued to provide critical precision fires, small-yield bombs being used where possible. Yet Daesh still resisted with every means at their disposal, and Iraqi casualties continued to mount. Furthermore, the launch of the northern axis was delayed again, partly for the 9th Armoured Division to complete its preparations, partly to allow for shaping from the air, and partly because of adverse weather predictions and the implied grounding of planned air support.

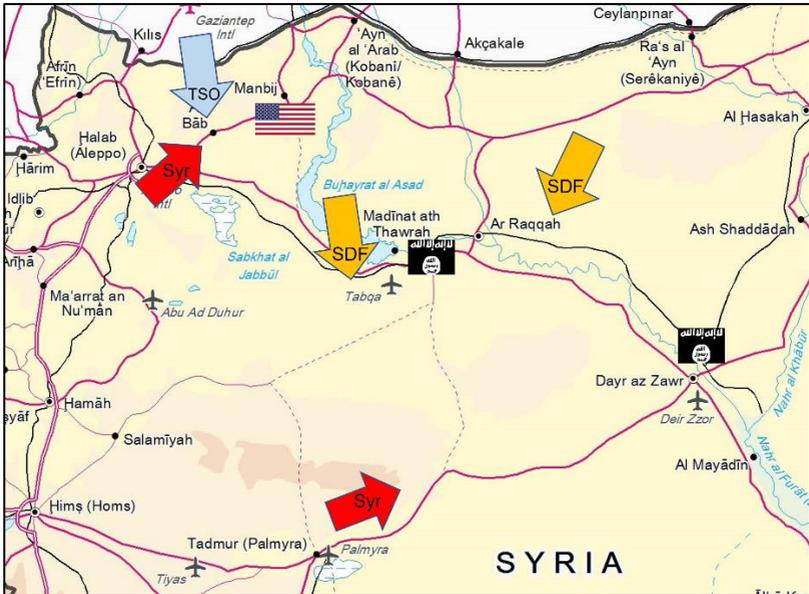
The 9th Armoured Division finally began their assault in the first week of May and soon eliminated the more outlying Daesh positions.¹⁷⁹ Flexibility in weapons carriage and employment remained a fundamental principle for the Air Component, and the RAF's Tornado GR4s therefore played a key role in sustaining the 9th Armoured Division's progress throughout the month. On 8 May, one pair executed a series of attacks to support the Iraqis, hitting Daesh fighters firing from rooftops and buildings, and destroying a local Daesh headquarters. Another pair used Paveway 4s to cut the road

network at three key choke points and prevent Daesh moving VBIEDs and other vehicles towards districts liberated by the Iraqis.¹⁸⁰ In the third week of May, 26 of the 38 munitions employed by the GR4s and Typhoons were released over Mosul, and there was a marked increase in the demand for Brimstone.¹⁸¹

While the struggle for west Mosul continued, in Syria a combined force of SDF and American SOF deployed across Lake Assad by air and boat to establish a hold on the southern shore (see Map 9). It was clear that considerable operational advantages would result from an assault on Tabqah from the south as well as the north.¹⁸² Furthermore, the SDF presence promised to halt any further move towards Tabqah by Daesh fighters fleeing Al Bab. Air preparation included extensive ISR and shaping strikes, the RAF participating in the destruction of a Daesh headquarters south of Raqqa on 12 March. GR4s released GPS-guided Enhanced Paveway 2s through heavy cloud and achieved direct hits on both targeted buildings.¹⁸³

The Lake Assad operation was mounted on the night of 21/22 March and initially involved some 500 SDF troops and a considerable quantity of equipment. RAF personnel supported planning activity at Al Udeid, and the air plan included vital RAF contributions in the form of Sentinel wide area surveillance, Reaper and GR4 missions. The SDF moved rapidly to secure Tabqah airfield, but the dam represented a significant tactical (and potentially environmental) problem. Overwhelming firepower was not a realistic option.

Resupply and reinforcement across the lake strengthened the SDF's hold on the southern shore, but their boats came under attack from Daesh vessels and armed UAS, and the troops on dry land were also targeted. The situation was further complicated by the American TLAM attacks on Shayrat airfield on the night of 6/7 April in response to the Syrian regime's use of chemical weapons. The complexity of the battlespace was underlined by an unfortunate 'blue-on-green' episode on 11 April, when 18 SDF troops were killed in an American RPAS strike after they had been wrongly identified as Daesh fighters by another SDF unit.¹⁸⁴



Map 9. The SDF crossed Lake Assad on the night of 21/22 March; meanwhile, after capturing Palmyra from Daesh, Syrian and Russian forces continued their eastward advance towards the Euphrates.

East of Tabqah, SDF elements that had crossed Lake Assad soon linked up with forces advancing from the north,¹⁸⁵ but reporting suggested that Daesh were strengthening their defences in the town, and it seemed certain in mid-April that the hardest fighting was yet to come. However, while Daesh held out stubbornly at the dam, extensive coalition ISR activity that included numerous RAF Reaper missions ensured that their dispositions in Tabqah were well understood by the SDF, and resistance there soon collapsed. Such support as was required from RAF combat aircraft was limited to a few isolated attacks by Typhoons with Paveway 4s. Of note, on 13 April, they destroyed seven strongly defended Daesh positions that were holding up the SDF advance. According to the MOD record:

Syrian Democratic Forces reported being in very close combat with a group of 7, strongly defended, Daesh positions. Despite heavy cloud, the Typhoons were able to destroy one position on their first pass, then having

confirmed the exact location of the other 6 targets, struck all of those simultaneously with Paveway 4s on a second pass.¹⁸⁶

Negotiations for a surrender began in the first week of May and both the town and the dam were formally liberated on the 10th, some Daesh fighters being allowed to leave to avoid further bloodshed.¹⁸⁷

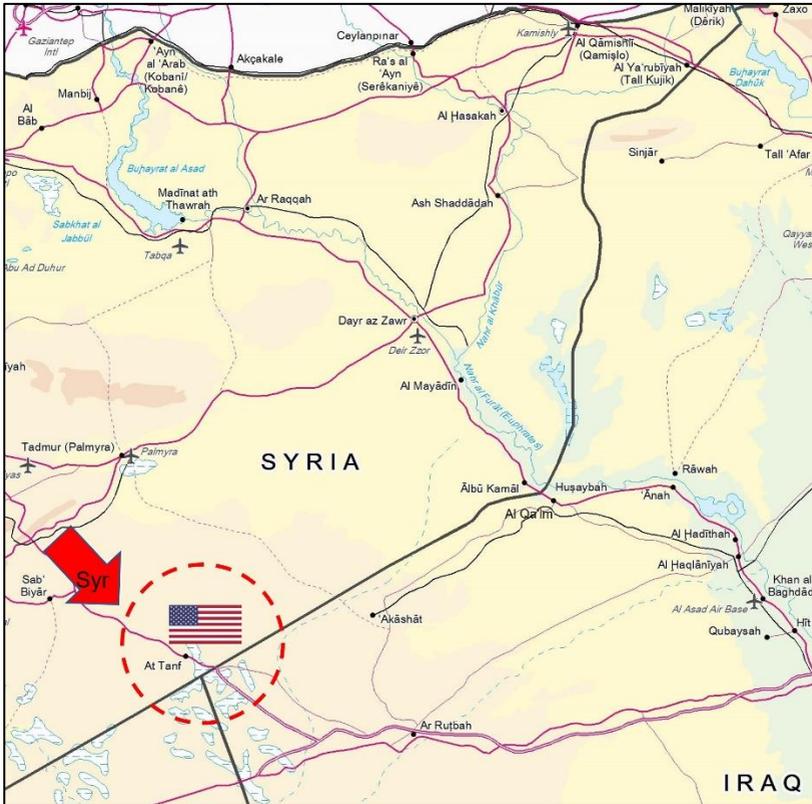
To the south, along the MERV, a new and particularly difficult phase of Operation Shader was about to begin. The first indicators of the problems to come appeared in the third week of May, not in the MERV but in the tri-border area (the meeting point of the Iraqi, Syrian and Jordanian frontiers) further west. There, some 24 miles inside Syria, the Americans had constructed a small military base at At Tanf as part of an operation named Apex Edge. Its activities included support and training for Syrian rebel elements fighting Daesh, but its presence was also a symbol of Washington's determination not to give Russia or Iran a free rein to extend their influence in Syria as the threat from Daesh receded. It was positioned on the Baghdad-Damascus highway – the main over-land communications route through Iraq to Syria and Lebanon. Predictably enough, the Syrian regime was unhappy with the US presence and the 55km deconfliction area imposed by the Americans around the At Tanf base.¹⁸⁸

Tension rose when Syrian ground forces began to probe the 55km zone, allegedly in operations against Daesh. The coalition responded with shows of air presence and combat air patrols, but it became clear that the Syrians had ulterior motives. Matters came to a head when a formation that included armour and engineering units ventured within 30km of the At Tanf garrison and ignored demands to withdraw, including firepower demonstrations. In response, CENTCOM authorised USAF strikes, which achieved their intended effect by destroying several Syrian military vehicles.¹⁸⁹

An increasingly uncertain situation developed, involving Russian, Syrian regime, American and Syrian rebel ground elements. Inevitably, in these circumstances, the senior coalition air commanders had to reconsider the possibility of friction with the Syrians or the Russians in the air and initiate appropriate measures. In the short term, these included some temporary reapportionment of aircraft away from the tri-border area.

The At Tanf incident hinted strongly at what was to come as rival forces approached eastern Syria. From this point onwards, the deconfliction issue assumed greater prominence in coalition plans and actions: it became a more significant operational constraint. Moreover, physical deconfliction was not

the only problem. As 2017 wore on, coalition assets operating over Iraq and Syria increasingly reported the presence of Electro-Magnetic Interference (EMI) and GPS jamming.¹⁹⁰ Periodically, too, the convergence of forces impacted on resource allocation. The need for continuous American air cover over At Tanf made the coalition more reliant on non-US aircraft – particularly RAF combat aircraft – over Mosul and northern Syria.



Map 10. The Americans established a base at At Tanf (circled); mounting friction between Syrian and US forces in the area then generated a significant demand for air cover, which was thus diverted from operations against Daesh.

By the beginning of June, the area of Daesh control in west Mosul had been reduced to around five square kilometres, but this included the dense urban environment of the old quarter and the high-rise Ja'mouri Hospital district, where there was a formidable array of elevated firing points. Before the ISF assault into this area began, a review of the Air Component's likely role again concluded that low-yield high-precision weapons would have a crucial part to play, and the RAF therefore increased Brimstone carriage by the Tornados and mounted more mixed Tornado and Typhoon missions to extend the periods when Brimstone was airborne over the target area.¹⁹¹ The review also resulted in the Americans giving priority to Mosul in the allocation of their best CAS platforms – USAF A-10s and Marine Corps F/A-18Ds. Separately, an Iraqi leaflet drop over Daesh-held areas directed civilians to leave and head for ISF lines if it was feasible to do so.

The CTS subsequently made limited progress against the more westerly objectives, but the 9th Armoured Division was halted completely in the hospital district. Although they called in precision air support and actually flew their armed quadcopters *inside* the high-rise hospital buildings in an attempt to identify Daesh sniper positions, they were ultimately compelled to withdraw and revise their plans. Supporting RAF missions involved, among other things, the release of some 15 Brimstones – 40 per cent of the UK weapons employed.¹⁹² On 2 June, in very close proximity to Iraqi forces, they used a mix of Brimstones and Paveway 4s to target eight Daesh positions, including three machine gun teams and three groups of fighters armed with RPG launchers. A VBIED concealed close to one of the positions was also fortuitously detonated. On the 3rd, two more mixed pairs delivered five attacks with four Brimstones and a Paveway 4 against a VBIED, RPG teams and snipers. On the 4th, another mixed pair used a Brimstone and two Paveway 4s against Daesh-held buildings. On the 5th, Tornados used Brimstones to destroy two Daesh firing positions containing an anti-tank gun and a machine gun.¹⁹³

Another upsurge of tension at At Tanf on the 8th and a further diversion of US aircraft then led to RAF GR4s and Typhoons being switched from Mosul to northern Syria. In May, the new US Trump administration had approved the supply of weapons – including heavier weapons such as mortars – to the YPG.¹⁹⁴ Nevertheless, the SDF's demand for air support remained high, and the two RAF platforms made a valuable contribution to their advance towards Raqqa in the middle of June, which brought them to the outskirts of the city. The MOD narrative records that RAF aircraft executed strikes in or near Raqqa on 14 days during the month.¹⁹⁵ Yet parallel

commitments in Mosul, Raqqa and At Tanf generated a continuing resource burden. In the week ending 18 June, the Air Component employed nearly 1,000 weapons – 318 in support of the Iraqis in west Mosul and more than 400 in support of the SDF. The RAF total was 50 (divided equally between the two cities) and included Hellfire as well as Paveway 4 and Brimstone.¹⁹⁶

The bitter struggle for the Ja'mouri Hospital continued, and the potential for civilian casualties in west Mosul's old quarter remained a major source of concern. Similar issues were arising in Raqqa, where Daesh had constructed part of their eastern defensive system around the ancient city wall – a structure of great cultural significance, which the coalition was inevitably reluctant to target. Meanwhile, Syrian regime forces moving quickly east captured the village of Arak, and further recourse to the hotline became necessary to deconflict coalition and Russo-Syrian activity. Despite this, on 18 June, a US Navy F/A-18E shot down a Syrian Air Force Su-22 Fitter after it had attacked SDF forces south of Tabqah, requiring an extensive Russian/coalition engagement and de-escalation effort and the introduction of measures to improve deconfliction in future. At the same time, the CFACC requested the deployment of more interceptor fighters from the United States and duly received six additional F-22s.¹⁹⁷

The danger in all this was that the coalition might lose focus on the primary task of defeating Daesh, yet Air Component support for the ISF and SDF continued along with deliberate strikes on Daesh networks away from the main battlefronts. Coalition aircraft successfully targeted VBIED facilities, weapons storage, bed-down locations and command, control, communications and intelligence at a range of locations in Iraq and Syria between April and June, including Al Baaj, Bulayj, Abu Kamal and Raqqa. On 25 May, two Typhoons struck a radio relay station in eastern Syria, which Daesh had been using to spread propaganda.¹⁹⁸ On 12 June, Tornado GR4s attacked a VBIED workshop near Karwi in Iraq, using Brimstones to destroy three parked VBIEDs and Paveway 4 to demolish the facility itself. The GR4s destroyed a similar workshop on the outskirts of Mayadin on the 26th.¹⁹⁹

In short, the pressure on Daesh was increasing inexorably; but whereas, previously, the coalition had enjoyed relative freedom of action on the main battlefronts, operations over Syria required a far more exacting deconfliction effort by the middle of 2017.²⁰⁰ On the 25th, in the absence of Russian concurrence, coalition aircraft were unable to intervene to prevent a Daesh public execution near Dayr-az-Zawr.

7. From Raqqa to the MERV

The next phase in the liberation of Raqqa began on the night of 3-4 July, when US aircraft struck the ancient perimeter wall at two locations approximately 200 metres apart, allowing the SDF to move into the old quarter along routes free from prepared Daesh defences. Single BLU-109 bombs were released against each aiming point, and pre-positioned excavation and engineering equipment was then deployed immediately to clear the rubble and allow the SDF to advance swiftly through the breaches. Proactively, the CJTFHQ published a press release to explain why the coalition had demolished part of the wall and emphasise that the two strikes represented the minimum necessary to support SDF operations.²⁰³

By mid-July, around two-thirds of coalition CAS capacity was operating over Raqqa in response to support requests from the Talon Anvil strike cell. Senior 83 EAG officers worked closely with the strike cell staff to enhance their understanding of the RAF's potential contribution and of the scrupulous engagement criteria observed by the RAF at all times, as well as to match UK strike capabilities to suitable Daesh targets. These included defensive firing positions, snipers and VBIEDs. On the 15th, GR4s and Typhoons mounted a coordinated attack with US assets on four separate mortar-firing areas, hitting multiple Daesh mortar teams and weapons caches in two parks. The SDF reported afterwards that the volume of indirect fire from Daesh had fallen appreciably; there had been no more incoming rounds from the targeted areas. The intensity of RAF operations over Raqqa in this period is captured by the MOD strike record for July 2017:

5 July. Tornados kept watch over the latest SDF advances in Raqqa and used a Paveway 4 to deal with a sniper team.

6 July. Two Royal Air Force Typhoons, armed with Paveway 4 bombs, operated over Raqqa. Syrian Democratic Forces (SDF) encountered a large building on the southern edge of the city, close to the bank of the Euphrates, which was heavily defended by Daesh extremists. Two Paveways struck the building and brought an end to the terrorists' activity. A mixed pair of a Typhoon and a Tornado were also active over Raqqa, and these aircraft bombed a sniper position which had been firing persistently at the SDF.

7 July. Two more Paveway 4s were used in attacks by Typhoons on a pair of defensive positions which the SDF had come up against in Raqqa.

8 July. Tornados continued to support the SDF in Raqqa, striking a Daesh position there.

9 July. Typhoons hit a further target in Raqqa.

12 July. Over Raqqa, a mixed Tornado and Typhoon pair flew overwatch as the Syrian Democratic Forces continued their advance through the city; our aircraft used Paveway 4s to engage three Daesh positions which opened fire on the SDF, and successfully silenced each threat in turn.

14 July. The major focus for RAF missions has been to assist the Syrian Democratic Forces fighting in Raqqa. Two Typhoons used a Paveway 4 to destroy the entrance to a tunnel dug beneath an area in the west of the city.

15 July. Tornados and Typhoons utilised 11 Paveway 4 bombs against mortar positions in Raqqa.

16 July. In the course of surveillance over Raqqa, a Reaper delivered a Hellfire missile attack which killed a small group of terrorists armed with rocket-propelled grenades, who had been firing on the Syrian Democratic Forces from a rooftop. Tornados and Typhoons were also very active over the city and used a Brimstone missile to attack one terrorist firing point, and Paveway 4s to deal with three sniper teams and two other positions defended by Daesh extremists.

19 July. A mixed pair of one Tornado and one Typhoon provided close air support to the Syrian Democratic Forces (SDF) fighting to clear the terrorists from Raqqa. A coalition surveillance aircraft identified a Daesh defensive position, and our aircraft conducted a successful attack with a Brimstone missile. A terrorist command post was also identified within the city, and this was struck with two Paveway 4s.

20 July. Operations over Raqqa continued, when a Typhoon mission assisted SDF engaged in combat with a group of extremists firing from a building; this was hit with a single Paveway 4, which eliminated the threat to the SDF.

21 July. A pair of Tornados bombed the top of a grain silo in Raqqa, where a group of Daesh were stationed in a combined observation and sniper post.

23 July. Three flights of Tornados and Typhoons conducted missions over Raqqa, in which they delivered successful attacks on six Daesh positions, using Paveways IV bombs and Brimstone missiles.

24 July. Three more Paveway 4s were dropped, targeting a further three terrorist firing points.

27 July. A Tornado and Typhoon pair attacked mortar and sniper positions in Raqqa.

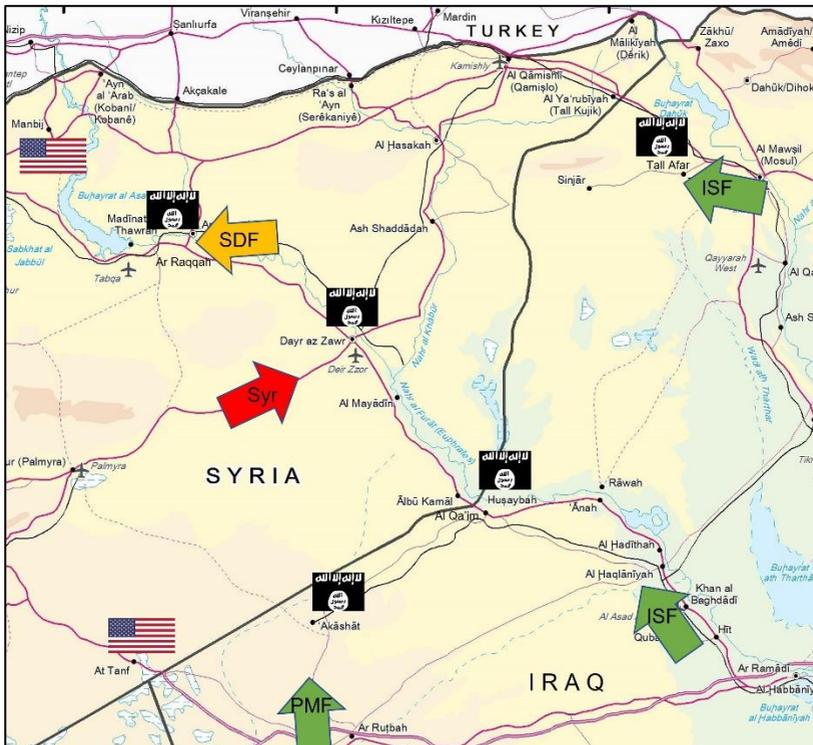
28 July. A Tornado and Typhoon pair struck a Daesh position in Raqqa.

30 July. A Tornado and Typhoon pair eliminated two terrorist snipers in Raqqa.²⁰⁴

In Iraq, the coalition now planned to eliminate the remaining Daesh strongholds of Tal Afar and Hawijah, and clear Anbar and the MERV up to Al Qa'im and the Syrian frontier. Preparations for Tal Afar took just over a month while the battle for Raqqa raged on. The coalition continued to focus ISR and deliberate targeting on the MERV, striking Daesh logistics, weapons storage, command nodes and IED/VBIED production, but parallel requirements over Raqqa and (for preparatory strikes) Tal Afar maintained the pressure on air resources. Once again, numerous concurrent demands for ISR caused priority to be assigned largely to ongoing operations at the expense of longer-term target development. It was unfortunate that, at this time of heightened demand, the RAF's Sentinel deployment ended; it had been extended several times since 2015. The UKACC paid tribute to Sentinel's contribution but also noted that RAF ISR support would be increased again in October by another RC-135 Airseeker deployment.

Sentinel was also scheduled to resume Operation Shader tasking towards the end of the year.

Meanwhile, Syrian forces pressed further east towards the MERV. Coalition commanders eyed their progress with no little concern and began to discuss ways of speeding up Raqqa's liberation, exploiting the brief hiatus between the Mosul battle and the assault on Tal Afar to intensify operations, defeat remaining Daesh forces in Raqqa, and free up the SDF to launch their next offensive south and evict Daesh from the river valley – Operation Talon Spear. The plan once again raised the issue of deconfliction and of how this could be managed as Syrian regime forces reached the western bank of the Euphrates.



Map 12. The SDF assault on Raqqa began early in July 2017; the ISF turned their attention to Tal Afar and Syrian regime forces approached the MERV.

During the second week of August, the Commander CJTF officially moved the coalition campaign from Phase 2 (Dismantle) to Phase 3 (Defeat). This was a measure that reflected the enormous progress achieved by operations against Daesh over the preceding twelve months.²⁰⁵ However, the justification for progressing to Phase 3 was subsequently underlined by the Iraqi offensive against Tal Afar on the 20th. Once again, the coalition expected strong opposition. There were reports that up to 1,000 Daesh fighters were defending the town, which was ringed by defensive outposts and a huge belt of IEDs.

Yet Tal Afar was liberated in about 10 days. Daesh proved to be numerically weaker than expected, their command and control was poor, and there was further evidence of friction between indigenous and foreign fighters. Effective intelligence preparation allowed the Air Component to shape the battlespace very effectively, and the ISF plan was boldly executed on multiple axes with abundant CAS.²⁰⁶ The rapid fall of Tal Afar persuaded the Iraqis to bring forward their planned operation to regain Hawijah, where shaping air strikes soon began. The achievement of this goal would leave Daesh's residual presence in Iraq confined to the Anbar region. During the liberation of Tal Afar, RAF GR4s and Typhoons provided CAS to the ISF and targeted defensive positions, fielded forces and Daesh-occupied buildings.²⁰⁷

The defeat of Daesh forces in Tal Afar occurred at the same time as their opposition in Raqqa's old quarter began to crumble in the face of a ferocious SDF attack and sustained precision air strikes. For the RAF, operating over both cities, this was one of the most intensive periods of air-to-ground warfare of the entire Shader campaign:

20 August. Typhoons bombed a further Daesh position in Raqqa. In eastern Syria, Tornados targeted a group of terrorists deployed near the border with Iraq; two Paveways hit their trucks and killed several of the extremists. Meanwhile, two mixed flights of Tornados and Typhoons assisted the Iraqi forces around Tal Afar; Paveway 4s destroyed two mortar and rocket teams, an anti-tank missile team, and a group armed with rocket-propelled grenades, whilst a Brimstone missile accounted for a small group of terrorists caught manoeuvring in the open.

21 August. Two mixed pairs of Royal Air Force Typhoons and Tornados supported Iraqi forces fighting around Tal Afar in northern

Iraq. East of the city, Brimstone missiles were used to destroy two pickup trucks carrying terrorists, while an attack with a Paveway 4 guided bomb destroyed a car bomb to the south west.

23 August. A Typhoon flight used Paveway 4s to destroy two defensive positions in Raqqa, from which Daesh extremists were firing on the SDF. Tornados bombed two groups of terrorists spotted on foot to the north east of Tal Afar, while a mixed flight used a Brimstone to destroy an armed truck hidden under a building's overhang on the western edge of the city.

24 August. Typhoons and Tornados struck a further four positions in Raqqa with Paveways, including a sniper and a machine gun team. Typhoons and Tornados were also very busy around Tal Afar: Paveway 4s were used to target one large and two small buildings comprising a truck bomb factory, and five other positions from which terrorists armed with suicide vests, rocket-propelled grenades, a mortar and a heavy machine gun were operating. In addition, two Brimstone missiles were fired successfully at a truck bomb, and a mechanical excavator used to construct defensive positions.

25 August. A mixed Typhoon and Tornado pair delivered three further Paveway attacks in Tal Afar, hitting two mortar teams and a Daesh-held building. Over Raqqa, our aircraft continued to support the SDF, and used Paveway 4s against two sniper positions and another terrorist strong point.

26 August. The focus for RAF missions remained on Raqqa over the weekend when a mixed flight bombed four sniper teams...

27 August. On Sunday, three RAF flights used Paveway 4s to attack a total of ten Daesh positions in the city.

28 August. Raqqa operations continued when Typhoons hit three more terrorist-held buildings. In Iraq, Iraqi forces engaged Daesh forces positioned several miles north of Tal Afar, and our aircraft provided close air support, conducting attacks on ten buildings occupied by the extremists.

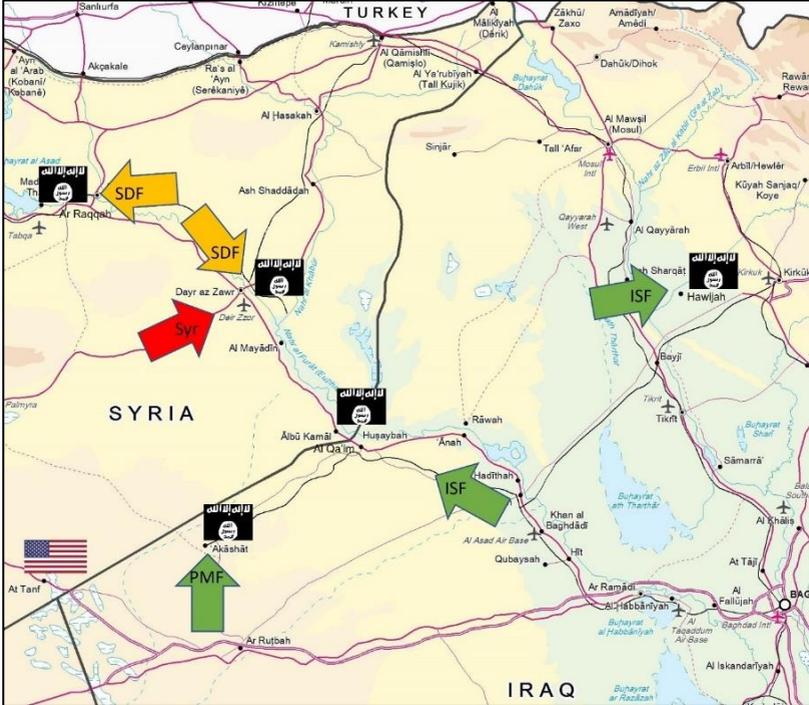
30 August. Three flights of RAF Tornados and Typhoons provided close air support to the fighting to liberate Raqqa from Daesh control. Five attacks were successfully conducted, which eliminated three sniper positions, a light machine gun team, and a group of extremists armed with rocket-propelled grenades. Each of the attacks required careful planning and execution by our aircrew, given the proximity of the SDF to the desired targets.²⁰⁸

The CJTFHQ continued to examine the scope for accelerating Raqqa operations, but it became clear that this would not pay sufficiently rapid dividends. Consequently, Operation Talon Spear was launched ahead of schedule on 7 September while the fighting in Raqqa continued. Apart from providing direct air support, the Air Component struck targets in Abu Kamal, Mayadin and Al Qa'im, from where a number of key logistics networks were supplying lethal aid throughout Anbar Province and north into the MERV. On 1 September, coalition aircraft that included RAF GR4s and Typhoons struck a major Daesh operating base at Al Qa'im, where ISR had revealed entry checkpoints and defensive berms. Intelligence subsequently linked the site to command and control, anti-air weapons storage and VBIED manufacturing.²⁰⁹

The SDF were soon approaching Dayr-az-Zawr, advancing along the north-east bank of the Euphrates while Syrian regime forces approached the opposite bank from the south-west. With the two armies converging, the deconfliction issue loomed larger still, coalition aircraft regularly operating close to their Russian and Syrian counterparts. A significant command and control effort was required to demarcate their respective operations.²¹⁰ Nevertheless, on the night of 15/16 September, Russian air strikes on the north-eastern bank of the Euphrates injured several SDF fighters, risking potential US retaliation. High-level conversations between the Americans and Russians helped to relieve the tension, but a residual threat remained, and the RAF's Typhoons flew in a combined DCA and CAS role for the next two months at the CFACC's request.²¹¹

Quite apart from the strategic consequences that could have resulted from a clash between coalition and Russian aircraft, the arrival of Syrian ground troops and the Syrian and Russian air forces in the MERV had direct operational implications. For some time, coalition planners had predicted that Daesh leaders and their followers, driven out of the MERV, might disperse to the south to fight another day. There were extensive plans to target them before this could happen, but the unexpectedly rapid Syrian and

Russian advance reduced the scope for their implementation, leaving Daesh with an opportunity to evacuate with less interference from the air and reduced ISR tracking.



Map 13: The arrival of Syrian regime forces in the MERV forced the early launch of Operation Talon Spear, while the struggle for Raqqa continued; in Iraq, the ISF liberated Hawlajah, another pocket of Daesh resistance.

The Russians remained open to dialogue, and the hotline continued to serve its purpose, but agreements reached verbally or set down in writing were soon made redundant by the unfolding ground campaign. Moreover, while the Russians were prepared and sometimes eager to discuss deconfliction issues, their activities were also accompanied by increasingly aggressive strategic communications that questioned the entire basis for US-led action in Syria, and they made periodic overtures to the SDF that were partly designed to undermine their relationship with the coalition. Another

tactic involved disinformation, including an alleged Syrian regime plan (passed to the CJTFHQ) to bridge the Euphrates and advance east to the Iraqi border, effectively halting SDF progress south into the MERV. The coalition rightly assessed that Syrian ambitions, in the short term at least, were confined to the establishment of a limited footprint on the east bank of the river as part of their operation to evict Daesh from Dayr-az-Zawr. This was achieved by building a pontoon bridge (which was actually constructed by Russian forces), as well as by using boats, to transport vehicles, equipment and personnel. Rising water levels destroyed the bridge in January 2018, and there was no attempt to build another until the spring.²¹²

At the end of September, the burden of parallel commitments tested the coalition yet again. Continuing operations in support of the SDF over Raqqa and the MERV coincided with the start of the Iraqi offensive to liberate Hawijah and ongoing ground activity in the Anbar region, notably an assault on Anah. At the same time, there were further requirements for DCA cover over At Tanf and northern Syria, and a brief carrier gap did not help matters. It is hardly surprising that a pair of RAF Typhoons mounted the longest sorties flown by the aircraft during operations against the caliphate on the 23rd. After flying in support of Talon Spear, their mission was extended to fill a break in air cover over Hawijah, as no other strike assets were available. They delivered six Paveway 4s against VBIEDs and a weapons cache before recovering to Akrotiri. Other RAF formations also targeted weapons stockpiles, fielded forces, command posts and road obstacles in support of Hawijah's liberation.²¹³

Fortunately, rapid progress in Raqqa and Hawijah soon brought welcome relief. At the same time, the PMF's liberation of Akashat – another Daesh pocket in the western desert near the Syrian border – provided further evidence that their movement was in terminal decline. Increasingly, it seemed likely that they would embrace more insurgent-type operations rather than seek to hold ground. This was underlined by several hit-and-run actions, including a raid in the Ramadi area on the 27th that combined VBIED attacks with the infiltration of fighters and was only defeated following a large-scale diversion of Iraqi and coalition resources. Tornados and Typhoons struck Daesh fighters on foot and in a trench and employed Paveway 4 and Brimstone against a convoy of Daesh vehicles.²¹⁴

The culminating act in the defeat of Daesh in Iraq was complicated at the last moment by yet another extraneous development. On 25 September, President Barzani of Kurdistan held a referendum on Kurdish independence that extended into Iraqi territory captured by the Peshmerga from Daesh,

including the Kirkuk oil fields. The result – 93 per cent in favour of independence – precipitated a conflict in which Iraq regained the disputed territory. Quite apart from diverting Iraqi forces from planned operations in Anbar, the confrontation threatened such coalition ground units as remained in the north-east and, as the Commander CJTF considered that they could not be withdrawn, it was necessary to provide them with air cover – both combat and ISR. In the context of this unwelcome diversion, the collapse of Daesh resistance in Hawijah was very welcome but would have been greeted with still more coalition enthusiasm had the Iraqis been poised to move immediately on to the last, decisive operations in the west.²¹⁵

During the third week of October, the SDF finally liberated Raqqa. Killed in action, their casualties totalled some 400 troops; many more were wounded. As with Mosul, imagery of ruined streets and levelled buildings flooded the world's media and was misleadingly associated with coalition air strikes rather than a ground battle that was more damaging and not nearly so precise. While the SDF lacked some of the heavier weapons employed by (or in support of) the Iraqis, mortars and rocket-propelled grenade launchers were extensively employed, and US forces also provided artillery support. Between the start of the SDF offensive and 12 October, the RAF struck 213 targets in and around Raqqa;²¹⁶ on every occasion, they employed exceptionally accurate precision-guided weapons that were only released in accordance with highly exacting ROE designed to minimise the risk of civilian casualties. Many of these were low-yield Hellfires or Brimstones. By contrast, a single coalition ground unit that represented a tiny fraction of the force that captured Raqqa fired some 13,000 mortar rounds – indirect fire munitions – during the battle for the city, while a US Marine artillery battalion expended 35,000 shells.²¹⁷ The Marines fired off so many consecutive artillery rounds that they burned out the barrels of two M777 155mm howitzers.²¹⁸

A ceasefire was followed by negotiations and then the brokered withdrawal of hundreds of Syrian Daesh fighters, a smaller number of foreigners, and a much larger contingent of family members. They left the city in a convoy of buses, trucks and other vehicles, which was observed by coalition ISR as it moved eastwards to Markadah. There, a large element split off and drove south. It was clear that they would soon take up arms again, but their departure from Raqqa outweighed all other considerations.²¹⁹ In terms of air strikes, the RAF experienced its quietest week since 2014. The SDF immediately transferred more troops to Talon Spear and pressed further south down the eastern bank of the Euphrates, but their priorities were

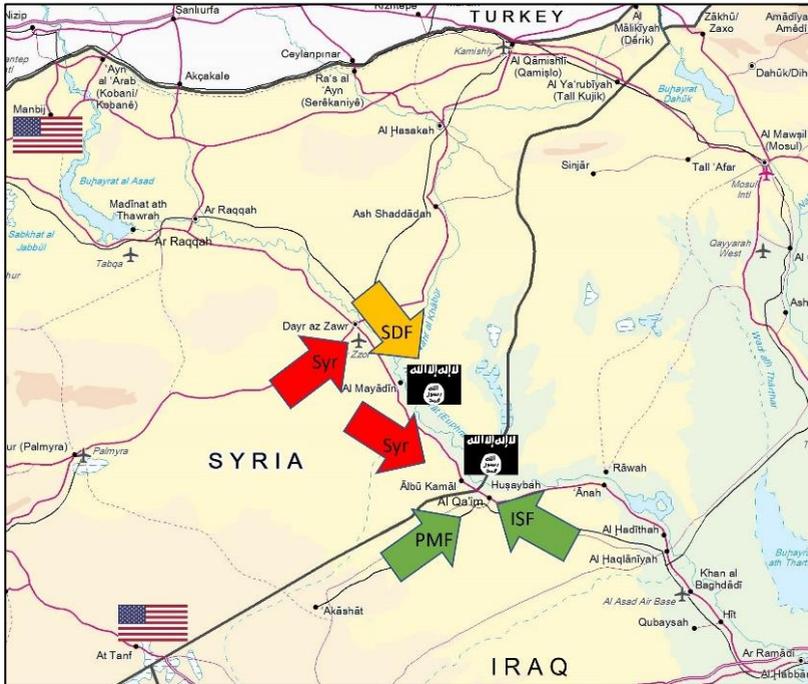
still divided. Over the following month, they directed a substantial military effort east of the river valley to establish a firm hold on Syria's main oil fields.²²⁰

The liberation of Raqqa allowed the CAOC to reapportion coalition air power over northern and southern Syria, but it was still necessary to maintain cover over At Tanf and the Kurdish Autonomous Region of north-eastern Iraq; both commitments continued to divert air resources from operations against Daesh. The Air Component provided ample CAS coverage to Talon Spear, but deliberate targeting was reduced to a minimal scale, and virtually all theatre ISR resources were assigned to short-term tactical tasking.²²¹ Among the last major operations was Phantom Dawn, which was developed in the UK and focused on Daesh logistics networks in Abu Kamal. Associated RAF activity included a GR4 strike on a weapons storage site near the town on 17 September.²²² Forward planning meanwhile concentrated on Iraqi operations to liberate Al Qa'im (Operation Desert Lion). Projected air support for Desert Lion included round-the-clock CAS, strikes on Daesh facilities around the town and shaping attacks to assist subsequent ground manoeuvre. The assault started on 26 October and made rapid progress against unexpectedly weak opposition.²²³ On 1 November, RAF GR4s struck a Daesh command post outside Al Qa'im; on the 2nd, they destroyed an observation post that had been directing mortar fire against Iraqi ground forces.²²⁴

In Syria, the SDF continued to advance slowly but steadily along the eastern bank of the Euphrates in the face of determined Daesh resistance. However, the issue of deconfliction with Russian and Syrian forces became more challenging by the day, and there were frequent unannounced incursions by their aircraft of a potentially hostile character. It appeared that the Russians were seeking to provoke an engagement that had the potential to undermine the coalition's strategic narrative and justification for continued operations in Syria.

At the beginning of December, after Syrian regime forces and their allies captured Abu Kamal, President Putin announced that Daesh had been defeated in Syria. Quite apart from the inaccuracy of this statement, it was again transparently intended to support Russia's contention that there was no longer any need for a coalition presence inside Syria or its airspace. In truth, Daesh was still a force to be reckoned with on the east bank of the river.²²⁵ While some of their units were vacating the area, others were preparing to stand and fight, and their numbers had been swelled by withdrawals from the west bank – something that was certain to prolong SDF clearance operations

south towards the Iraqi border. Yet this had, to an extent, simplified coalition air targeting as they enjoyed more deconflicted access to the east bank than the west. RAF Reapers were among the aircraft striking Daesh forces in this area in December.²²⁶



Map 14. With Raqqah liberated, the SDF pushed south along the MERV; in Iraq, the ISF liberated Al Qa'im; the Euphrates demarcated Syrian regime and SDF operations.

Mr Putin's announcement was followed by a limited reduction of Russian air strength in Syria in purely numerical terms but there was no meaningful change in Russian capabilities, and the revised Russian posture was assessed to be more sustainable in the long term. Moreover, while Russian and Syrian attention now switched towards north-west Syria, scaled-down operations west of the Euphrates continued.

More significant was the announcement by the Iraqi Prime Minister, Mr Abadi, declaring victory over Daesh.²²⁷ Of course, this did not mean that they

had been entirely eradicated in Iraq but that they had been reduced to the status of an insurgent organisation. They had been driven out of all the conurbations they had occupied at the end of 2014 and were no longer capable of holding ground on the Iraqi side of the border with Syria, which was now secure.

Thus, the successful conclusion of SDF operations on the east bank of the Euphrates and the eradication of a few other Daesh pockets in Syria such as Dashisha, in the Khabur river valley to the north-east, promised to defeat all that remained of their caliphate. In mid-December, the coalition estimated that MERV clearance might be achieved in a matter of months. In fact, it was not completed until March 2019.

In October, Turkish ground forces unexpectedly moved into the Idlib area of north-west Syria. A convoy of armed vehicles crossed the frontier and advanced five kilometres to reach a position near the town of Salwah – an action co-ordinated with local Syrian opposition elements. Then they began constructing defences orientated towards the nearby border with Kurdish Afrin. The Turks continued their build-up in November and positioned two battalions around Salwah and Deir Semaan. Supporting them just inside Turkey was a much larger force.²²⁸

The threat to coalition operations in the MERV was soon abundantly clear. Large-scale Turkish incursions into Afrin Canton might well distract the largely Kurdish SDF from MERV clearance. Furthermore, at precisely the same time, while the scale of counter-Daesh operations would be declining, the coalition resource base would be shrinking too. The Americans were finalising plans to transfer some of their assets, including Reapers and A-10s, from Iraq and Syria to Afghanistan, and both France and Australia were preparing to reduce their combat air contributions.²²⁹ The air component would thus have to manage with fewer conventional combat aircraft and less RPAS coverage. To match demand and supply, it would have to rely increasingly on multi-role missions and mixed CAS and DCA formations.

The reductions ensured that a greater proportion of high-priority missions was assigned to the RAF. During the second week of January 2018, RAF combat aircraft released 30 munitions – the highest figure since the previous September – against Daesh targets in MERV villages north of Hajin. Once again, targeting in the urban environment generated an increased demand for low-yield weapons such as Hellfire and Brimstone. On 10 January, the MOD's published strike record provided an illustration.

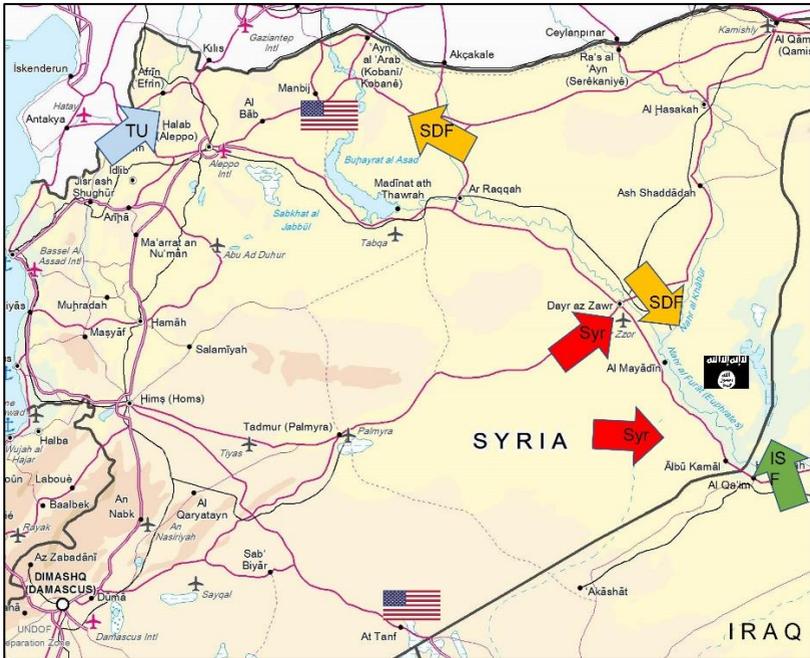
Our [Reaper] aircraft supported coalition air attacks on a Daesh-held building and a mortar position, and conducted three attacks with its own Hellfire missiles, destroying an armed truck parked under cover of a vehicle shelter, and hitting two groups of terrorists on foot. A flight of Tornado GR4s also took part in this operation and targeted an armed truck positioned within a compound; the use of a Brimstone missile allowed the vehicle to be destroyed without posing a risk to nearby buildings.²³⁰

On the following day, an RAF Reaper attacked three groups of fighters with Hellfire and used a fourth missile against ‘a Daesh extremist spotted on a rooftop, controlling a small drone of the type used by terrorists to attempt to spot opponents and conduct harassing attacks with improvised weaponry’. Another UAS team was eliminated two days later. On the 14th, a Reaper identified a third UAS control team working from the top floor window of a building. To quote the MOD record again, ‘A Hellfire was directed accurately through the window.’²³¹ Throughout the month, RAF Reapers expended some 50 Hellfires as well as eight GBU-12s.²³²

Turkish military operations in Afrin Canton began under the cynically named Operation Olive Branch in the third week of January. Combat aircraft were extensively employed in preparation for a major ground offensive. The Turks maintained that they were targeting terrorist organisations in Afrin, including the PKK, the YPG and Daesh, and that their actions were justified under Article 51 of the UN Charter – in other words, they were exercising the inherent right of self-defence.²³³

In the context of the campaign against Daesh, this was a destabilising and distracting development that seemed certain to impact on the progress of Talon Spear, as the SDF repositioned forces in the Manbij area to guard against follow-on Turkish incursions (see Map 15).²³⁴ Many SDF members viewed the Turkish advance as an existential threat – particularly if it continued towards Manbij. By contrast, Daesh represented a manageable long-term problem. Complicating matters further was the presence of the US ground base in Manbij. By the end of the month, the SDF were repositioning some of their forces to the north,²³⁵ and the Air Component was facing another challenging division of commitments between northern Syria (to protect US forces and reassure the SDF), the MERV, where Russian air activity was again on the increase, and At Tanf.

The Royal Air Force in Operation Shader



Map 15. The Turkish advance into Afrin Canton drew the SDF's attention back to northern Syria and led them to pause their offensive against Daesh in the MERV; multiple dispersed commitments and the challenge from Syria and Russia imposed considerable pressure on the Air Component.

The situation became more complex still in February due to mounting tension between Israel and Syria. With the Turkish offensive in the north and the Israeli-Syrian confrontation in the south, it briefly seemed possible that both RAF ingress routes from Cyprus might be denied. Then, on the 7th, a substantial force that included Syrian troops and Russian Private Military Contractor personnel crossed the Euphrates at Dayr-az-Zawr and launched an assault on SDF and accompanying US forces near Al Tabiyah – far behind the SDF's front line. Confronted by an array of American military hardware, the attack was a costly failure, but it highlighted the potential vulnerability of SDF forces further south and presented yet another distraction from the primary goal of defeating Daesh.²³⁶

In the face of stubborn Daesh resistance, the SDF struggled to sustain their operations in the MERV, but they ground to a halt on the 21st.²³⁷ The

implications were far-reaching. The counter-Daesh mission had reached a critical phase and conditions had been set for the final, decisive operations in the southern reaches of the MERV, as well as shaping operations in Dashisha. Coalition plans would now have to be extensively revised both to deter those seeking to exploit this change to the operational environment and to reassure the SDF.

Meanwhile, the SDF moved on to the defensive, prioritising the defence of MERV territory and positions of tactical importance pending the resumption of their offensive once the immediate threat from Turkey receded. To this end, they began constructing a protective line – a ditch, berms and counter-mobility obstacles – that extended 40km east from the Euphrates. In the north, as expected, Turkish forces and their Syrian rebel allies captured Afrin, but the Americans increased their air patrolling over Manbij and deployed additional ground troops into the area. CENTCOM's aim was to discourage any further Turkish advances, support the SDF and secure a resumption of ground operations against Daesh.²³⁸

Again, a higher proportion of MERV air tasking was simultaneously assumed by non-US coalition forces, particularly the RAF. Again, for a limited period, the Typhoons flew in a combined CAS and DCA role, and, with the GR4s, periodically mounted extended missions to overcome shortages in scheduled CAS coverage. Yet with the SDF offensive paused, there was little demand for direct air support, and the scope for deliberate targeting was, as ever, limited by conflicting ISR priorities that were determined by the CJTFHQ. At best, this period provided some marginal opportunity for the coalition to look beyond the defeat of the caliphate to the anticipated Daesh insurgency and the dispersed cells they were establishing across the Shader battlespace. A number of these were successfully targeted in April in both northern and western Iraq. For example, GR4s bombed a group of Daesh fighters on a hillside in the north-west on the 23rd and attacked a tunnel complex on an island in the Tigris, south of Mosul, on the 30th.²³⁹

For their part, Daesh used March 2018 to regroup. Their activities in the MERV were subdued during periods of clear weather, but they took immediate advantage of cloud cover and reduced visibility to attack static SDF elements. Some of their members sought to escape from the MERV, but Daesh reinforced their defences at Hajin with hundreds of additional fighters, technical vehicles and armoured VBIEDs.

On 7 April, the Syrian regime attacked the town of Douma, near Damascus, using a chemical agent delivered via helicopter-released barrel-

bombs. In response, overnight on 13-14 April, US, UK and French forces executed coordinated strikes against three targets assessed to be facilitating the regime's use of chemical weapons. The UK element consisted of four Tornado GR4s each carrying two Storm Shadow missiles; they were escorted by two Typhoons and a Voyager for pre-strike and post-strike AAR. The GR4s launched all four missiles successfully, and BDA subsequently confirmed physical and functional destruction of their targets. The RAF provided the following information about the attack in a press release:

Our action is proportionate, specifically aimed at degrading the regime's ability to use chemical weapons and deterring further such appalling acts; it is therefore focused on regime facilities linked to the production and use of chemical weapons.

The UK element of the carefully coordinated joint action was contributed by four Royal Air Force Tornado GR4s. They launched Storm Shadow missiles at a military facility – a former missile base – some fifteen miles west of Homs, where the regime is assessed to keep chemical weapon precursors stockpiled in breach of Syria's obligations under the Chemical Weapons Convention. Very careful scientific analysis was applied to determine where best to target the Storm Shadows to maximise the destruction of the stockpiled chemicals and to minimise any risks of contamination to the surrounding area. The facility which was struck is located some distance from any known concentrations of civilian habitation, reducing yet further any such risk.

Detailed analysis of the effectiveness of the strike is currently underway, but initial indications are that the precision of the Storm Shadow weapons and meticulous target planning have resulted in a successful attack.²⁴⁰

The Royal Air Force in Operation Shader



The April 2018 strike on Syria: loading Storm Shadow.



One of the GR4s taxiing at Akrotiri.



Take-off, with Storm Shadow clearly visible.

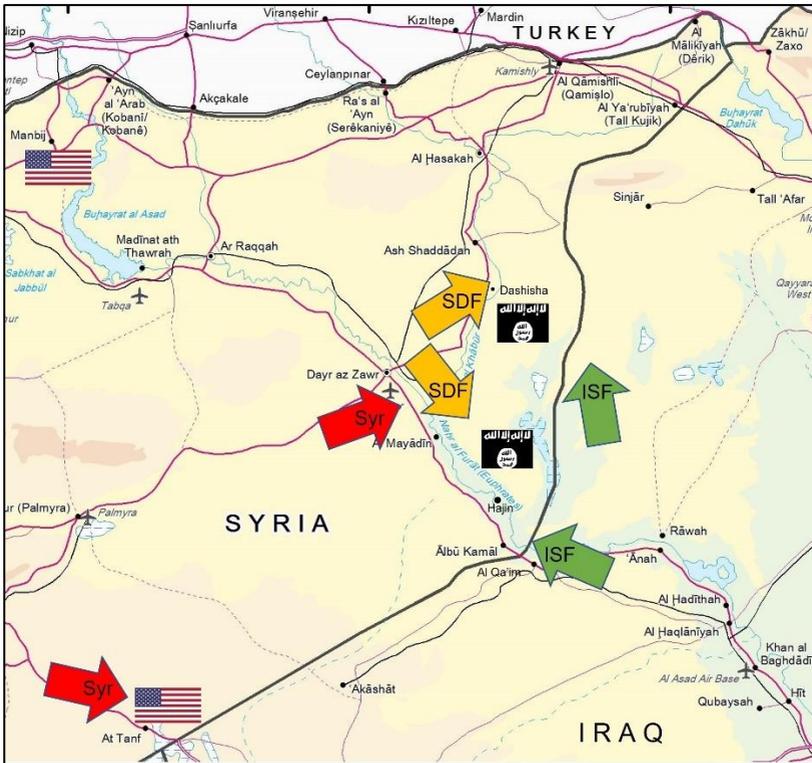
While Syrian and Russian air defence activity increased considerably during the operation, normal patterns resumed within 24 hours. Hence, the coalition strikes exerted no major impact on operations against Daesh. By the second half of April, the situation in northern Syria had stabilised and the coalition was confidently looking forward to renewed SDF progress in the MERV.

The SDF returned to the offensive in the first week of May;²⁴¹ Operation Talon Spear was renamed Operation Roundup.²⁴² Although there was further progress south to seal the Syria-Iraq border on the east bank of the Euphrates, this area was still heavily contested. There were more enduring gains around the eastern Daesh enclave of Dashisha. As the fighting flared up, the demand for air support increased, and there were more regular calls for the RAF's GR4s and Typhoons to intervene. The inter-relationship between air and ground operations was particularly close at this stage, the SDF's momentum helping to fix Daesh in position so that they could be targeted from the air. On 5 May, Typhoons released Paveway 4s against three buildings that were being used by Daesh as an operating base, as well as a nearby defensive position. Tornados similarly used Paveway 4 to strike a large Daesh security post.²⁴³

Meanwhile, the coalition continued to track elements that had fled from the MERV and those preparing for longer-term insurgent activity. On 4 May, GR4s struck remote Daesh positions south of Kirkuk; on the 9th, the Typhoons attacked fighters near Rutbah; on the 20th, a GR4 mission was tasked against a tunnel complex south-west of Mosul, and three tunnel entrances were identified and targeted. On 23 May, the GR4s' target was a Daesh safe house that had been identified by intelligence at a remote wadi deep in the western Iraqi desert.²⁴⁴

The Dashisha operation started at the end of the month. Following extensive coalition ISR activity, shaping strikes paved the way for the SDF assault. On the 31st, a combined force of Tornados and Typhoons delivered an attack with 12 Paveway 4s against two large adjoining compounds, which were being used by Daesh as a headquarters, weapons store and muster point.²⁴⁵ The SDF then advanced rapidly on two axes, while Iraqi blocking forces deployed along the border. The subsequent RAF contribution included kinetic support in the form of Paveway 4 and Hellfire strikes, and ISR from both Reaper and Sentinel.²⁴⁶

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Map 16. The SDF resumed their offensive in May 2018, attacking Daesh enclaves in the MERV and at Dashisha.

As always, the wider operational environment generated periodic challenges and maintained considerable pressure on coalition resources. This period witnessed Syrian harassment of the SDF near Dayr-az-Zawr and probing by Russian and Syrian aircraft near the agreed deconfliction line in eastern Syria, forcing appropriate coalition responses. There were several ‘intercepts’ of Russian and Syrian aircraft early in June. Friction also continued near the At Tanf garrison. Combat air cover had to be maintained continuously over the MERV and At Tanf, where a Typhoon released a single Paveway 4 in defence of coalition ground forces on the 21st.²⁴⁷

By mid-July, the SDF had taken Dashisha, after which they crossed from the Khabur valley to the border area and moved south-west towards the last

Daesh-held pocket east of the Euphrates. On reaching it, they paused to prepare for the final phase of Operation Roundup. By mid-August, they were well postured to start this final assault on 1 September, and coalition air power was already shaping the battlespace, but subsequent reports ominously noted increased regime and Turkish activity in northern Syria.²⁴⁸

Coalition ISR closely monitored Daesh as they made their own preparations for the SDF offensive with their backs to the river; it was clear that few of their remaining fighters intended to capitulate. They periodically launched raids on SDF positions and were observed building defensive berms in As Susah. Among other things, intelligence suggested that Daesh were expecting the final SDF thrust to come from the north, so plans were revised. When the offensive began, their north-to-south advance through Hajin (on the Daesh left) was synchronised with a south-west manoeuvre towards Baghuz Fawqani (on the Daesh right), which was to be followed by a northward thrust. Yet progress was slowed by fanatical Daesh resistance. In the end, instead of seizing Baghuz Fawqani and, further north, Marshida, the SDF's advance bypassed them both and focused on the clearance of the main supply route east of the Euphrates (see Map 17). The contribution of air power remained as vital as ever, and the Air Component reacted rapidly and flexibly to repeated changes in the ground scheme of manoeuvre.

Coalition assessments at the beginning of October looked forward to Daesh's final defeat, but the more optimistic predictions were again to be disappointed. The SDF were confronted by an immense IED clearance task, and coalition ISR was impeded by dense clouds of smoke, which Daesh created by burning tyres. A barrage of indirect fire awaited SDF ground units and coalition advisory elements that deployed too far forward. RAF GR4s, Typhoons and Reapers remained heavily committed, but the concentration of numerous aircraft over a steadily shrinking battle area generated further challenges. The risk of mid-air collision – always the greatest threat to coalition aircraft during Shader – was at its highest in these final months of the operation to destroy the caliphate.

In the second week of October, a period of poor weather grounded many coalition aircraft and, in the absence of air support, the SDF's advance became even more hesitant. Daesh capitalised on this situation by launching a series of counterattacks against the northern and southern SDF axes and maintaining the bombardment of the more exposed positions, forcing limited withdrawals. Such was the situation when Turkey reinvigorated operations along her southern frontier, shelling SDF border posts east of the Euphrates and sending combat aircraft into northern Syrian airspace.²⁴⁹



Map 17. Confronted by determined Daesh resistance, the SDF bypassed Marashida and Baghuz Fawqani and converged on Hajin from north and south.

The SDF again halted completely. In response, the CFACC sought to maintain pressure on Daesh, intensifying air operations and urgently seeking to identify and develop more targets. Over the next two weeks, the Air Component mounted over 300 strikes (employing 700 PGMs), hitting Daesh command and control, staging areas and defensive positions.²⁵⁰ All three RAF combat air platforms engaged Daesh targets throughout this period despite persistently adverse weather conditions. On the 26th, two GR4s intervened in support of SDF troops who were in close combat with Daesh fighters positioned in two strongpoints. The Tornados had to bomb through cloud, and their crews could see neither the target nor the friendly forces close by. The SDF nevertheless reported afterwards that both Daesh positions had been hit.²⁵¹ Under renewed pressure from the air, many Daesh fighters took refuge in central Hajin. Restricted freedom of movement and increasingly desperate shortages of water, fuel and food severely impacted on their morale, but periodic counterattacks continued.²⁵²

In the north, the Turks maintained pressure on the SDF, who consequently remained static in the MERV, and it became clear that Roundup would not recommence until the security of their northern flank was assured beyond all doubt. In desperation, the Americans intervened with a range of measures designed to reassure both sides and create the conditions in which the SDF could return to offensive manoeuvre.²⁵³

With Kurdish reinforcements, the SDF advance resumed north to south in the first week of December, initiating some of the most intense fighting since the start of the conflict. The SDF typically attacked at night, while Daesh staged counterattacks and attempted breakouts by day, which were successfully repulsed with the support of coalition air power. Enduring concerns about the situation in northern Syria were reflected in the pronounced sense of urgency that accompanied the offensive, with CENTCOM urging the maximum pressure and the use of all available resources to bring Operation Roundup to a successful conclusion. Coalition air commanders were in turn directed to maximise the volume of air support provided to the SDF.

The RAF struck Daesh targets in support of the SDF advance on 20 days during the month, the geographical orientation of air support directly reflecting the progress of ground manoeuvre. From 3 to 6 December, the RAF targets were north-west of Hajin but by the 9th they were on the northern outskirts of the town. By the following day, the fighting had moved into Hajin itself, where Reaper's Hellfires were repeatedly employed along with two GBU-12s. By the 13th, the GR4s and Typhoons were supporting the clearance of eastern and southern Hajin, but their focus soon switched further south as the SDF moved on. On the 16th, an RAF Reaper targeted counter-attacking Daesh forces south of Hajin with three Hellfires and one GBU-12.²⁵⁴

After the liberation of Hajin, the second half of December witnessed significant progress on the ground as the SDF advanced towards the small territorial pocket that remained under Daesh control between Marashidah and Baghuz Fawqani (see Map 18).²⁵⁵ Daesh counterattacks became less effective as their munitions and manpower neared exhaustion. Captured fighters were found to be demoralised and malnourished; their wounded were left untreated. Refugee convoys out of the pocket increased in size and frequency and had to be screened for Daesh fighters. To prevent their dispersal into the desert, the SDF also established a defensive cordon.²⁵⁶

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Preparation for the Tornado GR4's last operational mission,
31 January 2019.



Heading for home: a GR4 beginning the journey back
to RAF Marham.



Map 18. With coalition air support, the SDF finally brought Roundup to a successful conclusion at Baghuz Fawqani.

The last stages of MERV clearance were characterised by continuing stop-start patterns of manoeuvre, with one halt occurring in the third week of January to allow Daesh to trade SDF prisoners for food supplies. After the assault on Marashidah began, Daesh launched their final counterattack, but it was blocked once again; RAF combat aircraft were in the thick of the engagement.²⁵⁷ When Marashidah fell at the end of the month, there was a further pause for negotiations.

For the RAF, 31 January was a date of particular note: it marked the final operational mission by Tornado GR4s.²⁵⁸ The CFACC flew to Akrotiri to witness the event, speak to personnel, and thank the Tornado force for nearly 28 years of continuous operations in the AFCENT area of responsibility. The GR4s returned to the UK for the last time in two waves in the first week of February. While the Tornado was now finally withdrawn from service after a long and illustrious career, an extensive upgrade programme adapted the Typhoon to carry such critically important weapons as Storm Shadow and Brimstone 2.²⁵⁹

The culminating SDF move on Baghuz Fawqani was delayed by the weather. Given the confused, congested and contested nature of the operational environment and the presence of numerous civilians, clear conditions were an essential prerequisite for effective air support. Yet even after the weather improved and the ground offensive resumed, it was virtually impossible to engage targets from the air without a high civilian casualty risk, and RAF participation largely took the form of reconnaissance and armed overwatch. On 11 February, Typhoons struck two Daesh defensive positions that were firing on SDF forces, while on the 19th they destroyed a moored boat on the Euphrates using a Brimstone 2 – the Typhoon’s first operational Brimstone 2 engagement.²⁶⁰

Another halt for negotiations towards the end of February made way for a renewed west-to-east ground advance at the beginning of March to clear the Baghuz Fawqani cliffs. Despite the departure of more refugees in the intervening period, the remaining Daesh-held area was still extremely crowded, so the RAF rarely intervened. On just three days, Reapers or Typhoons targeted armed fighters or defensive positions, and a Typhoon also destroyed a single VBIED on the 12th.²⁶¹ The UKACC, Air Commodore Reuter, wrote his concluding comments on the operation on 24 March, the day after the SDF officially declared victory over Daesh:

Employment of Air Power in direct support of SDF ground operations in the final phase of the MERV clearance has been exceptionally demanding. Reaper crews and Typhoon pilots have been attempting to employ sensors and weapons in the most challenging and congested piece of battle space that I have witnessed as the fighting in the tented encampment south of Baghuz Fawqani took place; their performance and that of the UK Dynamic Targeting Team has been exemplary.

In Retrospect

The final destruction of Daesh's caliphate did not bring Operation Shader to an end. The RAF continued to fly in Iraqi and Syrian skies. Yet the events of March 2019 clearly mark the achievement of the operation's primary goal. After their final defeat in the MERV, Daesh could no longer hold ground in a conventional military sense or impose their tyrannical institutions of government on the Iraqi and Syrian people. This is therefore a logical point at which to end this study and offer a few concluding observations.

By the time Shader began, Daesh had established a firm hold across northern Syria and Iraq; the task of dislodging them was certain to be difficult and drawn-out. The coalition had little option but to adopt an 'Iraq first' strategy, which provided abundant scope for the RAF to use all its deployed capabilities in the struggle to halt Daesh's advance and then liberate the main conurbations on the lower Euphrates. Its role over Syria was necessarily more limited in 2014 and 2015 although still of considerable importance where ISR and airborne command and control were concerned. The expansion of RAF combat operations into Syrian airspace fortuitously occurred just as SDF ground manoeuvre was gaining momentum, but the Iraqi offensives continued to absorb the bulk of coalition air resources, notably during the liberation of Mosul, which extended for a gruelling nine months from October 2016 to July 2017.

The loss of Mosul fatally weakened Daesh in Iraq and allowed the ISF to suppress residual pockets of resistance in Tal Afar, Hawijah, the MERV and Al Qa'im with relative ease. The more demanding challenges meanwhile faced the SDF and involved the liberation of Raqqa and the destruction of Daesh forces on the east bank of the Syrian MERV. They were confronted by extremely tough opposition, which took 19 months to overcome. Between the fall of Mosul and the battle of Baghuz Fawqani, coalition air forces were overwhelmingly employed in a conventional tactical support role to strike as and when Daesh blocked ISF or SDF progress or counter-attacked in any strength.

In the campaign that defeated Daesh, coalition ground and air forces complemented one another; indeed, they were mutually reinforcing, and it was a combination of ground and air effects that ultimately destroyed the caliphate. The US-led coalition needed proxy ground forces to capture and hold territory, but neither the ISF nor the SDF were strong enough to defeat Daesh on a level playing field. Air power gave them a decisive advantage in terms of situational awareness and precision fire support for both offensive

and defensive action, while the ground threat pinned Daesh in position, reducing their scope to employ effective passive air defence measures.

Yet in searching for lessons from Shader, it is still legitimate to ask how air and ground operations might have been combined to greater effect. For example, with better coordination, it might have been possible to avoid scheduling major ground actions during ‘carrier gaps’ or other periods of reduced air support. Equally, the balance between close and deep tasking requires careful consideration. In Shader, under the CJTFHQ’s direction, air plans were overwhelmingly defined in tactical terms: the vast majority of combat air missions provided CAS, overwatch or shaping in direct support of ground activity. Most theatre airborne ISR was likewise assigned to tactical support, either to locate targets or assist target clearance; indeed, the scale of provision led some in the air component to argue that far more ISR was being assigned to the close fight than could be efficiently employed. One illustration, which was not exceptional, involved the operation of up to seven RPAS over Ramadi simultaneously while the ISF were static. Quite apart from the generous scale of this apportionment, there was always the danger that the assignment of so many assets to a relatively limited task would overwhelm the capacity of the responsible directing agencies. This allocation of highly capable resources substantially reduced the scope for mounting and sustaining pre-planned, deliberate attacks on deeper target sets of potential operational significance.²⁶²

Periodically, there were deviations from this more general pattern that illustrated the scope for deeper and more systematic target development, and several senior coalition commanders, including one Commander CENTCOM, acknowledged the desirability of increasing the weight of air effort assigned to deliberate targeting in the deep. Nevertheless, in practice, this proved difficult to achieve because of the priority assigned to the close battle.

As a result, ISF and SDF forces were often fielded against Daesh adversaries that might have been degraded locally and tactically, but not in a general or operational sense. The obvious question is whether, with better alignment and balance between close and deep targeting, it might have been possible to shorten operations to some extent and achieve greater economy of effort. Much would have depended on whether deeper target sets were available and on the impact of striking them. The historical analysis so far directed towards this subject focuses on particular case studies, notably the targeting of Daesh oil production and trade, and their cash stockpiles, and operations against GLOCs in the Iraq-Syria border area and around Mosul.

It is perhaps worth noting here that there were few other case-study options to choose from.

Coalition strikes on oil-related targets accounted for by far the largest proportion of missions in support of the deep battle, and it is argued that they eventually eliminated a significant proportion of Daesh's oil revenue. However, activities such as taxation and extortion generated considerably more of their funds and offered few viable air targets except for cash stockpiles and banks – which were thus bombed in a separate series of operations.²⁶³

The GLOC targeting was reportedly less successful. Around Al Qa'im and Abu Kamel, it involved a drawn out and labour-intensive target development process that resulted in just a handful of strikes that were not repeated and that probably exerted, at best, a marginal short-term impact on Daesh ground operations. GLOC strikes around Mosul, largely conducted via the deliberate targeting process, exerted some effect, but deliberate targeting was allegedly too laborious to address the rapidly changing demands of the ground battle – particularly the massed deployment of VBIEDs against Iraqi ground forces in eastern Mosul. Counter-VBIED efforts are said to have depended more on a separate initiative generated by the Land Component and involving special ISR, boarding and clearance processes and deliberate-dynamic targeting, whereby cleared targets were struck dynamically within the ATO cycle. It is argued that this was responsible for the declining number of VBIED attacks in the spring of 2017.²⁶⁴

Such contentions must be viewed in context. First, the overwhelming majority of combat and ISR missions flown during operations against the caliphate directly supported the close battle. The resources assigned to deeper and deliberate targeting rarely represented more than a small fraction of the deployed theatre air assets. There was a considerable delay even before operations of any scale began against Daesh oil production and trade, and the CFACC had to argue strongly for the necessary reallocation of resources.

It was particularly difficult to secure ISR for deep target development. Indeed, this was an issue that assumed bizarre proportions in the months preceding the Al Qa'im-Abu Kamal GLOC operation late in 2015, when, deprived of its own assets, AFCENT was obliged to secure the services of government-owned, contractor-operated, or contractor-owned, contractor-operated RPAS to undertake much of the preparatory intelligence collection effort.²⁶⁵ Given the need for such hand-to-mouth measures, we should not be

surprised by the protracted duration of target development for just 14 targets that were attacked on a single day.²⁶⁶

Operations around Mosul were similarly constrained by the prioritisation of the close battle. As we have seen, air support was only shifted north from the Qayyarah area shortly before Eagle Strike began, by which time Daesh had already manufactured and pre-positioned many of the VBIEDs that they used so effectively in their defence over the next three months. This could only have been prevented (or limited), by targeting VBIED manufacturing facilities in the Mosul area over time, well before Eagle Strike began, which would in turn have required substantial ISR support. Instead, much of the available ISR was assigned elsewhere. Initiated in October 2016, GLOC interdiction strikes around the city were only likely to inhibit resupply.

However, we should not overestimate the impact of intelligence-led deliberate-dynamic targeting, and any suggestion that deliberate targets were only struck within the ATO cycle due to the intervention of the Land Component would be misleading. A proportion of deliberate targets was attacked dynamically throughout Operation Shader. In Mosul, viable proposals for deliberate-dynamic targeting could only have come from the Land Component due to its preponderant influence over the allocation of resources – particularly the necessary supporting intelligence provisions.²⁶⁷

The factors that contributed to the decline of the VBIED menace in the western sector of the city have already been described, but the number of VBIED attacks in the east was swelled by pre-positioning over an extended period before the beginning of Operation Eagle Strike in October 2016, and a high rate of attack was then sustained by moving weapons from the west to the east. Consequently, the ISF were confronted by far fewer pre-positioned VBIEDs in the west in the following February, by which time Daesh were virtually surrounded and had little scope for re-supply. From the RAF's perspective, the number of attacks executed against command or manufacturing facilities was substantially exceeded by the blunt instrument of road cratering strikes, but the volume of CAS activity continued to dwarf all deliberate and deliberate-dynamic targeting, and requirements for the future development of ground operations increasingly drew both combat and ISR resources into Syria.

The fact is that deeper targeting in Operation Shader involved the campaigns against the Daesh oil trade and its revenue, plus a few more limited initiatives. Moreover, aside from the counter-oil and revenue strikes, there were periods that witnessed very little deeper targeting at all, particularly after the fall of Mosul, when there was rarely sufficient ISR to

support the necessary target development. The absence of systematic deeper target development was particularly visible when, for whatever reason, ground operations were halted or suspended, reducing the requirement for the Air Component to support the close battle. For deeper targeting to have exerted a measurable impact, it should have been sustained throughout Operation Shader and methodically conducted via the consistent apportionment of a proportion of coalition theatre ISR and combat air assets to the deep (or at least deeper) battle. The aim should have been to achieve cumulative effects by continuously degrading multiple interrelated primary, secondary and tertiary target sets.

This did not happen for several reasons. First, the US Army-dominated command chain was firmly focused on the close battle; second, air output was substantially measured in terms of volume (i.e., sortie) delivery for the CJTFHQ rather than effect; third, although still doctrinally embraced by western air forces, deeper targeting was by 2014 unfamiliar to planners, intelligence staffs and targeteers, and there had clearly been a decline in the *ability* of coalition air forces to conduct targeting of this nature due to the demands of the close battle during earlier operations in Iraq and Afghanistan.

At the same time, in considering how operations against Daesh might have been conducted more effectively, we could reasonably question whether the rigid distinction maintained between the deep and close battles during Operation Shader was helpful. There would perhaps have been more utility in viewing the battlespace as a single entity and in developing an understanding of the linkages between deep and close target arrays – in other words, how the close battle might have been influenced by targeting Daesh beyond the front line. For example, the fighting along the lower Euphrates in 2015 and 2016 might have been concluded more rapidly if coalition air power, supported by the necessary intelligence collection and analysis, had systematically and repeatedly attacked the lines of communication that helped to sustain Daesh's presence in cities like Ramadi, Hit and Fallujah.

Accelerated campaign progression might have offered particularly significant rewards in the context of Shader due to the extreme complexity of the operational theatre. Bordering Iraq and Syria were Iran, Israel and Turkey. Syria, in the grip of a drawn-out civil war, was Russia's principal ally in the Middle East. Kurdish nationalism was a further complicating factor in northern Iraq, Syria and southern Turkey. Within CENTCOM's area of responsibility, Afghanistan retained the potential to divert air resources, and Yemen's slide into civil war distracted Arab partners.

Over time, this environment was certain to become even more volatile, reducing the coalition's freedom of action and complicating the task of defeating Daesh, and this might have happened in a variety of ways. In the event, Turkey and Russia decided that their vital interests were being jeopardised by the situation in Syria and decided to intervene. The Syrian battlespace then became increasingly congested, and there was a troubling rise in EMI. By 2018, the threat from Turkish, Russian and Syrian actions was enough to halt the SDF's ground advance repeatedly during its final, crucial stages, by which time it had been necessary to transfer some of the most capable US air assets to Afghanistan.

The challenge of sustaining air operations at high levels of intensity over such a protracted campaign should not be underestimated. The provision of enduring and intensive tactical air support required, at peak, more than 300 US aircraft and 115 non-US aircraft, and more than 3,200 aircrew, groundcrew and headquarters staff. Between August 2014 and March 2019, the piloted strike aircraft under the CFACC's command flew 88,622 sorties over Iraq and Syria, while coalition ISR assets, including RPAS, flew a total of 48,901. Over the same period, 117,533 air weapons were released by piloted aircraft and RPAS. On average, 41 per cent of piloted strike sorties released at least one weapon. The scale and continuity of the coalition air presence was only maintained through a colossal AAR effort. In total, AAR assets flew 56,717 sorties, carried out 331,454 refuellings and offloaded 3,556 million pounds of fuel.

During periods of heightened activity, the operational tempo was even more impressive than these figures suggest. In both 2015 and 2016, coalition crewed strike aircraft flew more than 21,000 sorties. In 2016 and 2017, more than 50 per cent of piloted strike sorties involved at least one weapon release. In 2017, the Air Component dropped 39,577 weapons over Iraq and Syria, chiefly over western Mosul and Raqqa. In comparative terms, the operation involved a lower flying rate than the peak period of Operation Herrick (2009-2013) but a much higher target engagement rate.

What did operations of this scope, intensity and duration mean for the RAF? Operation Shader followed immediately on from Herrick (which overlapped with Telic), so that deployed squadrons and detachments had minimal time for rest or reconstitution, and it drew on the RAF's smallest personnel base since the depression years of the 1930s: the RAF's trained strength stood at 31,000 personnel at the end of 2015.

The RAF's commitment to Shader increased steadily after August 2014, reaching 28 aircraft by the following May. In terms of aircraft deployed, the

operation peaked at the end of October 2016, when 24 RAF aircraft of six types were based at Akrotiri. Additionally, eight Reapers, two Shadow R1s and one RC-135 Airseeker were supporting the operation from other airfields, bringing the total to 35 aircraft of nine types. The RAF was the largest non-US air contributor to the coalition and provided combat air power, wide-area surveillance, tactical reconnaissance, FMV, SIGINT, command and control (on the ground and in the air), air transport, AAR and a range of other supporting capabilities, particularly in the intelligence field.

By the end of 2018, the 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 RAF's Reapers had mounted 3,080 missions and expended 964 weapons. The GR4s released more bombs during the first six months of Shader than during five years of operations in Afghanistan. In Afghanistan, they flew approximately 240 hours per weapon release; the equivalent figure for the two fast jets in Shader was just 15.6 hours per release. 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 three GR4 squadrons on Shader by January 2019, the Typhoons had flown 22,296 by the time Daesh were cleared from Baghuz Fawqani, and the Reapers 44,329. For the Voyager detachment, the figure was 16,123 hours, and the Hercules detachment had flown 7,220 on Shader and many more on wider Middle East tasking. The contribution of the Sentinel, Airseeker and E-3D detachments totalled another 7,280 hours, more than half of which were flown by Sentinel.²⁶⁸

Operations on this scale inevitably ensured that a significant proportion of the RAF's trained personnel might be employed on Shader at any given time, either in theatre or in UK-based supporting roles. Moreover, Shader had to be sustained at the same time as other operations and commitments. While the three-squadron Tornado force was maintained purely for Shader, beyond its scheduled retirement from RAF service, the Typhoon force had to shoulder the counter-Daesh burden alongside Baltic Air Policing, home-based quick-reaction alert, and Falklands air defence. ISR commitments also developed in the European theatre during the later stages of the operation. Not surprisingly, the term 'running hot' was regularly coined in the RAF at this time, and Air Commodore Stringer elaborated on this aspect of Shader in evidence to the House of Commons Defence Committee in May 2018. As he put it,

We are now coming up to four years' support to Operation Shader. I would say that the Air Force, relative to its size, has not operated at this tempo or scale since 1945. It has been a big commitment, and that has taken a standing figure of around 800 to 900 airmen and airwomen in the region, from the eastern Mediterranean down to the southern end of the Gulf, all in the air component command.²⁶⁹

The specific issue of Harmony guidelines was raised by the Defence Committee at the same session, but Harmony breach rates provided an imperfect yardstick for measuring the operation's impact on personnel. This was because, for the RAF, Harmony breach was redefined in April 2014. Continued application of the pre-April 2014 measurement of Harmony breach would have substantially increased the levels recorded in subsequent years.²⁷⁰

If we focus specifically on Operation Shader, the personnel of 83 EAG worked hours well beyond those associated with UK working patterns. Some, particularly those holding senior or specialist posts, operated at the higher levels of fatigue management scales with a workload that consistently extended them both mentally and physically, in organisations and units that were functioning at full capacity and supporting air operations for 24 hours per day. Personnel across theatre worked a minimum of six days per week for the entirety of their deployments, and numerous posts had a duty/on-call requirement that could hold them on base, where they were exposed to a constant battle rhythm of air activity – take-offs, landings, taxiing, maintenance, tests of emergency responses – as most operating locations were situated on airfields directly and continuously generating air power.

While the Tornado squadrons deployed for three months and the Typhoon squadrons for four, their personnel rapidly accumulated time on deployment. As Air Commodore Stringer later noted: 'We have Tornado engineers on Cyprus, some of whom, at the three-year point of the operation, had already done over a year in theatre, servicing aircraft come rain or shine in support of the fight.'²⁷¹ Like so many other Shader personnel, they were stationed at RAF Akrotiri. Akrotiri had for many years functioned chiefly as a staging post and logistical hub, and its sudden transformation into a mounting base in 2014 imposed a heavy strain on facilities. Despite considerable investment in base infrastructure thereafter, the burden was increased further by the arrival of more aircraft at the end of 2015.²⁷²

The pressure on aircrew was especially pronounced. Aircrew deployed on Shader regularly flew extended sortie lengths (fast jet sorties averaged more than six hours), utilising AAR in challenging climatic environments and over hostile territory. Tornado GR4 and Typhoon aircrew would have taken off anticipating combat and would have had to execute strikes within the extremely exacting parameters that governed all coalition bombing, with frequent modification of support requests in collaboration with the strike cells and periodic rejection of requests that did not fulfil UK engagement criteria.²⁷³ The operational environment was hostile, to say the least. Hazardous terrain would have ruled out emergency landing across much of Iraq and Syria, and there was a strong chance of capture, torture and execution in the event of emergency landing or ejection. Larger ISR platforms, lacking the speed and agility of the fast jets, sometimes faced particularly high risks. From late 2015, new challenges emerged, such as airspace deconfliction with Russian and Syrian aircraft.

As for the Reaper operators at RAF Waddington and Creech Air Force Base, they faced continuous operations for three years or more, which involved levels of stress substantially exceeding those associated with more routine service duties. While the physical conditions of a Ground Control Station could not be classed as harsh or demanding, research has suggested that RPAS crews are exposed to more fatigue and emotional strain than those operating crewed (and deployed) platforms.²⁷⁴

In summary, Operation Shader imposed a considerable burden on committed RAF personnel and periodically stretched human resources close to the limit. Ultimately, the Daesh caliphate was defeated but only through the successful prosecution of an exceptionally difficult and arduous air campaign. Moreover, while, as a service, the RAF characteristically rose to the challenge, a truly comprehensive analysis of how UK air operations were sustained over Iraq and Syria from 2014 to 2019 would have to venture beyond the parameters of this study to consider such issues as contingent capability and the performance of deployed equipment. Given the substantial proportion of the RAF's first-line combat and ISR force committed to Shader, how much capacity remained for contingent tasks? How far were enduring operations against irregular adversaries such as the Taliban and Daesh eroding the more conventional war-fighting skills potentially needed to cover a wider range of liabilities? Had all deployed equipment fully matched operational requirements and fulfilled the necessary standards of reliability and maintainability? If not, had it been possible to address identified problems, implement enhancements or remedial measures and

reap meaningful operational benefits within the four-and-a-half-year Shader timeline?

In Shader, the RAF made a vital contribution to coalition operations against Daesh and the ultimate destruction of their caliphate. The Iraqi armed forces and the SDF would never have prevailed without coalition air power. The RAF not only fielded an extremely valuable range of combat, ISR and supporting capabilities but sustained those capabilities in the heat of battle until coalition objectives had been realised. Yet it is hard to avoid the impression that resources and commitments have rarely been so finely balanced throughout the RAF's operational history. Stresses and strains that might have been more easily accommodated in a shorter or more limited military undertaking were periodically exposed and were, to an extent, magnified by the campaign's tactical focus. The experience raises far-reaching questions about how the RAF will in future meet enduring commitments and contingent liabilities while continuing to fulfil the hopes and expectations of close allies.

Annex A

Tornado GR4 squadrons deployed on Operation Shader

August 2014	-	2 Squadron
December 2014	-	9 Squadron
February 2015	-	31 Squadron
June 2015	-	12 Squadron
September 2015	-	9 Squadron
December 2015	-	31 Squadron
March 2016	-	12 Squadron
June 2016	-	9 Squadron
September 2016	-	31 Squadron
December 2016	-	12 Squadron
March 2017	-	9 Squadron
June 2017	-	31 Squadron
September 2017	-	12 Squadron
December 2017	-	9 Squadron
March 2018	-	31 Squadron
June 2018	-	9 Squadron
October 2018	-	31 Squadron, elements of 9 Squadron

Annex B

Typhoon squadrons deployed on Operation Shader

December 2015	-	1 Squadron
April 2016	-	6 Squadron
August 2016	-	3 Squadron
January 2017	-	11 Squadron
May 2017	-	2 Squadron
September 2017	-	1 Squadron
February 2018	-	6 Squadron
May 2018	-	3 Squadron
September 2018	-	11 Squadron
February 2019	-	2 Squadron

Annex C

Sub-operation names mentioned in the text

Apex Edge

US ground operations centred on the At Tanf garrison in Syria.

Biollante

Peshmerga operations against ISIL in north-west Iraq in late August 2015.

Desert Lion

Operations to liberate Al Qa'im, October to November 2017.

Eagle Strike

Operations to liberate Mosul, October 2016 to July 2017.

Eclipse

Operations to isolate Raqqa, December 2016-April 2017.

Lagertha

Peshmerga operations against ISIL near Sinjar in early August 2015.

Mekur Sur

Peshmerga operations in Ninawa province in January 2015.

Phantom Dawn

Air strikes on Daesh logistics networks, Abu Kamal, October 2017.

Phoenix Blitz

Shaping air strikes in the Upper Tigris area in preparation for the resumption of Operation Valley Wolf in June 2016.

Roundup

Operations to liberate the MERV and eastern Syria, April 2018 to March 2019.

Talon Anvil

Operations against Daesh in northern Syria, launched May 2015.

Talon Spear

Operations to liberate the MERV, September 2017 to March 2018.

Tidal Wave II

Coalition air operations against Daesh oil production and trade.

Valley Wolf

Operations to liberate the upper Tigris River valley, 2016.

Annex D

Glossary of abbreviations

83 EAG	-	83 Expeditionary Air Group
A3E	-	Advise, Assist, Accompany and Enable
AMRAAM	-	Advanced Medium Range and Air-to-Air Missiles
ASRAAM	-	Advanced Short Range Air-to-Air Missiles
ATO	-	Air Tasking Order
BMA	-	Battle Management Areas
CAOC	-	Combined Air Operations Centre
CAP	-	Combat Air Patrol
CAS	-	Close Air Support
CFLCC	-	Combined Forces Land Component Commander
CFLCHQ	-	Combined Forces Land Component Headquarters
Commander CJTF	-	Commander Combined and Joint Task Force
CTS	-	Counter-Terrorism Service (Iraqi)
DCA	-	Defensive Counter-Air
DMSB	-	Dual Mode Seeker Brimstone

EMI	-	Electro-Magnetic Interference
ERD	-	Emergency Response Division (Iraqi)
FEDPOL	-	Federal Police (Iraqi)
FLOT	-	Forward Line of Own Troops
FMV	-	Full-Motion Video
GLOC	-	Ground Lines of Communication
GMTI	-	Ground Moving Target Indicator
GRF	-	Global Response Force (US)
HA	-	Humanitarian Assistance
IADS	-	Integrated Air Defence System
IED	-	Improvised Explosive Device
ISF	-	Iraqi Security Forces
ISIL	-	Islamic State of Iraq and the Levant
ISR	-	Intelligence, Surveillance and Reconnaissance
ISRD	-	Intelligence, Surveillance and Reconnaissance Division
JOC	-	Joint Operations Centre
KAA	-	Ketab Allah Akbar (Syrian opposition force)
LOAC	-	Law of Armed Conflict
MERV	-	Middle Euphrates River Valley

The Royal Air Force in Operation Shader

MSO	-	Moderate Syrian Opposition
PED	-	Processing, Exploitation and Dissemination
PGM	-	Precision-Guided Munitions
PKK	-	Kurdistan Workers' Party
PMF	-	Popular Mobilisation Forces (Iraqi)
RPAS	-	Remotely Piloted Air System
RPG	-	Rocket-Propelled Grenade
ROE	-	Rules of Engagement
SAM	-	Surface-to-Air Missile
SAR	-	Synthetic Aperture Radar
SDF	-	Syrian Democratic Forces
SOF	-	Special Operations Forces
SOJTFHQ	-	Special Operations Joint Task Force Headquarters
TIW	-	Tactical Imagery Wing
TSO	-	Turkish Supported Opposition (Syrian)
UAS	-	Uncrewed Air Systems
UKACC	-	UK Air Component Commander
VBIED	-	Vehicle-Borne IED
VSO	-	Vetted Syrian Opposition

YPG - Peoples' Protection Units (Kurdish)

Notes

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